Industrial and Activity Zones and Economic Diversification: Evidence from Algeria with Comparative Insights from Saudi Arabia and Italy

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Abstract:

Economic diversification remains a central challenge for hydrocarbon-dependent economies, as growth patterns shaped by extractive industrial activities expose them to external shocks and persistent structural vulnerabilities. This study explores the integration of industrial and activity zones into urban areas as a strategy to foster economic diversification. It examines whether urban integration provides a conducive environment for SMEs and startups by activating inter-firm synergies and complementarities, strengthening the service sector, and reducing export concentration by redirecting industrial activities toward non-extractive activities. The empirical strategy follows a sequential analytical framework. Algeria constitutes the core case study, analyzed through correlation, cointegration and causality analysis. Subsequently, to assess robustness and external validity, the analysis is extended to Saudi Arabia as a structurally similar hydrocarbon-dependent economy and to Italy as a contrasting, highly diversified economy. The results show that urbanization and the expansion of the service sector (hallmarks of developed economies) exert a stronger influence on economic diversification than the industrial sector. Industrial development contributes to diversification only when it is redirected away from extractive dominance and embedded within urban ecosystems that foster strong synergies with the service sector. Overall, the findings indicate that, in less diversified economies, diversification primarily responds to coordinated and multidimensional structural dynamics rather than to isolated sectoral shocks.

Key words: Economic diversification; Urbanization; Industrial zones; Activity zones; Causality; Hydrocarbon-dependent economies.

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1. Introduction

A number of countries endowed with a wealth of natural resources rely heavily on a limited number of industries engaged in extraction activities, which makes their economies vulnerable to outside shocks and restricts growth prospects. The case of Algeria perfectly illustrates such structural vulnerability, as the hydrocarbon industry is still responsible for more than a half of GDP and fiscal revenues. Although oil and gas have always contributed to economic growth, dependence on these commodities has increased the economy's sensitivity to the fluctuations of the prices of energy on the world market.

In this context, Algerian authorities have introduced several measures aimed at developing their economy, including the establishment of industrial zones (IZ) and activity zones (AZ) across the country. The purpose of these zones is to create investment opportunities, promote local production, support small and medium enterprises (SMEs) and startups, as well as create jobs. However, besides their spatial aspect, IZ and AZ have also recently been seen as a potential means of inducing structural change if incorporated properly into urban areas, making use of agglomeration effects and labour pool advantages. Nonetheless, to what extent the incorporation of industrial and activity zones into urban environment can help with economic diversification is a question that is still under discussion.

It is essential for policymakers in resource-rich countries to comprehend the connection between industrial zones and the economic diversification of their economies, as economies that have diversified are more flexible and resilient (Esanov, 2012). While it is possible that industrial and activity zones (ZI and ZAC) can bring about this diversification, this depends largely on urban, institutional, and sectorial aspects of the larger picture, which have to be understood for inclusive development rather than enclave type of industrial activity. Nonetheless, even though there are already a number of studies on resource-rich nations (Amira & Alkama, 2021), the empirical evidence for the connection between urban integration of ZIs and ZACs and economic diversification in Algeria is very limited. Besides, it is worth mentioning that the previous studies seldom place Algerian context within the framework of international comparison, creating a gap in terms of whether this could be explained by the specificity of Algeria's case or it reflects some structural distinctions in economies based on hydrocarbons and diversified economies.

Against this backdrop, the present study pursues a twofold objective. First, it empirically examines the relationship between the integration of industrial and activity zones into urban

areas and economic diversification in Algeria, with particular attention to the roles of urbanization, industrial and service sectors, and entrepreneurial dynamics. Second, to enhance external validity and robustness, the analysis is extended to an international comparative setting by incorporating Saudi Arabia (a hydrocarbon-dependent economy as a structurally similar case to Algeria), and Italy (a highly diversified economy as a contrasting case serving as a benchmark). This comparative perspective allows us to assess whether the mechanisms observed in Algeria are specific to its institutional and economic context or consistent with more general patterns of structural transformation.

The central research question guiding this study is therefore: ***To what extent does the integration of industrial and activity zones into urban areas foster economic diversification, and how does this relationship differ between hydrocarbon-dependent and diversified economies?***

More specifically, the study tests the hypotheses that (**i**) whether the urban integration of ZI and ZAC supports economic diversification by providing a conducive environment for SMEs and startups, activating synergies and complementarities among firms, and fostering the expansion of the service sector; (**ii**) whether the industrial sector, in hydrocarbon-dependent economies, may reinforce exports concentration unless it is redirected towards non-extractive activities; (**iii**) whether urbanization and service-sector expansion exert a stronger and more consistent influence on economic diversification than industrial sector in hydrocarbon-dependent economies; and finally (**iiii**) whether diversification, in less diversified economies, responds mainly to coordinated and multidimensional structural dynamics rather than isolated sectoral shocks.

By addressing these hypotheses, the study contributes to the literature on economic diversification and urban development, while offering policy-relevant insights into how the spatial integration of industrial and activity zones can support structural transformation in resource-dependent economies.

Methodologically, the study adopts a quantitative approach based on correlation analysis, cointegration tests, and Granger causality techniques. Correlation analysis provides initial insights into the strength and direction of associations among variables, cointegration tests assess the existence of long-run equilibrium relationships, and causality tests (both pairwise and VAR-based) identify short-run dynamic interactions. Applied first to Algeria and subsequently extended to Saudi Arabia and Italy, this empirical strategy allows for a rigorous

assessment of country-specific dynamics as well as the external validity and robustness of the findings across contrasting economic structures.

2. Literature review

The integration of industrial and activity zones into urban areas is a widely adopted strategy to foster economic development and diversification. Industrial zones, typically located on the outskirts of cities, provide crucial infrastructure and logistical support to businesses, while activity zones offer a diverse range of commercial and service-oriented activities. Scholars, such as Krugman & Venables (1996), assert that integrating economies through specialization in production and trade can yield greater efficiency, heightened productivity, and increased incomes. Additionally, the reorganization of industrial zones within urban areas holds the potential to contribute to the sustainable development of cities (Baranova et al., 2021) and help address the challenges associated with underdevelopment (Santos, 1974).

Algeria, like many other developing countries, faces challenges related to economic diversification. Bouklia-Hassane (2013) argues that despite the considerable efforts to diversify its economy, Algeria remains heavily dependent on hydrocarbons. This excessive reliance on a single sector makes the country vulnerable to fluctuations in global oil prices and limits opportunities for growth and development in other sectors. To address this issue, Cavatorta & Tahchi (2019) suggest that the government should focus on policies that promote economic diversification, including investments in infrastructure and the promotion of non-oil sectors. The integration of industrial and activity zones into urban areas could be an important component of these policies, as it can facilitate the growth of a range of industries and help diversify the economy. Djemaci et al. (2016) found that the location of industrial activities in Algeria is influenced by a series of factors, including access to transportation infrastructure, the availability of labor, and proximity to markets.

Consequently, the integration of industrial and activity zones into urban environments has the potential to address various challenges, including the issue of bedroom communities[1], lowering transportation costs, and preserving agricultural land in rural areas.

Overall, the relationship between urbanization and economic development has been extensively documented. Urbanization is widely recognized as both a driver and a

[1] Please note that the phenomenon of "bedroom communities" is also commonly referred to as "commuter towns" or "dormitory towns".

consequence of economic growth (Hanlon & Heblich, 2022). (Polèse & Shearmur (2005) argue that high levels of urbanization are systematically associated with higher income levels, and that no country has achieved sustained prosperity without significant urban concentration. Attempts to restrain urbanization have generally failed or only delayed an otherwise inevitable process. From this perspective, integrating industrial and activity zones into urban fabrics appears less as a policy choice than as an adaptive response to market forces, potentially enhancing inter-firm coordination and sectoral complementarities.

3. Methodology and Data

This study investigates the integration of industrial (ZI) and activity zones (ZAC) within urban areas as a strategic approach to mitigate Algeria's heavy reliance on hydrocarbons and foster economic diversification. By leveraging urban centers which offer the skilled labor, infrastructure, and networks necessary to support SMEs, startups, and service-sector growth this integration aims to cultivate a more resilient economic environment. To evaluate these dynamics, the research employs a robust empirical framework utilizing correlation, cointegration, and causality analyses (including pairwise Granger and VAR Granger Causality/Block Exogeneity Wald tests) to systematically capture both static associations and dynamic, long-term interdependencies in time-series data. Using Algeria as the primary case study, the research also incorporates an international robustness analysis in its later stages to validate the stability of the empirical findings and offer a broader, comparative perspective on the global mechanisms driving economic diversification.

3.1.Measuring Economic Diversification

To measure economic diversification, UNCTAD proposes two key metrics: the Herfindahl-Hirschman Index (HHI) [2], which measures export concentration where values close to 1 indicate low diversification (such as Algeria's reliance on hydrocarbons) and values close to 0 signal high diversification, and the modified Finger-Kreinin Index, which compares a country's export structure with global trade patterns (Finger & Kreinin, 1979). In this study, the HHI is selected as the most suitable metric because it directly captures export product concentration, making it ideal for evaluating Algeria’s reliance on a narrow range of exports. By tracking changes in export concentration, the HHI allows this research to quantify how

[2] Known as the HHI of products, this index indicates the degree of concentration of a country's exports in relation to the products it exports. It has been normalized to obtain values ranging from 0 to 1. A value close to 1 indicates that a country's exports are highly concentrated on a few products. Conversely, values close to 0 reflect a more even distribution of shares among products. Please see: UNCTAD stat, https://unctadstat.unctad.org/datacentre/dataviewer/metadata/dimension/US.ConcentDiversIndices/indicator (consulted in October 2024).

the urban integration of industrial and activity zones (ZI and ZAC) fosters entrepreneurship, SMEs, and startups, and how these internal policy shifts impact national diversification—making it far more appropriate than the Finger-Kreinin Index[3], which focuses on global comparisons rather than internal structural transformation.

3.2.Variables and Conceptual Framework

Building on this choice, the empirical analysis incorporates five key variables. In addition to the HHI, new business density (NBD) is used as a proxy for entrepreneurial activity, reflecting the role of SMEs and startups in fostering diversification. Sectoral structure is captured through the value added by industry (INDUST) and the value added by services (SERV), both expressed as percentages of GDP. These variables reflect the relative contribution of these two productive sectors to the economy.

Although industrial and activity zones are not directly observable in macroeconomic datasets, it is assumed that industrial value added (INDUST) indirectly captures the contribution of industrial zones (ZI), while service value added (SERV) reflects the role of activity zones (ZAC), which primarily support service-oriented activities. While this correspondence is not exact, it provides a reasonable approximation at the macroeconomic level.

Finally, urban population as a percentage of total population (URB) is included as an indicator of urbanization. Urbanization is expected to influence both entrepreneurship and sectoral dynamics by providing infrastructure, skilled labor, and agglomeration effects that may enhance the functioning of industrial and activity zones.

3.3.Data Sources and Coverage

The dataset for this analysis consists of variables sourced from both UNCTAD and the World Bank. Specifically, the Herfindahl-Hirschman Index (HHI) is retrieved from UNCTAD, while the other variables “urban population as a percentage of the total population (URB), percentages of value added by industry (INDUST), percentages of value added by services (SERV), and the new businesses density (NBD)” are obtained from the World Bank data.

The econometric analysis spans the period from 1995 to 2023; however, some values for three variables are unavailable for certain years within this timeframe. For NBD, data are

[3] For more information on this index, please see: UNCTAD stat, https://unctadstat.unctad.org/datacentre/dataviewer/metadata/dimension/US.ConcentDiversIndices/indicator (consulted in October 2024).

only available from 2006 to 2022, leaving gaps before 2006 and for the year 2023. Similarly, INDUST and SERV are available from 1999 to 2023, meaning data prior to 1999 are missing for these two variables.

3.4.Imputation of Missing Values

To ensure a balanced dataset and a uniform number of observations across all variables, missing values for NBD, INDUST, and SERV were imputed. This step was necessary to maintain consistency in the subsequent econometric analysis. The imputation was carried out using SPSS 27, applying a trend extrapolation method (as detailed in the table below) which extends observed trends backward and forward while preserving the general trajectory of each series. This method is deemed appropriate as it assumes a constant rate of change between known data points, preserving the underlying trend of the variables without introducing unrealistic volatility.

Table 1: Imputation of Missing Values Using Trend Extrapolation.

Result Variable	*Number of Missing Values Imputed*	*First Year of Non-Missing Data*	*Last Year of Non-Missing Data*	*Sample Size After Imputation*	*Sample Size Before Imputation*	*Function Used*
NBD_ext	12	2006	2022	29	17	TREND (NBD)
INDUST_ext	4	1999	2023	29	25	TREND (INDUST)
SERV_ext	4	1999	2023	29	25	TREND (SERV)

Source: Authors' calculations using SPSS 27

After imputation, the dataset for each variable was extended to cover the entire period from 1995 to 2023, resulting in 29 valid observations for all variables. This process preserves data continuity and ensures robust analysis while minimizing potential bias from missing values.

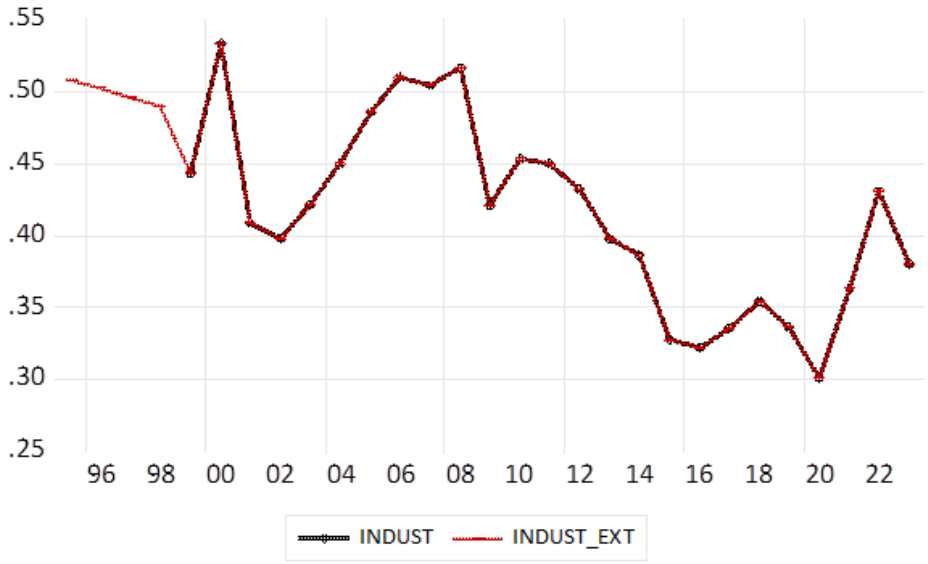
3.5.Validation of the Imputation Process

To assess the reliability of the imputed data, two complementary validation procedures were conducted. First, graphical comparisons between original and extended series were used to ensures that the imputed values follow the existing trends observed in the original data, aligning the imputed values closely with the general direction of each variable's series. The figures below (*1, 2 and 3*) illustrate the original data series alongside the imputed values for each of the three variables.[4] In each graph, the original series is represented by one color,

[4] Note that in Figures 1, 2, and 3, the horizontal axis represents the time dimension expressed in years (1995–2023). The vertical axis reports the values of each corresponding variable, expressed in their measurement units.

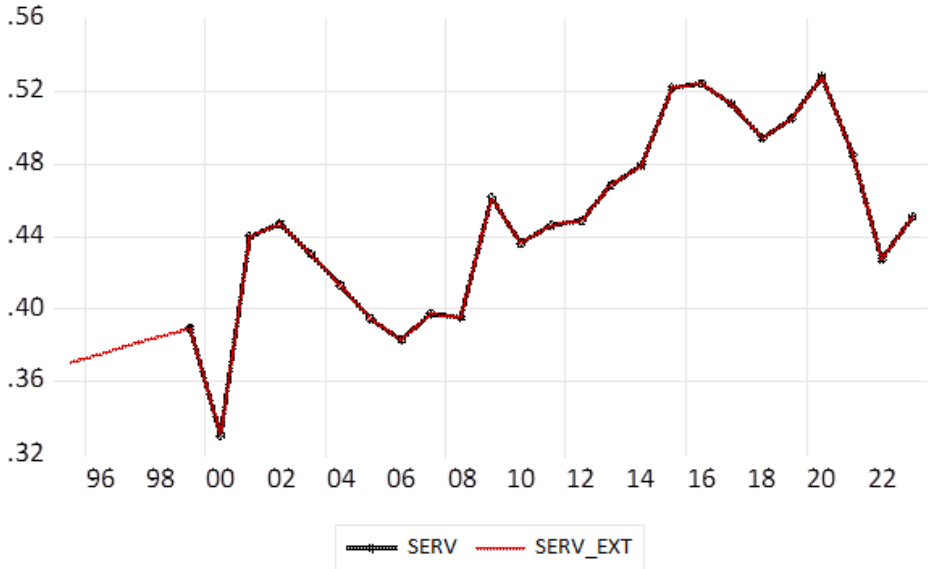
while the imputed values are shown in a contrasting color "*the series containing imputed values is marked with the suffix "_EXT" to distinguish it from the original series*":

Figure 1 : Trend Alignment for Industry Value Added (INDUST) Series with Imputed Values (1995–2023)



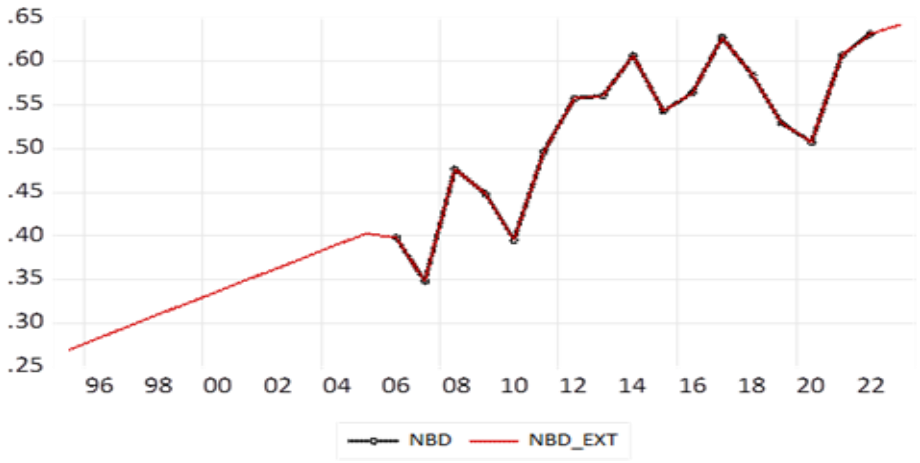
Source: Authors' calculations using Eviews 13

Figure 2 : Trend Alignment for Services Value Added (SERV) Series with Imputed Values (1995–2023)



Source: Authors' calculations using Eviews 13

Figure 3 : Trend Alignment for New Business Density (NBD) Series with Imputed Values (1995–2023)



Source: Authors' calculations using Eviews 13

This visual comparison demonstrates how well the imputed values align with the overall trends of the original data, thereby confirming the reliability of the imputation.

This analysis includes not only the imputed variables but also the two variables that did not require imputation, providing a holistic view of the dataset's characteristics. The results are presented in the following table:

Table 2: Descriptive Statistics Before and After Imputation

Statistic	*HHI*	*URB*	*NBD*		*INDUST*		*SERV*	
	(No Imputation)	*(No Imputation)*	*(Before)*	*(After)*	*(Before)*	*(After)*	*(Before)*	*(After)*
Mean	0,52	0,66	0,52	0,46	0,41	0,43	0,45	0,44
Median	0,52	0,67	0,54	0,45	0,42	0,43	0,45	0,44
Maximum	0,60	0,75	0,63	0,64	0,53	0,53	0,53	0,53
Minimum	0,46	0,56	0,35	0,27	0,30	0,30	0,33	0,33
Std. Dev.	0,04	0,06	0,09	0,12	0,07	0,07	0,05	0,05
Skewness	0,49	-0,17	-0,60	0,06	0,09	-0,17	-0,21	0,06
Kurtosis	2,35	1,78	2,32	1,59	2,11	1,90	2,51	2,09
Jarque-Bera	1,68	1,94	1,34	2,42	0,86	1,61	0,43	1,02
Probability	0,43	0,38	0,51	0,30	0,65	0,45	0,80	0,60
Sum	15,12	19,25	8,88	13,23	10,35	12,34	11,21	12,72
Sum Sq. Dev.	0,05	0,10	0,12	0,40	0,10	0,13	0,06	0,08
N	**29**	**29**	**17**	**29**	**25**	**29**	**25**	**29**

Source: Authors' calculations using Eviews 13

The descriptive statistics reveal important insights into the quality of the imputation process, particularly for the three variables that underwent imputation: NBD, INDUST, and SERV. For NBD, the mean decreased slightly from 0.522 to 0.456 after imputation, while the standard deviation increased from 0.085 to 0.120, indicating a wider dispersion of values. This suggests that the imputed values introduced greater variability, reflecting the effect of filling in missing data. The skewness of NBD shifted from -0.599 (left-skewed) to 0.065 (nearly symmetric), suggesting a more evenly distributed dataset. Similarly, the kurtosis decreased from 2.322 to 1.592, reflecting a flatter distribution with fewer extreme values.

For INDUST, the mean increased slightly from 0.414 to 0.426, while the standard deviation remained relatively stable, rising only from 0.065 to 0.067. This stability suggests that the imputation process preserved the central tendency and variability of the original data. The skewness of INDUST changed from 0.088 to -0.174, indicating a shift toward a nearly symmetric distribution with a slight leftward tendency. The kurtosis also decreased from 2.107 to 1.899, confirming that the imputation did not introduce significant distortions in the distribution.

For SERV, the mean showed a slight decrease from 0.448 to 0.439, while the standard deviation increased marginally from 0.051 to 0.053. These minor changes suggest that the imputation process had a limited impact on the overall distribution of the variable. The skewness of SERV shifted from -0.209 to 0.063, indicating a move toward symmetry, while the kurtosis decreased from 2.508 to 2.090, reflecting a reduction in the concentration of extreme values.

Overall, the comparison of descriptive statistics before and after imputation demonstrates that the imputation process successfully preserved the essential characteristics of the original data. While minor variations are observed in the mean, standard deviation, skewness, and kurtosis, these changes remain within acceptable limits and do not distort the underlying trends. The results of the Jarque-Bera test indicate that the overall distributional properties of the imputed variables remain reasonably stable. These findings confirm the reliability of the imputation method and provide a solid foundation for the subsequent econometric analysis.

3.6.Descriptive Overview and Recent Economic Structure

A snapshot of the latest values for the five variables in 2023 provides a contextual baseline for the subsequent dynamic analysis: HHI (0.46), URB (0.75), NBD (0.64), INDUST (0.38), and SERV (0.45). Together, these indicators offer an overview of Algeria's economic

structure in 2023 and provide critical insights into the country's diversification efforts, sectoral contributions, and urbanization trends. Interpreted within the context of their definitions and roles in this study.

- Herfindahl-Hirschman Index (HHI):

The HHI value of 0.46 reflects a moderate level of export concentration, indicating that Algeria's economy remains reliant on a limited number of products, primarily hydrocarbons. While this value suggests some progress toward diversification compared to higher historical levels, it still underscores the structural vulnerability of the economy to fluctuations in global energy markets. This highlights the pressing need for policies that promote non-hydrocarbon sectors, such as manufacturing, agriculture, and high-value-added services to foster sustainable economic diversification.

- Urbanization Rate (URB):

With 75% of the population residing in urban areas, Algeria's high urbanization rate underscores the central role of cities as engines of economic activity. Urbanization is typically associated with increased demand for services, infrastructure development, and industrial output, all of which can drive economic growth. However, this concentration is contingent upon an optimal level of urban concentration, beyond which congestion, urban overcrowding and efficiency losses may arise (Polèse & Shearmur, 2009). The integration of industrial zones (ZI) and activity zones (ZAC) into urban areas is likely to play a critical role in shaping the economic landscape, as these zones contribute to both industrial and service sector activities. Policymakers must ensure that urbanization is managed sustainably to maximize its economic benefits while addressing potential social and environmental costs.

- Density of New Businesses (NBD):

The NBD value of 0.64 reflects a relatively high density of new businesses, indicating a dynamic entrepreneurial environment in 2023. This suggests that Algeria is making progress in fostering entrepreneurship, likely driven by recent government initiatives aimed at promoting startups and SMEs. Key measures include the facilitation of business creation, the introduction of a simplified auto-entrepreneur status, tax incentives and exemptions for new businesses, the establishment of business incubators, and the implementation of the ministerial decree No. 1275 of September 27, 2022, which promotes the "One Degree, One Startup" policy. Additionally, efforts to develop industrial and activity zones, as well as the creation of micro-industrial zones, have provided conducive environments for economic activities. However, the variability observed in the descriptive statistics (high standard

deviation) suggests that entrepreneurial activity remains unevenly distributed across time and space. This disparity highlights the need for targeted policies to support entrepreneurship in lagging regions, ensuring that all areas benefit from economic opportunities. A robust entrepreneurial ecosystem is essential for driving innovation, creating jobs, and supporting economic diversification.

- Industrial Sector Contribution (INDUST):

The industrial sector's share of 38% in GDP reflects its continued significance in Algeria's economy, though its relative weight has declined slightly compared to previous years. This trend may be attributed to structural challenges, including a reliance on traditional industries, limited diversification within the sector, and global economic shifts affecting industrial output. To strengthen the industrial sector's role in economic growth, Algeria must invest in modernizing infrastructure, fostering technological innovation, and diversifying into high-value-added industries. Such measures would enhance industrial productivity, stimulate job creation, and reinforce the sector's contribution to economic resilience.

- Service Sector Contribution (SERV):

With a 45% share of GDP, the service sector has become an increasingly vital pillar of Algeria's economy, mirroring global trends toward service-oriented economic structures. This sector, often linked to activity zones (ZAC), plays a crucial role in economic transformation by creating employment opportunities and stimulating growth. The relatively low standard deviation (0.5) suggests that the sector's contribution to the economy is stable over time, reinforcing its reliability as an engine of economic expansion. To unlock its full potential, Algeria should prioritize the development of high value-added services, such as finance, technology, and education.

In line with the empirical findings of (Polèse & Shearmur, 2003), which emphasize that urban agglomerations function as hubs of innovation and intersectoral synergy, the integration of activity zones into urban areas can appears as a key mechanism to amplify service-sector development and strengthen the mutually reinforcing relationship between urbanization and economic diversification.

In summary, the 2023 indicators reveal both progress and persistent challenges in Algeria's economic structure. While urbanization and entrepreneurship are on the rise, the economy remains heavily concentrated in hydrocarbons. Strengthening industrial and service sector contributions, alongside sustainable urban planning and targeted support for SMEs, will be

crucial in driving long-term economic diversification and resilience. These insights lay the groundwork for an in-depth econometric investigation into the complex interplay between these factors.

Building on these findings, it is essential to explore further the relationship between the HHI, as an indicator of economic diversification, and the other variables. While the HHI reflects a moderate level of concentration, its slight positive skewness and limited dispersion suggest that diversification efforts in Algeria may face structural constraints or show only modest progress. To deepen this analysis, the study employs correlation, cointegration, and causality tests to examine the interactions between the integration of industrial and activity zones into urban areas and the diversification of the Algerian economy. This comprehensive approach will provide a clearer understanding of the extent and nature of this relationship, allowing for more robust conclusions and better-informed strategies for sustainable economic growth.

3.7.Empirical Strategy and Analytical Sequence

The empirical analysis follows a sequential three-step strategy for the Algerian case. First, correlation analysis is used to identify the strength and direction of linear associations between the variables, providing preliminary insights. Second, cointegration analysis is conducted using the Johansen approach after confirming the non-stationarity of the series and verifying that they share the same order of integration, $I(d)$, through Augmented Dickey–Fuller (ADF) unit root tests. This step aims to test the existence of a stable long-run equilibrium relationship among the variables, which would indicate the presence of common stochastic trends. Third, causality analysis is performed using pairwise Granger causality tests, followed by a VAR-based Block Exogeneity Wald test, to uncover short-run directional influences among the variables. This multi-method approach allows for a comprehensive understanding of both static associations and dynamic interdependencies.

These core analyses are conducted exclusively for Algeria, which serves as the main case study. To assess the robustness and broader relevance of the findings, the empirical strategy is subsequently extended through an international robustness analysis. This complementary step applies correlation and causality tests to two additional countries: Saudi Arabia, representing a hydrocarbon-dependent economy with structural similarities to Algeria, and Italy, representing a highly diversified economy. The objective is to evaluate whether the findings in the Algerian case are specific to local conditions or reflect more general structural patterns.

4. Results and Empirical Analysis: Evidence from Algeria

4.1.Correlation Analysis

The correlation analysis (*Table 3*) provides initial insights into the relationships between economic diversification, urbanization, entrepreneurship, and sectoral structure in Algeria.

Table 3: Results of the correlation test between the selected variables.

	HHI	*URB*	*NBD_EXT*	*INDUST_EXT*	*SERV_EXT*
HHI	1,00				
URB	-0,44	1,00			
NBD_EXT	-0,46	0,95	1,00		
INDUST_EXT	0,72	-0,73	-0,70	1,00	
SERV_EXT	-0,59	0,79	0,75	-0,96	1,00

Source: Authors' calculations using Eviews 13

The Herfindahl–Hirschman Index (HHI) exhibits a negative correlation with urbanization (–0.44), entrepreneurial activity measured by new business density (–0.46), and the service sector share (–0.59), indicating that higher levels of urban concentration, entrepreneurship, and service-sector development are associated with lower export concentration and, therefore, greater economic diversification. In contrast, the strong positive correlation between HHI and the industrial sector share (0.72) reflects Algeria's persistent dependence on hydrocarbon-related industries, which continue to reinforce export concentration rather than diversification.

Urbanization is strongly and positively correlated with entrepreneurial activity (0.95) and service-sector expansion (0.79), confirming that urban areas function as hubs for business creation and service-oriented growth. Conversely, the negative correlation between urbanization and the industrial sector (–0.73) suggests a structural shift in urban environments away from traditional industrial activities toward more flexible, service-based economic structures.

Entrepreneurial activity is negatively correlated with the industrial sector (–0.70) and positively associated with the service sector (0.75), reinforcing the idea that new business formation aligns more closely with service-oriented and innovation-driven activities than with traditional industrial production. Furthermore, the very strong negative correlation between the industrial and service sectors (–0.96) is logical and expected, as these variables represent shares of GDP; an increase in one sector's share naturally leads to a decline in the other, assuming other components of GDP remain constant.

Overall, the correlation results indicate that urbanization, entrepreneurship, and service-sector expansion are systematically associated with lower export concentration, while industrial activity (when dominated by extractive industries) remains a structural constraint on diversification. These findings suggest that the integration of industrial zones (ZI) and activity zones (ZAC) into urban environments can play a key role in fostering complementarities between industry and services. By embedding industrial activities within urban ecosystems that support entrepreneurship and service-sector linkages, such integration may help reconcile industrial development with diversification objectives. These preliminary associations provide a foundation for the subsequent econometric analysis, which investigates causality and long-run equilibrium relationships through Granger causality and cointegration tests.

4.2.Stationarity and Cointegration Analysis

Before conducting the co-integration test, it is essential to verify that all series are integrated of the same order, denoted as I(d). If a series is stationary at level I(0), it cannot be co-integrated with non-stationary series (Harris, 1995). To determine the order of integration, we applied the Augmented Dickey-Fuller (ADF) unit root test.

The process involved testing each variable at its level and, if non-stationary, at its first difference, as differencing is the appropriate transformation for difference-stationary (DS) processes, whereas trend-stationary (TS) processes require detrending using the ordinary least squares (OLS) method. For each variable, the most appropriate ADF model (with or without intercept and/or trend) was selected based on the significance of the coefficients, following the methodology outlined by Bourbonnais (2018).

Table 4: Summary of ADF Unit Root Tests and Model Selection

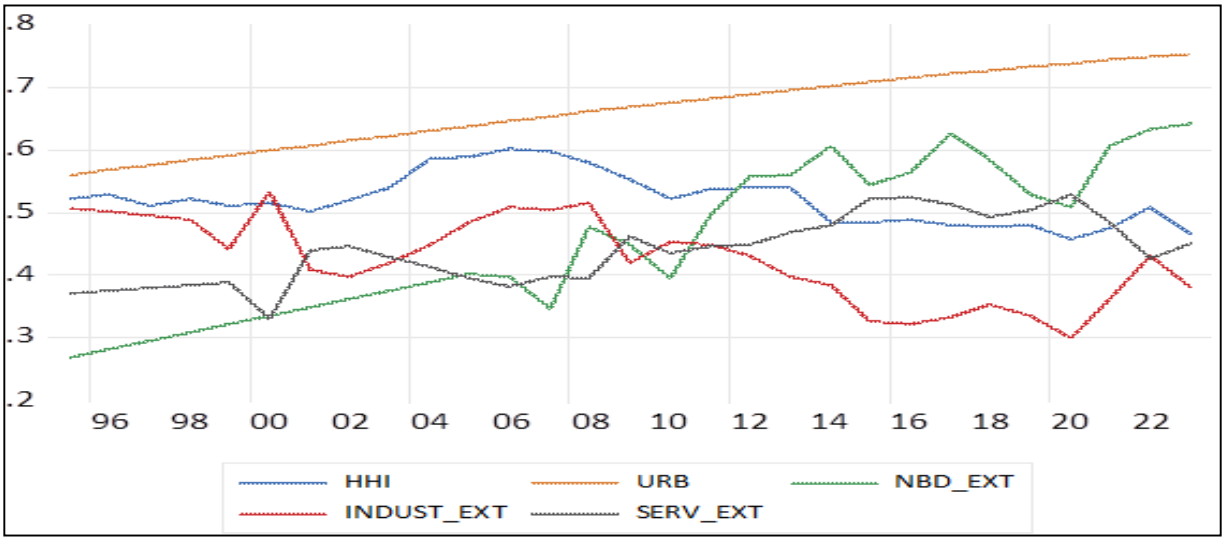
Variable	*Conclusive ADF Model (Level)*	*ADF Test (Level)*	*ADF Test (1st Difference)*	*Conclusion*
HHI	No Intercept and No Trend	Non-stationary	Stationary	I(1) - Difference Stationary (DS)
URB	With Intercept	Stationary (with constant) / Non-stationary (with trend)	Stationary	I(1) - Difference Stationary (DS)
NBD_EXT	With Intercept and Trend	Stationary (borderline)	Stationary	I(1) - Difference Stationary (DS)
INDUST_EXT	No Intercept and No Trend	Non-stationary	Stationary	I(1) - Difference Stationary (DS)
SERV_EXT	No Intercept and No Trend	Non-stationary	Stationary	I(1) - Difference Stationary (DS)

Source: Authors' calculations using Eviews 13

The results indicate that all variables were non-stationary at level but became stationary after first differencing, confirming that they are integrated of order one, I(1). These findings, summarized in Table 4, confirm that the conditions for co-integration analysis are met. This suggests the potential presence of a long-term equilibrium relationship among the variables, meaning they may move together in the long run and establish a stable, enduring relationship. If cointegration is confirmed, it would imply that despite short-term fluctuations, these variables share a common trend over time.

To further explore this possibility, it is advisable to begin by visualizing the graphs of all five series together. This graphical analysis will help assess whether the gaps between the series remain relatively constant over time, providing a preliminary understanding of their long-term relationship and behavior. Such visualization can offer valuable insights before proceeding with formal cointegration tests.

Figure 4: Temporal Behavior of the Five Series: Initial Evidence of Potential Cointegration



Source: Authors' calculations using Eviews 13

The graphical analysis reveals notable variations in the trajectories of the five series, making it difficult to determine whether their relative gaps remain stable over time. Although certain relationships appear visually suggestive, particularly between URB and SERV_EXT which exhibit periods of parallel movement, the presence of fluctuations and trend changes complicates the assessment of whether these series maintain a stable long-term relationship. The HHI and INDUST_EXT variables demonstrate particularly divergent behavior, while NBD_EXT exhibits intermittent convergence without sustained co-movement with other series.

Given this visual ambiguity, formal statistical tests become necessary. The results of the Johansen (1995) cointegration test are summarized in the table below.

Table 5: Summary of Johansen Cointegration Test Results

Hypothesized Number of Cointegrating Equations	Trace Statistic	5% Critical Value (Trace)	p-value (Trace)	Max-Eigenvalue Statistic	5% Critical Value (Max-Eigen)	p-value (Max-Eigen)
None	102.52	69.82	0.0000	35.63	33.88	0.0306
At most 1	66.89	47.86	0.0003	26.86	27.58	0.0617
At most 2	40.03	29.80	0.0024	21.72	21.13	0.0413
At most 3	18.31	15.49	0.0183	13.00	14.26	0.0784
At most 4	5.31	3.84	0.0212	5.31	3.84	0.0212

Source: Authors' calculations using Eviews 13

The Johansen cointegration test was applied to the five series (HHI, URB, NBD_EXT, INDUST_EXT, SERV_EXT) over the period 1995–2023 with one lag in first differences and a model including a constant in the cointegrating relationship. The Trace test rejects the null hypothesis of no cointegration across all levels up to "At most 4," indicating the presence of five cointegrating equations at the 5% significance level. In contrast, the Max-Eigenvalue test identifies only one cointegrating equation as significant at the 5% level. When faced with such divergence, greater weight is often given to the Trace test, especially when all series are integrated of the same order (I(1)).

Statistically, these results confirm that despite short-term fluctuations, the variables share a common long-term equilibrium relationship. In other words, even if deviations occur in the short run, the series tend to move together over time, converging to a stable stochastic trend.

Economically, the cointegration among HHI, URB, NBD_EXT, INDUST_EXT, and SERV_EXT implies that the underlying structure of the Algerian economy is interconnected. For instance, as urbanization (URB) and entrepreneurial activity (NBD_EXT) influence sectoral shifts (reflected in the changing shares of the industrial (INDUST_EXT) and service (SERV_EXT) sectors) the market concentration measured by HHI adjusts in the long run. This relationship underscores the potential impact of integrating industrial zones (ZI) and activity zones (ZAC) into urban areas, as such integration may balance sectoral dynamics and foster a more diversified and resilient economic structure.

Mathematically, one can express the first cointegrating equation (normalized on HHI) as follows:

$$HHI = \beta1 \cdot URB + \beta2 \cdot NBD\_EXT + \beta3 \cdot INDUST\_EXT + \beta4 \cdot SERV\_EXT + \epsilon$$

where the coefficients (β1, β2, β3, β4) reflect the long-term relationships among the variables. Although the exact numerical values depend on the normalization and estimation method, the significant cointegrating relationship suggests that policy measures aimed at promoting urban integration and supporting the service sector could help reduce the economy's dependence on traditional industrial (hydrocarbon) sectors.

In summary, the cointegration analysis provides robust evidence of long-term equilibrium relationships among the five variables. This insight lays the groundwork for further analysis (such as examining adjustment speeds and causality analysis) which will be essential for developing effective policies to promote sustainable economic diversification in Algeria.

4.3. Causality Analysis

To complement the previous correlation and cointegration analyses, a causality analysis is conducted to explore short-term interactions using Granger causality tests. The approach includes, first, pairwise Granger causality tests to assess the directionality of relationships among the variables, followed by the VAR-based Block Exogeneity test to determine whether changes in the selected explanatory variables can predict changes in economic diversification, as proxied by the Herfindahl-Hirschman Index (HHI).

The following table summarizes the results of the pairwise Granger causality tests, which were conducted with two lags over the period 1995–2023:

Table 6: Results of Pairwise Granger Causality Tests

Pairwise Granger Causality Tests				
Sample: 1995 2023				
Lags: 2				
Null Hypothesis: Null hypothesis: variable X does not Granger-cause variable Y	Obs	F-Statistic	Prob.	Causality Conclusion
URB does not Granger Cause HHI	27	3.13008	0.0636	Causality moderately accepted (10%)
HHI does not Granger Cause URB		0.55687	0.5809	No causality
NBD_EXT does not Granger Cause HHI	27	1.85166	0.1806	No causality
HHI does not Granger Cause NBD_EXT		0.18519	0.8322	No causality
INDUST_EXT does not Granger Cause HHI	27	0.06857	0.9339	No causality
HHI does not Granger Cause INDUST_EXT		1.50589	0.2438	No causality
SERV_EXT does not Granger Cause HHI	27	0.02115	0.9791	No causality
HHI does not Granger Cause SERV_EXT		1.03590	0.3716	No causality
NBD_EXT does not Granger Cause URB	27	0.25327	0.7785	No causality

URB does not Granger Cause NBD_EXT		5.80914	0.0094	Causality accepted (5%)
INDUST_EXT does not Granger Cause URB	27	0.01706	0.9831	No causality
URB does not Granger Cause INDUST_EXT		1.28852	0.2957	No causality
SERV_EXT does not Granger Cause URB	27	0.03495	0.9657	No causality
URB does not Granger Cause SERV_EXT		1.57252	0.2300	No causality
INDUST_EXT does not Granger Cause NBD_EXT	27	0.54918	0.5851	No causality
NBD_EXT does not Granger Cause INDUST_EXT		2.93676	0.0741	Causality moderately accepted (10%)
SERV_EXT does not Granger Cause NBD_EXT	27	1.31313	0.2892	No causality
NBD_EXT does not Granger Cause SERV_EXT		3.68251	0.0417	Causality accepted (5%)
SERV_EXT does not Granger Cause INDUST_EXT	27	1.31910	0.2877	No causality
INDUST_EXT does not Granger Cause SERV_EXT		2.23081	0.1312	No causality

Source: Authors' calculations using Eviews 13

The pairwise analysis reveals several noteworthy short-run relationships. Most notably, a strong causal relationship from URB to NBD_EXT (p = 0.0094), pointing to the role of urbanization in stimulating new business creation, and from NBD_EXT to SERV_EXT (p = 0.0417), highlighting how entrepreneurial dynamics can support service sector development.

In contrast, HHI does not exhibit significant short-run causality with any other variable in pairwise settings (whether as a cause or a result), except urbanization (URB) Granger-causes HHI with a p-value of 0.0636. This causality moderately accepted may reflect the fact that structural diversification requires a longer timeframe or is influenced by broader macroeconomic dynamics rather than isolated changes. Although only significant at the 10% level, the relationship from URB to HHI suggests a potential influence of demographic and spatial dynamics on economic concentration. It implies that changes in the urban population may precede structural shifts in sectoral diversification, possibly by shaping labor markets, infrastructure needs, or patterns of investment in industrial and activity zones.

Another meaningful result at the 10% level is the causality from NBD_EXT to INDUST_EXT (p = 0.0741), which may indicate that entrepreneurial activity gradually contributes to industrial expansion, even if this effect is less immediate than that observed for services.

These findings are consistent with the earlier correlation results, where the strongest associations were observed between urbanization and service-related variables, and with the cointegration analysis, which emphasized long-term equilibrium relationships over short-term causality. Together, the results suggest that while structural transformation is primarily

a long-term process, some short-run signals (especially those linked to urban dynamics) can offer valuable insights into the mechanisms of diversification.

To further explore the directionality and robustness of causal linkages, the VAR Granger Causality/Block Exogeneity Wald test was conducted, focusing specifically on HHI as the dependent variable, given its central role in this study on economic diversification and the integration of industrial and activity zones (ZI and ZAC) in urban areas. The following table presents the results for the HHI equation.

Table 7: VAR Granger Causality / Block Exogeneity Wald Test Results

VAR Granger Causality/Block Exogeneity Wald Tests				
Sample: 1995 2023				
Included observations: 27				
Dependent variable: HHI				
Excluded	**Chi-sq**	**df**	**Prob.**	**Causality Result**
INDUST_EXT	5.274	2	0.0716	Causality moderately accepted (10%)
NBD_EXT	4.676	2	0.0965	Causality moderately accepted (10%)
SERV_EXT	0.513	2	0.7737	No causality
URB	2.168	2	0.3382	No causality
All variables jointly	**21.820**	**8**	**0.0053**	**Joint causality accepted (1%)**

Source: Authors' calculations using Eviews 13

While no individual variable appears to Granger-cause HHI at conventional levels of significance, the joint test confirms that the group of variables (taken together) has a statistically significant influence on HHI ($p = 0.0053$). This result underscores the importance of multi-dimensional forces in shaping the structure of economic diversification. INDUST_EXT stands out with borderline significance ($p = 0.0716$), suggesting a potentially meaningful role for the industrial sector in influencing market concentration. These results reinforce the insights from the cointegration analysis, where HHI was shown to share long-term relationships with the other variables. The Block Exogeneity test highlights that, even in the short run, collective dynamics exert a measurable influence, even if individual effects remain hidden in isolation. Thus, the causality tests provide additional empirical support to earlier findings by confirming the following:

- Urbanization and entrepreneurship are strongly interlinked in the short run, and the growth of services is partly driven by entrepreneurial activity.
- HHI does not respond to isolated short-run shocks but is influenced by the combined behavior of demographic, entrepreneurial, and structural forces.

- The joint significance of all variables in the VAR model implies that economic diversification is a systemic phenomenon, requiring coordinated interventions rather than isolated measures.

5. Robustness and External Validity: Comparative Evidence from Saudi Arabia and Italy

To assess the robustness and external validity of the Algerian findings, the empirical analysis is extended to two benchmark cases: Saudi Arabia and Italy. Saudi Arabia represents a structurally comparable hydrocarbon-dependent economy, where diversification efforts coexist with persistent resource dependence (Albassam, 2015), while Italy serves as a contrasting case of a highly diversified economy with a mature urban–sectoral structure (Bruckner, 2023). Examining these two cases jointly allows us to distinguish structural patterns associated with rentier versus diversified economies.

Methodologically, this robustness exercise focuses on correlation and causality analyses to ensure consistency with the core empirical framework while avoiding excessive model complexity. The results are interpreted comparatively with those of Algeria, providing deeper insights into the structural conditions under which the integration of industrial and activity zones into urban environments may support economic diversification.

5.1.Correlation Analysis (Saudi Arabia and Italy)

The following table reports the correlation matrices for Saudi Arabia and Italy over the period 1995–2023:

Table 8: Correlation Matrices for Saudi Arabia and Italy

Variable	**HHI**	**URB**	**NBD**	**INDUST**	**SERV**	**FUEL_EXPORT**
Saudi Arabia (KSA)[5]						
HHI_KSA	1.00					
URB_KSA	-0.80	1.00				
NBD_KSA[6]	-0.73	0.94	1.00			
INDUST_KSA	0.91	-0.79	-0.63	1.00		
SERV_KSA	-0.85	0.72	0.54	-0.99	1.00	
FUEL_EXPORT_KSA[7]	0.93	-0.86	-0.74	0.97	-0.93	1.00

[5] For Saudi Arabia, the analysis incorporates, in addition to the five core variables, (FUEL_EXPORT_KSA) in order to explicitly account for the structuring role of hydrocarbons in the economy.
[6] Given the strictly positive nature of the new business density variable, missing observations were imputed using a log-linear trend extrapolation based on the observed period, ensuring positivity of the extended series.
[7] Missing observations for fuel exports, a bounded proportion, were imputed using a logit-based trend extrapolation, preserving consistency within the [0,1] interval.

Italy (ITA)[8]					
HHI_ITA	1.00				
URB_ITA	0.20	1.00			
INDUST_ITA	0.21	-0.81	-	1.00	
SERV_ITA	0.11	0.96	-	-0.82	1.00

Source: Authors' calculations using Eviews 13

The correlation structure for Saudi Arabia closely mirrors that observed for Algeria. Market concentration (HHI) is strongly and positively correlated with industrial activity and fuel exports, and strongly negatively correlated with urbanization, entrepreneurship, and services. This configuration confirms that, in hydrocarbon-dependent economies, industrial expansion (when dominated by extractive activities) reinforces concentration rather than diversification. Urbanization emerges as a central organizing force, strongly associated with entrepreneurship and services, and negatively related to both industry and fuel exports. Finally, the near-perfect negative correlation between INDUST_KSA and SERV_KSA (-0.99) reveals a pronounced structural trade-off between industry and services. This suggests that, in the Saudi context, industrial expansion (largely driven by hydrocarbons) tends to crowd out service-sector development, and vice versa, unless deliberate policies promote complementarities between the two sectors.

By contrast, the Italian correlation matrix displays a markedly different pattern. Correlations between HHI and the other variables are weak, indicating that market concentration in a highly diversified economy is largely decoupled from short-run sectoral or demographic fluctuations. Urbanization is strongly and positively correlated with services and negatively correlated with industry, reflecting a mature service-oriented urban structure typical of advanced economies. While the negative industry–services correlation persists, it is largely mechanical and no longer associated with concentration dynamics.

Taken together, these results suggest that strong negative links between services, urbanization, and concentration are a structural feature of rentier economies, whereas in diversified economies such relationships weaken once diversification has been largely achieved.

[8] For Italy, the analysis is limited to HHI, URB, INDUST, and SERV. Fuel exports are excluded due to their limited relevance in a diversified economy, while (NBD) is omitted because its markedly different scale (1.5–3, compared to 0–1 for Algeria and Saudi Arabia) reflects a distinct entrepreneurial environment, which could compromise cross-country coherence and comparability.

5.2.Causality Analysis (Saudi Arabia and Italy)

To investigate the dynamic dimension of these relationships, causality analysis is conducted using pairwise Granger causality tests and VAR-based Block Exogeneity Wald tests, maintaining methodological consistency with the Algerian case. Optimal lag lengths for the VAR models are selected using standard information criteria, including the Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn (HQ) criterion. The table below, presents the lag order selection criteria for the VAR models in Saudi Arabia and Italy. The selected lag order for each country is indicated by an asterisk (*). In cases of discrepancy among the criteria, the AIC is prioritized as it tends to select more parsimonious models and avoid under-specification (Bruns & Stern, 2019).

Table 9: VAR Lag Order Selection Criteria

Lag	Saudi Arabia (KSA)			Italy (ITA)		
	AIC	SC	HQ	AIC	SC	HQ
1	-37.82	-36.08	-37.32	-35.66	**-34.70***	-35.39
2	-42.68	-39.19	-41.67	-36.14	-34.40	-35.64
3	**-47.23***	**-42.00***	**-45.72***	**-36.68***	-34.16	**-35.95***

Source: Authors' calculations using Eviews 13

5.2.1. Pairwise Granger Causality

The pairwise Granger causality results (Table 10) reveal limited direct short-run causal effects on economic diversification in both countries, albeit for different structural reasons.

Table 10:Significant Pairwise Granger Causality Relationships

	Saudi Arabia (KSA)		Italy (ITA)	
Causal Relationship Direction	***F-Statistic***	***Prob.***	***F-Statistic***	***Prob.***
HHI → SERV	2.52	0.089*	-	-
URB → HHI	-	-	4.09	0.021**
INDUST → HHI	-	-	3.26	0.044**
SERV → HHI	-	-	2.95	0.059*
URB → FUEL_EXPORT	24.11	0.000***	n/a	n/a
NBD → FUEL_EXPORT	20.76	0.000***	n/a	n/a
SERV → FUEL_EXPORT	6.06	0.004***	n/a	n/a
INDUST → FUEL_EXPORT	3.89	0.025**	n/a	n/a
URB → SERV	-	-	5.38	0.008***
SERV → URB	-	-	3.39	0.039**

*Notes: ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Only relationships significant at the 10% level are shown. "n/a" indicates the variable is not included in the analysis for that country.

Source: Authors' calculations using Eviews 13

This comparative presentation reveals the starkly different short-run dynamics at play. For Saudi Arabia, causality is intensely focused on the fuel export variable, with strong flows from urbanization, entrepreneurship, and both industrial and service sectors. This indicates domestic structural changes are a key short-term driver of hydrocarbon dependency. However, a weak feedback from HHI to the service sector is observed, which suggests that in Saudi Arabia, diversification (HHI) does not respond significantly to isolated short-run shocks from urbanization, entrepreneurship, or sectoral variables.

Conversely, in Italy, the causality network is centered on market concentration (HHI) itself. Urbanization, industry, and services all show significant causal influence on the diversification index. Furthermore, a strong bidirectional causality between urbanization and the service sector, illustrating a mature, reinforcing synergy characteristic of a diversified, advanced economy. These patterns suggest that, once diversification is structurally embedded, sectoral dynamics can influence diversification outcomes more directly.

5.2.2. Block Causality (VAR) Analysis

The Block Exogeneity Wald tests provide a systemic perspective on diversification dynamics. The results, are presented in the table below:

Table 11: VAR Granger Causality/Block Exogeneity Wald Tests

	Saudi Arabia (KSA)			Italy (ITA)		
	Dependent variable: HHI					
Excluded Variable	**Chi-sq**	**Prob.**	**Inference**	**Chi-sq**	**Prob.**	**Inference**
URB	7.88	0.0485	**Reject H_0 (5%)**	0.74	0.6922	Do not reject H_0
NBD	7.62	0.0545	**Reject H_0 (10%)**	n/a	n/a	Not included
INDUST	8.69	0.0337	**Reject H_0 (5%)**	8.79	0.0123	**Reject H_0 (5%)**
SERV	8.29	0.0404	**Reject H_0 (5%)**	3.03	0.2198	Do not reject H_0
FUEL_EXPORT	8.43	0.0380	**Reject H_0 (5%)**	n/a	n/a	Not included
ALL	**31.18**	**0.0083**	**Reject H_0 (1%)**	**16.04**	**0.0135**	**Reject H_0 (5%)**

Source: Authors' calculations using Eviews 13

For Saudi Arabia, the joint null hypothesis of no causality is strongly rejected, indicating that diversification outcomes are driven by the combined interaction of urbanization, entrepreneurship, industry, services, and fuel exports. Individually, hydrocarbons and industrial activity play a dominant role, underscoring the structural embeddedness of resource dependence.

In Italy, while individual causal effects are more selective, the joint significance of all variables is also strongly confirmed. This result highlights that even in a highly diversified economy, diversification dynamics remain systemic rather than the outcome of isolated sectoral impulses.

5.3.Comparison with Algeria and Key Insights

When jointly compared with Algeria, several robust conclusions emerge. First, in hydrocarbon-dependent economies (Algeria and Saudi Arabia), diversification does not respond to isolated short-run shocks. Instead, it reflects a slow, multidimensional process shaped by the joint interaction of urbanization, entrepreneurship, sectoral structure, and resource dependence. In both cases, industrial activity reinforces concentration unless it is embedded within urban ecosystems that foster service-sector development and entrepreneurial synergies.

Second, the Italian case illustrates a contrasting equilibrium in which diversification is largely achieved, weakening the direct link between sectoral composition and concentration. Nevertheless, block causality results confirm that diversification remains a systemic outcome, even in advanced economies.

Overall, these findings strengthen the external validity of the Algerian results and confirm the study's central argument: the effectiveness of integrating industrial zones (ZI) and activity zones (ZAC) into urban environments depends on coordinated, cross-sectoral dynamics rather than standalone sectoral expansion. This comparative evidence reinforces the view that economic diversification is fundamentally an urban-embedded and structurally systemic process.

6. Discussion

This study set out to examine how the integration of industrial zones (ZI) and activity zones (ZAC) into urban areas may foster economic diversification, using Algeria as the core case and extending the analysis through an international robustness framework involving Saudi Arabia and Italy. The discussion follows the analytical sequence adopted in the empirical sections, moving from the Algerian case to the comparative international insights, and finally to broader theoretical and policy implications.

6.1. Core Findings from the Algerian Case

The Algerian results reveal a consistent and coherent pattern across correlation, cointegration, and causality analyses. The correlation matrix highlights strong negative associations

between economic concentration (HHI) and both urbanization (URB) and service-sector activity (SERV_EXT), while a strong positive correlation persists between HHI and industrial activity (INDUST_EXT). This configuration reflects a structural duality: urbanization and services appear as diversification-enhancing forces, whereas industry (largely hydrocarbon-based) continues to reinforce market concentration.

The cointegration analysis confirms that these relationships are not transitory. The existence of a stable long-run equilibrium, together with the magnitude of the normalized coefficients, underscores the pivotal role of the service sector in reducing concentration over time. In contrast, industrial activity exerts an opposite long-run effect, consistent with the hydrocarbon-dependent nature of Algerian industry.

Short-run causality results further refine this picture. Pairwise Granger tests identify urbanization as a key driver of entrepreneurial dynamics (URB → NBD_EXT) and, indirectly, of service-sector expansion (NBD_EXT → SERV_EXT). Economic diversification itself (HHI) does not respond to isolated short-run shocks, except marginally to urbanization, suggesting that structural transformation is not an automatic or instantaneous outcome. The VAR block exogeneity results reinforce this interpretation by showing that diversification responds to the joint behavior of urban, entrepreneurial, and sectoral forces rather than to any single variable in isolation.

Taken together, these findings suggest that in Algeria, diversification emerges as a cumulative and systemic process. The integration of ZI and ZAC into urban environments becomes critical in this context, as it provides the spatial and organizational framework through which urbanization can translate into entrepreneurship, service expansion, and eventually reduced concentration. This interpretation resonates with Traki & Boukrif (2022), who note that organizational proximity in Algeria remains largely inactive due to the weak integration of industrial zones into urban and inter-firm coordination networks.

6.2. International Robustness: Similarities and Contrasts

The robustness analysis provides important external validation. Saudi Arabia, as a structurally similar hydrocarbon-dependent economy, exhibits correlation and causality patterns that largely mirror those of Algeria. In both cases, fuel exports are closely intertwined with industrial activity and market concentration, while urbanization and services play more ambiguous or indirect roles in the short run. Notably, causality results show that nearly all structural variables Granger-cause fuel exports in Saudi Arabia, underscoring the continued

centrality of hydrocarbons in shaping economic dynamics. This reinforces the interpretation that without a clear reorientation of industrial and urban policies, industrial activity may perpetuate concentration rather than alleviate it.

By contrast, the Italian case represents a structurally diversified economy and offers a benchmark for comparison. Correlation results reveal weak links between HHI and sectoral or demographic variables, indicating that diversification has already been largely achieved and decoupled from short-term fluctuations. Strong positive correlations between urbanization and services, alongside negative correlations between industry and services, reflect a mature structural transformation. Causality analyses further show that sectoral and urban dynamics exert more immediate short-run effects on diversification, while block causality confirms the systemic nature of diversification even in advanced economies.

This contrast highlights a key insight: in less diversified, hydrocarbon-dependent economies, diversification tends to be slow, indirect, and highly contingent on coordinated structural transformations, whereas in diversified economies similar mechanisms operate more efficiently and with more immediate effects. Algeria's trajectory occupies an intermediate position, exhibiting relatively greater progress than Saudi Arabia but remaining well below the Italian benchmark, and even below Saudi Arabia in certain structural dimensions. This assessment is consistent with Medjdoub (2022), who argues that although Algeria has achieved an acceptable level of progress toward diversification, such advances remain insufficient and structurally constrained by the persistent predominance of extractive industries.

6.3. Urbanization, ZI–ZAC Integration, and Economic Theory

The central role of urbanization observed across cases aligns strongly with the international literature. Hanlon & Heblich (2022) emphasize urbanization as a core indicator and driver of economic growth, while Polèse & Shearmur (2005) argue that urbanization is an inevitable consequence of economic development. Their empirical observation *that no country combines high income (GNP) levels with low urbanization*, helps contextualize the Algerian findings: urban growth is not a policy anomaly but a structural necessity.

Historical attempts to curb or regulate urbanization, particularly by limiting rural–urban migration, have largely failed or produced only temporary effects. From this perspective, integrating ZI and ZAC into urban areas is not merely a planning choice but a natural adaptation to market forces and development dynamics. Properly integrated zones facilitate

proximity, coordination, and knowledge spillovers, enabling SMEs and startups to thrive and reinforcing service-led diversification.

6.4. Contribution to Policy and Global Understanding

This study contributes to the broader understanding of economic diversification by demonstrating that diversification is fundamentally a multidimensional and systemic phenomenon. It cannot be engineered through isolated industrial expansion, particularly when such expansion is tied to hydrocarbons. Instead, diversification requires the coordinated interaction of urbanization, entrepreneurship, services, and industrial sectors oriented toward non-extractive sectors.

From a policy perspective, the results suggest that strategies centered on integrating industrial and activity zones into urban fabrics can be effective, provided they are accompanied by institutional support for inter-firm coordination, innovation, and service-sector development. In the Algerian case, this implies moving beyond enclave-style industrial zones toward more embedded urban-economic ecosystems.

Overall, by combining a core national analysis with international robustness checks, this study bridges local empirical evidence and global theory. It shows how the Algerian experience both reflects and enriches international debates on urbanization, diversification, and structural transformation, offering insights relevant not only for Algeria but also for other resource-dependent economies seeking sustainable diversification paths.

7. Conclusion

This study demonstrates that economic diversification is not the outcome of isolated sectoral changes but rather the result of a systemic interaction between urbanization, entrepreneurial dynamics, and sectoral composition. For Algeria, the findings highlight the central role of urban-driven service sector and SMEs in reducing market concentration, while confirming the ambivalent effect of industrial sector when it remains hydrocarbon-oriented.

The international robustness analysis reinforces these conclusions. The Saudi case confirms that in hydrocarbon-dependent economies, sectoral and entrepreneurial dynamics tend to gravitate around fuel exports, limiting diversification. In contrast, the Italian case illustrates how, in a mature and diversified economy, industrial and service sectors exert more immediate and coordinated effects on diversification outcomes.

Overall, the results support the strategy of integrating industrial zones (ZI) and activity zones (ZAC) into urban areas as a lever for diversification, provided that this integration fosters synergies, entrepreneurship, and non-hydrocarbon activities. Such integration fosters cross-sector collaboration, mitigates industrial concentration, and promotes service-oriented diversification, consistent with the role of activity zones in accommodating diverse economic functions (Million, 2004). By linking urban development to productive and entrepreneurial ecosystems, this approach provides a coherent policy framework for advancing economic diversification in resource-dependent economies.

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