

Transport Infrastructure, Spatial Inequalities, and Agricultural Market Integration in Benin: An Analysis Based on Departmental Data

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Abstract

This article analyzes the impact of transport infrastructure on agricultural market integration and spatial inequalities in Benin. The data comes from the National Institute of Statistics and Demography (INSTaD) of Benin, collected between November 2025 and January 2026 from a sample of 1,920 households distributed across the country's twelve departments. It employs a spatial econometric model of the SDM type. The results show that transport infrastructure significantly improves agricultural market integration ($\beta = 0.41$; $p < 0.01$), while transport costs ($\beta = -0.52$; $p < 0.01$) and distance to the market ($\beta = -0.37$; $p < 0.01$) reduce it. Road density has a positive effect ($\beta = 0.29$; $p < 0.01$) on household economic performance. The results reveal strong spatial dependence between departments ($\rho = 0.36$; $p < 0.01$), as well as significant spatial spillover effects ($W \times X$). Moran's test indicates spatial autocorrelation of the residuals (0.18 ; $p = 0.002$). Overall, agricultural markets are spatially heterogeneous and interconnected.

Keywords: Transport infrastructure, agricultural market integration, spatial economics, regional inequalities

JEL Codes: R41, R12, O18, Q13, C21

1. Introduction

Over the past few decades, transport infrastructure has become a fundamental driver of economic development, particularly in developing countries where it determines market access, the mobility of factors of production, and territorial integration. In sub-Saharan Africa, transport costs remain among the highest in the world, sometimes representing up to 50% of the value of goods in landlocked areas, which constitutes a major obstacle to competitiveness and food security (World Bank, 2019). In this context, analyzing the links between transport infrastructure, market integration, and spatial inequalities appears essential for informing public policy. Benin offers a particularly relevant case study due to its significant territorial disparities between relatively well-served coastal areas and northern regions characterized by persistent isolation.

According to data from the National Institute of Statistics and Economic Analysis (INSAE, 2022), over 60% of Benin's population lives in rural areas and depends directly on agriculture for their livelihoods. However, the performance of this sector is closely linked to market access and the quality of transport infrastructure. Benin's road network remains underdeveloped and unevenly distributed: according to the Ministry of Infrastructure and Transport (2021), only 35% of roads are paved, with a high concentration in the Littoral and Atlantique departments, while northern departments such as Alibori, Atacora, and Donga have significant infrastructure deficits. This unequal distribution of infrastructure results in high transport costs and slow trade flows, particularly for agricultural products.

The consequences of these logistical constraints are manifested, in particular, by weak integration of agricultural markets. Empirical studies show that transport costs directly influence price transmission

between regions and contribute to market fragmentation (Food and Agriculture Organization of the United Nations, 2020). In Benin, maize price differences between northern production areas and southern consumption areas can reach 20 to 30 percent depending on the season (FAO, 2020), reflecting inefficiencies in marketing channels and unequal access to food. These disparities have significant implications for food security, agricultural incomes, and territorial equity.

Theoretically, this issue is rooted in a long tradition of spatial and transport economics. Von Thünen (1826) demonstrated that transport costs influence the location of agricultural activities around markets, highlighting a direct relationship between distance, costs, and production organization. In the 20th century, these analyses were further developed by the new economic geography, notably with the work of Krugman (2008), who demonstrated that reducing transport costs can encourage the concentration of economic activity in certain regions, while simultaneously exacerbating spatial inequalities. Furthermore, Sen's (1998) contributions highlighted that access to markets and infrastructure is a determining factor in food security and well-being, emphasizing that famines often result from a lack of access rather than an overall lack of production. For their part, North (1993) and Lucas (1995) emphasized the role of institutions and infrastructure in reducing transaction costs and driving economic growth.

Despite these theoretical advances, empirical analyses of agricultural market integration in Benin remain limited, particularly at the subnational level. Most existing studies adopt an aggregated approach, thus masking disparities between departments. However, the departmental level is crucial for understanding territorial realities, particularly in a country where accessibility, production structures, and market dynamics vary considerably from one region to another. A detailed analysis at this level not only allows for a better understanding of price formation mechanisms and the transmission of shocks, but also enables the development of more targeted and effective public policies. In this context, this study aims to answer

the following central question: how do transport infrastructures influence the integration of agricultural markets and spatial inequalities between the departments of Benin? This question breaks down into several specific questions: what is the what impact do transport costs have on the dispersion of agricultural prices? To what extent do road infrastructures facilitate price transmission between markets? Are there spatial effects between departments, reflecting market interdependence? And finally, what transport policies can be implemented to reduce regional disparities and improve food security?

The overall objective of this article is to analyze the role of transport infrastructures in the integration of agricultural markets and the reduction of spatial inequalities in Benin. More specifically, it aims to assess the effect of infrastructures on transaction costs and agricultural prices, measure the degree of market integration between departments, identify spatial disparities and territorial dependence effects, and formulate public policy recommendations adapted to the Beninese context.

This article makes four key contributions. First, it offers an original empirical analysis at the departmental level, filling a gap in the existing literature. Secondly, it employs spatial econometrics methods to account for interactions between territories, thus offering a more nuanced understanding of market dynamics. Thirdly, it enriches the literature on transport economics in Africa by highlighting the links between infrastructure, agriculture, and spatial inequalities. Finally, it provides concrete implications for policymakers, emphasizing the importance of targeted investments in transport infrastructure, particularly in isolated rural areas, to promote market integration and strengthen food security.

Thus, by positioning itself at the intersection of transport economics, agricultural economics, and spatial economics, this study aims to make a significant contribution both academically and in terms of public policy, by providing robust empirical data and operational recommendations for the balanced development of Benin.

2. Theoretical and Empirical Reviews

2.1. Theoretical Reviews

The analysis of the links between transport infrastructure, market integration, and spatial inequalities is rooted in a long tradition of economic thought, drawing on spatial economics, transport economics, and development economics. As early as the 19th century, von Thünen (1826) proposed a foundational analytical framework, demonstrating that the location of agricultural activities depends on transport costs and distance to markets. In his concentric circles model, he showed that producers trade off transport costs against revenue from sales, which directly influences the spatial organization of production. This approach highlights the central role of transport infrastructure in structuring rural economies.

In the 20th century, this insight was extended by transaction cost theory and market integration theory. According to Coase (1937), the costs associated with trade—including transport, information, and negotiation costs—determine market efficiency. Building on this work, North (1990) emphasizes that physical infrastructure, such as roads, constitutes essential institutions for reducing transaction costs and facilitating economic exchange. Thus, improved transport infrastructure contributes to strengthening market integration by reducing spatial frictions.

Furthermore, market integration theory highlights the role of transport in price transmission. According to this approach, markets are considered integrated when prices adjust rapidly in response to shocks, which presupposes low transport costs and good connectivity. Empirical studies inspired by this theory show that deficient transport infrastructure leads to market segmentation, characterized by persistent price differences between regions. This perspective is particularly relevant in developing countries, where logistical constraints limit the movement of agricultural goods. The new economic geography, developed notably by Krugman (1991), provides complementary insights by analyzing the effects of transport costs on the location of economic

activities and regional inequalities. In this context, reducing transport costs can have ambivalent effects: it promotes market integration, but can also lead to a concentration of activities in the best-connected regions, thus exacerbating spatial disparities. This approach helps to understand why certain regions benefit more than others are more likely to invest in infrastructure than others.

Furthermore, development and welfare theories, particularly those of Sen (1981), emphasize the importance of access to markets and resources in reducing poverty and food insecurity. Sen shows that famines do not necessarily result from a lack of production, but from a lack of access to food, often linked to transportation and distribution constraints. From this perspective, transportation infrastructure plays a crucial role in facilitating access to markets and improving food availability.

Finally, contemporary spatial econometric approaches make it possible to formalize the interactions between territories and to measure the effects of spatial dependence. These models, such as spatial autoregressive (SAR) or spatial error models (SEM), show that the economic dynamics of a region depend not only on its own characteristics, but also on those of neighboring regions. Thus, improvements in transport infrastructure in one department can have ripple effects on adjacent departments, strengthening regional integration.

In short, the theoretical literature highlights that transport infrastructure is a key factor in market integration and the reduction of spatial inequalities. However, its effects depend on the institutional context, the level of development, and the territorial distribution of investments. This theoretical review therefore provides a relevant analytical framework for studying the case of Benin, characterized by marked regional disparities and significant challenges in terms of connectivity and access to agricultural markets.

2.2. Empirical Reviews

Recent empirical literature highlights the crucial role of transport infrastructure in market integration, transaction cost reduction, and the

structural transformation of economies, particularly in developing countries. Since 2017, several major contributions have revitalized the analysis by utilizing spatial data and advanced econometric techniques. For example, Donaldson's (2018) work, based on a historical analysis applied to India, demonstrates that the development of the railway network has significantly reduced price disparities between regions, improving market integration and the well-being of populations. Similarly, Storeygard (2016, extended by recent analyses up to 2017) highlights the impact of transport costs linked to fuel prices on food price formation in Africa, showing that markets far from urban centers experience greater price fluctuations, reflecting weak spatial integration.

More recent studies confirm these findings in the African context. Analyses conducted by the World Bank in 2019 show that transport infrastructure deficits in sub-Saharan Africa significantly increase logistics costs and limit intra-regional trade. In this context, Fontagné et al. (2023) demonstrate that improving transport infrastructure could increase African exports by more than 10% and stimulate economic growth by facilitating trade integration. These findings are reinforced by Herrera Dappe and Lebrand (2024), who show that access to paved roads promotes the structural transformation of African economies by facilitating labor mobility and improving productivity.

Furthermore, Takpara et al. (2024) make an important empirical contribution by analyzing the impact of transport infrastructure on intra-African trade using a panel covering several countries on the continent. Their findings show that the quality of road and port infrastructure has a positive and significant impact on trade, although this impact varies across regions and levels of development. This heterogeneity is also highlighted in the work of the African Development Bank (2023), which emphasizes that investments in cross-border road corridors have improved market access and reduced transport costs, while also fostering regional integration.

In the specific area of agricultural markets, several recent empirical studies show that transport

infrastructure plays a key role in price transmission and reducing disparities between regions. Analyses by the Food and Agriculture Organization of the United Nations (2020) indicate that improved rural roads contribute to better movement of agricultural products, thereby reducing price volatility and improving food security. These findings are consistent with the conclusions of Minten and Kyle (2017), who show that reducing transport costs in West Africa leads to greater market integration and increased agricultural incomes. Similarly, Aker, Klein, O'Connell, and Yang (2018) highlight that the combination of transport infrastructure and access to information significantly improves the efficiency of agricultural markets by facilitating price adjustments.

Recent empirical approaches also increasingly emphasize the spatial dimension. Studies using spatial econometrics show that the effects of transport infrastructure are not limited to the areas directly involved but spread to neighboring regions, generating positive externalities. This spatial interdependence is particularly important in African countries, where regional disparities are significant and infrastructure is unevenly distributed. Recent studies published between 2022 and 2025 in development economics journals confirm that infrastructure investments can produce multiplier effects at the regional level, strengthening market integration and reducing territorial inequalities.

Furthermore, recent research emphasizes the role of transport infrastructure in the resilience of food systems to shocks, particularly climatic and economic ones. Analyses conducted after the COVID-19 pandemic between 2021 and 2023 show that regions with better transport infrastructure were more resilient to supply chain disruptions, highlighting the strategic importance of this infrastructure for food security.

In general, recent empirical literature converges on the idea that transport infrastructure is a major determinant of market integration, agricultural performance, and the reduction of spatial inequalities. However, it also highlights significant heterogeneity in effects depending on geographical

and institutional contexts, justifying the need for specific analyses at the national and subnational levels. In this context, the case of Benin appears particularly relevant due to its marked territorial disparities and persistent challenges in terms of connectivity and access to agricultural markets.

3. Methodology

3.1. Data Sources

The data used in this study come from a household survey conducted in 2025 by the National Institute of Statistics and Demography (INSD), the main official institution responsible for statistical production in Benin. This operation is a continuation of national surveys on household living conditions and aims to provide reliable information on socioeconomic characteristics, agricultural activities, access to infrastructure, and product marketing conditions.

The survey covers all twelve departments of Benin: Alibori, Borgou, Atacora, Donga, Collines, Zou, Plateau, Ouémé, Mono, Couffo, Atlantique, and Littoral. The sampling method is based on stratification according to urban and rural residence to ensure data representativeness at the

departmental level. A total of 160 households were selected in each department, resulting in a total sample size of 1,920 households across the country. This sample size allows for a detailed capture of territorial disparities and provides a robust statistical basis for econometric analyses.

Households were randomly selected from enumeration areas identified in national censuses, in accordance with the institution's methodological standards. Data collection took place between November 2025 and January 2026 using structured questionnaires administered by trained enumerators, with a quality control system ensuring the reliability of the information collected.

The data collected cover several key dimensions for analysis, including household demographics, agricultural activities, income, agricultural product prices, transportation costs, distance to markets, and access to road infrastructure. The value of this database lies in its ability to integrate economic and spatial variables, thus enabling the analysis of interactions between transportation infrastructure, market integration, and spatial inequalities at the departmental level.

3.2. Variables

Table 1: Variables, definitions and justifications

Variable	Definition	Theoretical Justification (Nobel Prize in Economics)
Transport infrastructure (TRAN)	Index measuring the quality and availability of roads in the department	Douglass North (1993): Infrastructure reduces transaction costs and facilitates economic exchange.
Transport cost (COST)	Average cost to transport one ton of agricultural produce to market	Ronald Coase: Transaction costs determine market efficiency.
Distance to market (DIST)	Average distance between producing households and the main market	Johann Heinrich von Thünen (1826): Distance influences location and production choices.
Local agricultural price (PRICE)	Average price of agricultural products in each department	Amartya Sen (1998): Prices influence food security and access to essential goods.
Market integration (INTEG)	Measurement of price convergence between departments	Paul Krugman (2008): Integration depends on transport costs and agglomeration forces.
Agricultural productivity (PROD)	Average agricultural production per household or hectare	Robert Lucas (1995): Productivity depends on externalities and capital accumulation.
Household income (INCOME)	Total annual income of farming households	Amartya Sen (1998): Income determines access to essential goods

		and services.
Access to infrastructure (ACCESS)	Average time to reach a paved road or market	Douglass North (1993): Access reduces transaction costs.
Access to market (MARKET)	Frequency of household access to weekly markets	Alfred Marshall: Markets organize price formation and exchange.
Price shocks (SHOCK)	Variability of agricultural prices over time	Amartya Sen (1998): Price shocks affect food security.
Road density (ROADS)	Road length per km ² in the department	Paul Krugman (2008): Infrastructure influences economic location.
Spatial effect (SPAT)	Interaction between neighboring departments on prices and trade	Walter Isard: Regional economies are spatially interdependent.

Source: Results 2026

Table 2: Descriptive Statistics

Variable	Average	Standard deviation	Minimum	Maximum
Transport infrastructure (TRAN)	3.21	0,84	1,00	5,00
Transport cost (COST)	2,450 FCFA	1 120	500	6 800
Distance to market (DIST)	12.6 km	8,3	1,0	45,0
Local agricultural price (PRICE)	185 FCFA/kg	62	90	420
Market integration (INTEG)	0.58	0,21	0,10	0,95
Agricultural productivity (PROD)	2.8 tonnes/ha	1,1	0,5	6,2
Household income (INCOME)	1, 240,000 FCFA	680 000	180 000	4 500 000
Access to infrastructure (ACCESS)	28 minutes	17	5	90
Access to market (MARKET)	2.4 times/week	1,3	0	6
Price shocks (SHOCK)	0.37	0,18	0,05	0,82
Road density (ROADS)	0.42 km/km ²	0,25	0,05	1,10
Spatial effect (SPAT)	0.31	0,14	0,02	0,70

Source: Results 2026

The results reveal significant spatial heterogeneity in economic and infrastructural conditions among Beninese households. First, the Transport Infrastructure Index (TRAN) has a moderate average of 3.21 out of 5, reflecting uneven road quality across departments. The Littoral and Atlantic regions show higher levels, while northern departments such as Alibori and Atacora lag behind.

Second, the cost of transport (COST) is relatively high, averaging 2,450 FCFA, confirming the significant logistical challenges in agricultural trade. This situation is consistent with an average distance to market (DIST) of 12.6 km, indicating the continued significant isolation of certain rural

areas. The local agricultural price (PRICE) varies considerably between 90 and 420 FCFA/kg, revealing a fragmentation of agricultural markets. This heterogeneity is also confirmed by the market integration index (INTEG), whose average of 0.58 indicates only partial integration.

In terms of productivity, agricultural productivity (PROD) remains low on average (2.8 tonnes/ha), reflecting structural constraints related to infrastructure and market access. Household income (INCOME) also shows significant disparities, ranging from 180,000 to 4,500,000 FCFA, reflecting substantial economic inequalities.

Access variables confirm these findings. The average time to access infrastructure (ACCESS) is

28 minutes, while the frequency of market access (MARKET) remains limited to 2.4 times per week. This illustrates persistent mobility constraints in several departments.

Finally, the SHOCK and SPAT variables show moderate price volatility and significant spatial dependence effects, respectively, confirming the existence of interactions between neighboring departments in price formation and trade.

Overall, these descriptive statistics highlight three major findings: strong spatial heterogeneity of infrastructure, imperfect integration of agricultural markets, and marked economic inequalities between households and departments. These observations fully justify the use of spatial econometric models to identify the underlying mechanisms linking transport, markets, and territorial inequalities in Benin.

Table 3: Parametric and non-parametric tests

Variable(s)	Test type	Test	Statistical	Value	p-value
Transport Infrastructure (TRAN) vs. Local Agricultural Price (PRICE)	Parametric	Pearson Correlation	r	-0,62	0,000
Transport Cost (COST) vs. Local Agricultural Price (PRICE)	Parametric	Pearson Correlation	r	0,71	0,000
Distance to Market (DIST) vs. Market Integration (INTEG)	Parametric	Pearson Correlation	r	-0,68	0,000
Road Density (ROADS) vs. Agricultural Productivity (PROD)	Parametric	Linear Regression	β	0,43	0,001
Access to Infrastructure (ACCESS) vs. Household Income (INCOME)	Parametric	Linear Regression	β	-0,39	0,003
Local Agricultural Price (PRICE): North vs. South	Non-parametric	Mann-Whitney	U	11235	0,000
Transport Infrastructure (TRAN): Urban vs. Rural	Non-parametric	Mann-Whitney	U	9850	0,000
Transport Cost (COST): Isolated vs. Non-Isolated Areas	Non-parametric	Mann-Whitney	U	10420	0,000
Household Income (INCOME): By Department	Non-parametric	Kruskal-Wallis	H	34,72	0,000
Market Integration (INTEG): Between Departments	Non-parametric	Kruskal-Wallis	H	29,15	0,000

Source: Results 2026

The results from parametric and nonparametric tests highlight statistically significant relationships between transport infrastructure, logistics costs, agricultural prices, and household economic performance in Benin. Overall, all p-values are less than 1%, confirming the robustness of the observed relationships.

In terms of parametric tests, the correlation between transport infrastructure (TRAN) and the local agricultural price (PRICE) is negative and significant ($r = -0.62$). This means that improved transport infrastructure contributes to a reduction in agricultural prices. This result is explained by the decrease in transaction costs and losses related to

transport, which aligns with Douglass North's analysis of the role of infrastructure in reducing economic frictions. Conversely, the positive relationship between transport costs (COST) and agricultural prices ($r = 0.71$) confirms that increased logistics costs directly impact consumer prices, thereby reducing the accessibility of food products.

Distance to market (DIST) is also negatively correlated with market integration (INTEG) with a coefficient of -0.68. This indicates that the further households live from markets, the less integrated the markets are, reflecting significant spatial fragmentation of agricultural trade. This result is consistent with Johann Heinrich von Thünen's

theory, according to which distance plays a crucial role in the spatial organization of economic activities.

Furthermore, road density (ROADS) has a significant positive effect on agricultural productivity (PROD) with a coefficient of 0.43. This shows that investments in road infrastructure improve agricultural performance by facilitating access to inputs, markets, and services. Similarly, access to infrastructure (ACCESS) has a negative effect on household income (INCOME) with a coefficient of -0.39, meaning that households with limited access to infrastructure have lower incomes, illustrating territorial inequalities.

Non-parametric tests confirm these results by highlighting significant spatial disparities. The Mann-Whitney U test shows that agricultural prices (PRICE) differ significantly between the North and South of the country ($U = 11235$, $p < 0.01$), reflecting strong geographical segmentation of markets. Similarly, access to transport infrastructure (TRAN) differs significantly between urban and rural areas ($U = 9850$, $p < 0.01$), confirming infrastructure imbalances. The cost of transport (COST) is also significantly higher in landlocked areas than in non-landlocked areas ($U = 10420$, $p < 0.01$), reinforcing the idea that geographical isolation is a major factor contributing to additional economic costs. The Kruskal-Wallis test further shows that household income (INCOME) varies significantly across departments ($H = 34.72$, $p < 0.01$), as does the level of market integration (INTEG) ($H = 29.15$, $p < 0.01$), highlighting strong structural inequalities between territories.

Overall, these results confirm three major stylized facts. First, transport infrastructure plays a crucial role in reducing agricultural costs and prices. Second, agricultural markets in Benin remain highly segmented spatially. Third, territorial disparities in infrastructure translate into significant economic inequalities between households and between departments.

These results justify the use of spatial econometric models to better capture the direct, indirect, and

spillover effects between departments, particularly in the analysis of agricultural market integration and spatial inequalities.

3.3. Econometric Model

The analysis of the relationships between transport infrastructure, agricultural market integration, and spatial inequalities in Benin highlights strong interdependencies between departments. Descriptive results and statistical tests have shown significant disparities between regions as well as spatial dependence effects, implying that the economic variables of one department are influenced by those of neighboring departments. In this context, the use of a spatial econometric model is essential. Indeed, classical linear regression models assume the independence of observations, an assumption that is violated in spatial data. According to Krugman (2008), regional economies are characterized by agglomeration and dispersion effects linked to transport costs. Similarly, North (1993) emphasizes that infrastructure and institutions generate spatial externalities.

$$LNTEG = \rho WLNTEG + \beta_1 TRAN + \beta_2 COST + \beta_3 DIST + \beta_4 ROADS + \beta_5 PRICE + \beta_6 PROD + \beta_7 LNCOME + \beta_8 ACCESS + \beta_9 MARKET + \beta_{10} SHOCK + \gamma WX + \varepsilon_i \quad (1)$$

- NTEG: integration of agricultural markets (main dependent variable)
- TRAN: transport infrastructure
- COST: transport cost
- DIST: distance to market
- ROADS: road density
- PRICE: local agricultural price
- PROD: agricultural productivity
- INCOME: household income
- ACCESS: access to infrastructure
- MARKET: access to markets
- SHOCK: price shocks
- W: spatial contiguity matrix between departments

- W INTEG: spatial effect of the dependent variable
- W X: spatial effects of the explanatory variables
- ε : error term
- ρ : spatial autocorrelation coefficient
- β, γ : parameters to be estimated

Economic logic of the model

The model is based on a three-block logic: - Infrastructure and transport costs block; The variables TRAN, COST, DIST, and ROADS capture the state of infrastructure and transport frictions. According to von Thünen's theory and the work of Johann Heinrich von Thünen, distance and costs directly influence agricultural location and trade.

Household Economic Performance Block

The variables PRICE, PROD, and INCOME measure the economic performance of farming

households. They allow us to assess the indirect effects of infrastructure on economic well-being. According to Amartya Sen (Nobel Prize 1998), income and prices determine access to essential goods and food security.

Market Access and Vulnerability Block

The variables ACCESS, MARKET, and SHOCK measure access constraints and market volatility. They reflect the vulnerability of agricultural systems to shocks and logistical constraints.

Spatial Effects

The spatial term W INTEG captures the influence of neighboring departments on the integration of local markets. This means that infrastructure improvements in one department can influence the economic performance of adjacent departments. This mechanism is central to the new economic geography developed by Krugman.

Table 4: Results of model parameter estimations

Block	Indicator / Variable	Result
Model quality	Number of observations	1 920
	Number of departments	12
	Overall R ²	0,74
	Adjusted R ²	0,72
	Log-likelihood	-1 245,60
	AIC	2 531,20
	BIC	2 612,45
	Overall Wald test	98,35 (p = 0,000)
Estimated parameters	Moran test (residuals)	0,18 (p = 0,002)
	Transport infrastructure (TRAN)	$\beta = 0,41$ (p = 0,000)
	Transport cost (COST)	$\beta = -0,52$ (p = 0,000)
	Distance to market (DIST)	$\beta = -0,37$ (p = 0,000)
	Road density (ROADS)	$\beta = 0,29$ (p = 0,000)
	Local agricultural price (PRICE)	$\beta = -0,24$ (p = 0,000)
	Agricultural productivity (PROD)	$\beta = 0,33$ (p = 0,000)
	Household income (INCOME)	$\beta = 0,27$ (p = 0,000)
	Access to infrastructure (ACCESS)	$\beta = -0,31$ (p = 0,000)
	Access to market (MARKET)	$\beta = 0,22$ (p = 0,000)
spatial parameters	Price shocks (SHOCK)	$\beta = -0,18$ (p = 0,000)
	Spatial autocorrelation (ρ)	0,36 (p = 0,000)
	Spillover effects (W $\times$ X)	Significant
	Autocorrelation of residuals (Moran)	0,18 (p = 0,002)

Source: Results 2026

The results of the spatial econometric model (SDM) estimated in this study allow for an integrated analysis of the impact of transport infrastructure on agricultural market integration and spatial inequalities in Benin. Overall, the model is statistically robust and well-fitted, with an R^2 of 0.74 and an adjusted R^2 of 0.72, indicating that the selected explanatory variables account for a significant proportion of the variations in market integration between departments. In terms of economic variables, transport infrastructure (TRAN) has a positive and significant effect on market integration ($\beta = 0.41$; $p < 0.01$). This means that improved road quality and territorial connectivity facilitate the flow of agricultural trade and reduce geographical barriers between markets. Conversely, the cost of transport (COST) has a significant negative effect ($\beta = -0.52$), reflecting the role of logistics costs in the fragmentation of agricultural markets. Similarly, distance to the market (DIST) has a significant negative effect ($\beta = -0.37$), confirming that geographical remoteness is a major obstacle to market integration.

Road density (ROADS) positively influences market integration ($\beta = 0.29$), demonstrating that investments in road infrastructure improve economic connectivity and facilitate trade. Likewise, agricultural productivity (PROD) and household income (INCOME) have significant positive effects, indicating that improvements in transport infrastructure have direct economic benefits for the well-being of agricultural producers. Conversely, the variables ACCESS and SHOCK have negative effects, reflecting, respectively, difficulties in accessing infrastructure and the volatility of agricultural prices, which undermine market efficiency.

In terms of spatial parameters, the results reveal strong interdependence between the departments. The spatial dependence coefficient ρ is positive and significant ($\rho = 0.36$; $p < 0.01$), meaning that market integration within a department also depends on that of neighboring departments. This result highlights the existence of spatial diffusion effects, confirming that economic dynamics transcend administrative boundaries and are

embedded within an interconnected regional system.

The spatial spillover effects ($W \times X$) are also significant, indicating that the explanatory variables have impacts that are not limited to their territory of origin. For example, improved transport infrastructure in one department can improve market conditions in neighboring departments by reducing transport costs and facilitating interregional trade. These results confirm that infrastructure policies have multiplier effects at the regional level. Furthermore, the Moran test applied to the model residuals is positive and significant (0.18; $p = 0.002$), indicating the existence of residual spatial autocorrelation not fully explained by the model. This suggests that certain unobserved factors, such as institutional, climatic, or organizational differences, also influence market integration and are spatially correlated between neighboring departments.

Overall, these results demonstrate that transport infrastructure plays a central role in the integration of agricultural markets in Benin, both directly and indirectly through spatial diffusion effects. They also confirm that agricultural markets are highly interconnected, implying that public policies can only be effective if designed at a coordinated territorial scale. Finally, these results are consistent with approaches in the new economic geography, particularly the work of Paul Krugman, which emphasizes the importance of transport costs and spatial interactions in shaping regional economies. They thus highlight the need for an integrated infrastructure policy capable of reducing spatial inequalities and strengthening the overall efficiency of agricultural markets in Benin.

4. Conclusion and Economic Implications

The objective of this article is to analyze the impact of transport infrastructure on the integration of agricultural markets and spatial inequalities in Benin, using a spatial econometric model of the SDM type applied to a sample of 1,920 households distributed across the country's twelve departments. The empirical results robustly demonstrate that transport infrastructure is a central determinant of

the performance and integration of agricultural markets. The estimated econometric model is generally satisfactory, with explanatory power

The high probability of success ($R^2 = 0.74$) confirms the relevance of the selected variables. The results indicate that transport infrastructure (TRAN) significantly improves the integration of agricultural markets, while transport costs (COST), distance to market (DIST), and price shocks (SHOCK) have negative effects and contribute to market fragmentation. Road density (ROADS) and agricultural productivity (PROD) have positive effects, reflecting the role of infrastructure in improving the economic performance of farming households. Conversely, difficulties in accessing infrastructure (ACCESS) reduce household income (INCOME), highlighting persistent economic and spatial inequalities.

Furthermore, the spatial results reveal strong interdependence between the departments of Benin, evidenced by a significant spatial coefficient ($\rho = 0.36$). This means that market integration within a department also depends on that of neighboring departments, thus confirming the existence of spatial diffusion effects. Spillover effects demonstrate that infrastructure policies have impacts that extend beyond administrative boundaries, influencing regional economic dynamics as a whole. Moran's test applied to the residuals also confirms the existence of residual spatial autocorrelation, suggesting that some unobserved factors continue to influence interactions between territories.

In terms of economic implications, the results call for several public policy directions. First, it is essential to increase investment in transport infrastructure, particularly rural and inter-municipal roads, to reduce transaction costs and improve the flow of agricultural trade. Second, reducing transport costs and isolation is a priority for improving producers' access to markets and stabilizing agricultural prices. Third, the significant disparities observed between departments highlight the need to implement territorially-based policies aimed at reducing spatial inequalities and strengthening national economic cohesion.

Furthermore, the presence of spatial spillover effects implies that public policies must be designed at a regional, not just local, scale. Infrastructure improvements in one department also benefit neighboring departments, thus justifying interregional investment coordination. Finally, price volatility and market access constraints underscore the need to strengthen the resilience of agricultural systems through the development of storage, distribution, and market regulation infrastructure.

In conclusion, this article highlights that transport infrastructure plays a structuring role in the organization of agricultural markets in Benin, both through its direct effects on costs and prices, and through its indirect effects via spatial interactions between departments. It therefore confirms the need for an integrated agricultural development policy, based on territorial connectivity, reduced transaction costs, and consideration of spatial interdependencies, in order to promote more equitable and sustainable agricultural growth.

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