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# *Regional Price Dynamics Of Flour In Madagascar: Evidence From Econometric Analysis*

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**Abstract: This study investigates the regional price dynamics of flour in Madagascar using an econometric approach based on panel data. The dataset, sourced from the National Institute of Statistics (INSTAT), covers multiple regions and provides detailed information on price levels expressed in Malagasy Ariary (MGA). Descriptive evidence shows that the average price of flour ranges between approximately 3,400 and 3,600 MGA, with significant dispersion across regions and over time. Econometric analysis highlights the presence of moderate price variability, with regional deviations from the national average reaching up to ±30 percent in certain periods. The results further indicate that while price movements are generally positively correlated across regions, the degree of co-movement varies considerably, suggesting incomplete market integration. The persistence of regional price gaps and the heterogeneity in price transmission point to the existence of spatial frictions, including transportation constraints and localized supply conditions. Overall, the findings provide strong evidence of regional disparities in flour markets in Madagascar and underscore the importance of improving market connectivity to enhance price convergence and efficiency.**

**Keywords: Econometric modeling; Price dynamics; Market integration; Spatial dispersion; Madagascar**

## INTRODUCTION

Price dynamics and market integration remain central issues in development economics, particularly in countries where spatial frictions and infrastructure constraints limit the efficient transmission of price signals across regions. In such contexts, analyzing regional price behavior provides important insights into the functioning of markets and the extent of economic integration [1]. Theoretical and empirical studies have long emphasized that well-integrated markets should exhibit co-movements in prices and a tendency toward convergence, whereas persistent price differentials reflect structural inefficiencies and barriers to trade [2]. In Sub-Saharan Africa, and especially in island economies such as Madagascar, regional price disparities are often pronounced due to geographic isolation, high transportation costs, and limited infrastructure development [3]. These factors can lead to fragmented markets, where local supply and demand conditions dominate price formation, thereby weakening national price integration mechanisms [4]. Previous empirical studies have shown that agricultural and food markets in developing countries frequently exhibit incomplete integration, with varying degrees of price transmission across regions [5]. Madagascar presents a particularly relevant case for examining these dynamics. The country is characterized by diverse agro-ecological zones, uneven infrastructure, and significant logistical challenges, all of which contribute to spatial price heterogeneity [6]. Flour, as a widely consumed staple product, provides an appropriate case study for analyzing regional price behavior and market integration patterns. This study aims to investigate the regional price dynamics of flour in Madagascar using an econometric modeling framework applied to panel data. The analysis is based on regional price data collected by the National Institute of Statistics of Madagascar (INSTAT), which provides reliable and consistent information on market prices across regions [7]. By combining descriptive analysis with econometric

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techniques, the study seeks to assess the extent of price dispersion, convergence, and interregional market integration. The contribution of this paper is twofold. First, it provides new empirical evidence on spatial price dynamics in Madagascar, a context that remains underexplored in the literature. Second, it applies a comprehensive econometric approach to evaluate both temporal and cross-sectional dimensions of price behavior. The results are expected to contribute to a better understanding of market functioning in developing economies and to inform policy discussions on improving market efficiency and regional integration [8][9].

## MATERIALS AND METHODS

This study relies on a combination of secondary and primary data sources to analyze regional price dynamics of flour in Madagascar. Secondary data were obtained from the National Institute of Statistics of Madagascar (INSTAT), which provides official and standardized price statistics across regions. These data ensure consistency, comparability, and reliability for econometric analysis, as they are collected following nationally harmonized statistical procedures [10]. In addition, complementary field data were collected through on-site surveys conducted in selected regions. These field investigations aimed to validate official statistics and to capture local market conditions, including price-setting mechanisms, transportation constraints, and supply chain characteristics. The empirical analysis was conducted using a computational environment based on Jupyter Notebook, which allows for reproducible and transparent data processing workflows. The main Python libraries used include pandas for data manipulation and cleaning, NumPy for numerical operations, matplotlib for data visualization, and statsmodels for econometric estimation. Time-series visualization was enhanced using the matplotlib. dates module to ensure accurate temporal representation of price dynamics. The methodological approach combines descriptive statistical analysis with econometric modeling techniques. First, summary statistics were computed to characterize price distributions, dispersion, and temporal coverage. Second, several graphical tools were implemented to explore spatial and temporal patterns, including heatmaps of price deviations from the national average, fan charts illustrating regional price distributions, and correlation matrices capturing interregional price co-movements. These graphical methods provide intuitive insights into market integration and price variability [11]. In the econometric stage, panel data techniques were employed to analyse price dynamics across regions and over time. The use of log-transformed prices and their first differences allow for the examination of growth rates and convergence patterns. Lagged variables were also incorporated to capture price persistence and dynamic adjustment processes. This approach is consistent with standard practices in empirical price analysis and market integration studies [12][13]. The combination of official statistical data, field-based observations, and advanced computational tools enhances the robustness of the analysis. By integrating descriptive, graphical, and econometric methods, the study provides a comprehensive framework for understanding regional price dynamics in Madagascar [14][15][16].

The table below presents an excerpt of the data used across all regions of Madagascar. The dataset covers multiple products, including food staples and basic consumption goods, and provides information on price levels and variability over time. These statistics allow for an initial assessment of spatial price differences and temporal variability across regions and commodities.

Table 1: Reports descriptive statistics of regional prices for a set of essential commodities across selected regions in Madagascar

| Region | Product | n_obs | mean_price (MGA) | std_price (MGA) | Date |
|---|---|---|---|---|---|
| ALAOTRA MANGORO | CIMENT | 44 | 38165,90909 | 2404,73788 | 2023-01-01 |
| ALAOTRA MANGORO | FARINE | 44 | 3555,454545 | 131,210014 | 2023-01-01 |
| ALAOTRA MANGORO | HUILE CACHETEE | 44 | 10147,5 | 180,208213 | 2023-01-01 |
| ALAOTRA MANGORO | HUILE EN VRAC | 44 | 8123,181818 | 72,393393 | 2023-01-01 |
| ALAOTRA MANGORO | MAKALIOKA | 44 | 2765,403409 | 497,884104 | 2023-01-01 |
| ALAOTRA MANGORO | RIZ LOCAL | 44 | 2700,636364 | 701,972026 | 2023-01-01 |

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| | | | | | |
|---|---|---|---|---|---|
| ALAOTRA MANGORO | SEL | 44 | 790 | 0 | 2023-01-01 |
| ALAOTRA MANGORO | SUCRE BLANC | 1 | 5050 | | 2023-11-06 |
| ALAOTRA MANGORO | SUCRE ROUX | 44 | 4531,590909 | 130,668108 | 2023-01-01 |
| AMORON'I MANIA | CIMENT | 51 | 41383,98693 | 1816,336433 | 2023-01-01 |
| AMORON'I MANIA | FARINE | 51 | 3597,058824 | 116,715151 | 2023-01-01 |
| AMORON'I MANIA | HUILE CACHETEE | 51 | 10976,27451 | 368,573728 | 2023-01-01 |
| AMORON'I MANIA | HUILE EN VRAC | 51 | 8173,186275 | 278,93596 | 2023-01-01 |
| AMORON'I MANIA | MAKALIOKA | 33 | 2964,772727 | 126,955583 | 2023-01-01 |
| AMORON'I MANIA | RIZ IMPORT | 35 | 2428,666667 | 45,528936 | 2023-01-01 |
| AMORON'I MANIA | RIZ LOCAL | 51 | 2631,127451 | 173,428165 | 2023-01-01 |
| AMORON'I MANIA | SEL | 49 | 798,928571 | 106,413817 | 2023-01-01 |
| AMORON'I MANIA | SUCRE BLANC | 51 | 4891,029412 | 149,140183 | 2023-01-01 |
| AMORON'I MANIA | SUCRE ROUX | 44 | 4673,106061 | 130,252855 | 2023-01-01 |
| ANALAMANGA | CIMENT | 47 | 35676,27503 | 231,652853 | 2023-01-01 |

Source: Author's calculations based on data from the National Institute of Statistics of Madagascar (INSTAT), available at: https://www.instat.mg/p/tableau-de-bord-de-leconomie-tbe-n0-60-octobre-2025

## RESULTS AND DISCUSSION

### 1- Descriptive statistics for the main variables used in the econometric analysis

Table 2 reports descriptive statistics for the main variables used in the econometric analysis. Prices are expressed in Malagasy Ariary (MGA), and both level and transformed variables are presented to capture different dimensions of price dynamics across regions and over time.

Table 2: Descriptive statistics for the main variables used in the econometric analysis

| variable | count | mean | std | min | 25% | 50% | 75% | max |
|---|---|---|---|---|---|---|---|---|
| price | 7810 | 8750,32 | 11195,13 | 440 | 2965,417 | 4600 | 8050 | 50500 |
| ln_price | 7810 | 8,5701 | 0,9414 | 6,0868 | 7,9948 | 8,4338 | 8,9934 | 10,8297 |
| dln_price | 7617 | 0,0011 | 0,0568 | -1,1801 | 0 | 0 | 0 | 1,4692 |
| lag_ln_price | 7617 | 8,5695 | 0,9418 | 6,0868 | 7,9896 | 8,4338 | 8,9934 | 10,8297 |
| sigma_product_date | 7793 | 0,1 | 0,0611 | 0,0232 | 0,0593 | 0,0782 | 0,1265 | 0,4656 |
| gap_to_national_mean | 7810 | 0 | 0,1121 | -0,8142 | -0,052 | 0,0004 | 0,0503 | 1,4594 |

Source : Author

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**Interpretation**

The average price level is 8,750 MGA, with a relatively large standard deviation of 11,195 MGA, indicating substantial dispersion across products and regions. The distribution is highly skewed, as reflected by the wide range between the minimum value of 440 MGA and the maximum value of 50,500 MGA. The median price of 4,600 MGA is considerably lower than the mean, suggesting the presence of high-price observations that drive the upper tail of the distribution. The logarithmic transformation of prices yields a mean of 8.57 with a standard deviation of 0.94, indicating a more stable and symmetric distribution suitable for econometric modeling. The similarity between the mean and median of the log price confirms that the transformation reduces skewness and improves comparability across observations. The growth rate of prices, measured as the first difference of log prices, has a mean close to zero (0.0011), suggesting that, on average, prices are relatively stable over time. However, the standard deviation of 0.0568 and the presence of extreme values, ranging from −1.18 to 1.47, indicate occasional episodes of sharp price adjustments. The lagged log price variable exhibits statistical properties very similar to the contemporaneous log price, reflecting the persistence of price levels over time and supporting the relevance of dynamic specifications in the econometric analysis. The variable measuring cross-sectional dispersion at the product-date level has an average value of 0.10, indicating moderate variability in prices across regions for a given product and time period. The relatively wide range of this variable suggests that dispersion can vary substantially depending on market conditions.

**2- Regional Deviations from the National Average Price of Flour in Madagascar (%)**

Figure 1 illustrates the evolution of regional deviations from the national average price of flour across regions in Madagascar over the study period. The figure reports percentage deviations from the national benchmark, allowing for a direct comparison of relative price levels across space and time.

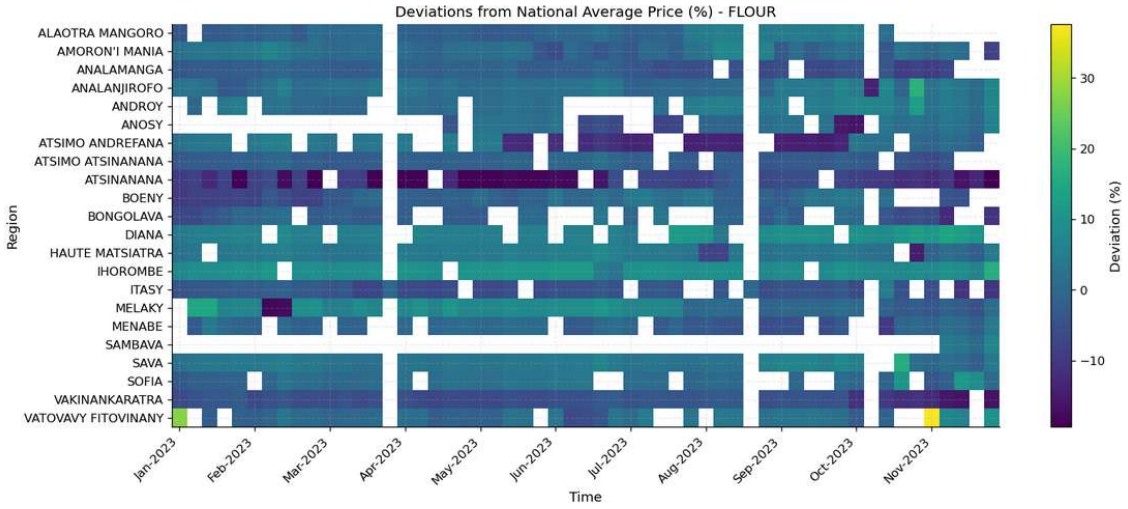


Figure 1: Regional Deviations from the National Average Price of Flour in Madagascar (%)

Source: Author

**Interpretation**

The results reveal substantial spatial heterogeneity in flour prices, with deviations ranging approximately from −15% to over +35% relative to the national average. Several regions consistently exhibit positive deviations, indicating persistently higher price levels compared to the national benchmark, while others remain below the average throughout most of the period. This pattern suggests the presence of structural differences in market conditions across regions. The figure also highlights temporal fluctuations in price deviations. In certain periods, particularly toward the latter part of the year, some regions experience sharp increases in relative prices, with deviations exceeding +30%, while others simultaneously display negative deviations below −10%. Such divergence points to uneven price adjustments across regions, potentially reflecting differences in supply conditions, transportation constraints, or local demand pressures. Moreover, the persistence of positive or negative deviations in specific regions suggests limited short-run price convergence. Regions that remain consistently above or below the national average indicate that market integration may be incomplete, as price signals are not fully transmitted across all areas.

Figure 2 presents the evolution of the regional distribution of flour prices in Madagascar over time. Prices are expressed in Malagasy Ariary (MGA). The figure summarizes the distribution using a fan chart, where the shaded areas represent the 10th–90th and 25th–75th percentiles, and the solid line indicates the median price across regions.

**3- Evolution of the regional distribution of flour prices in Madagascar over time**

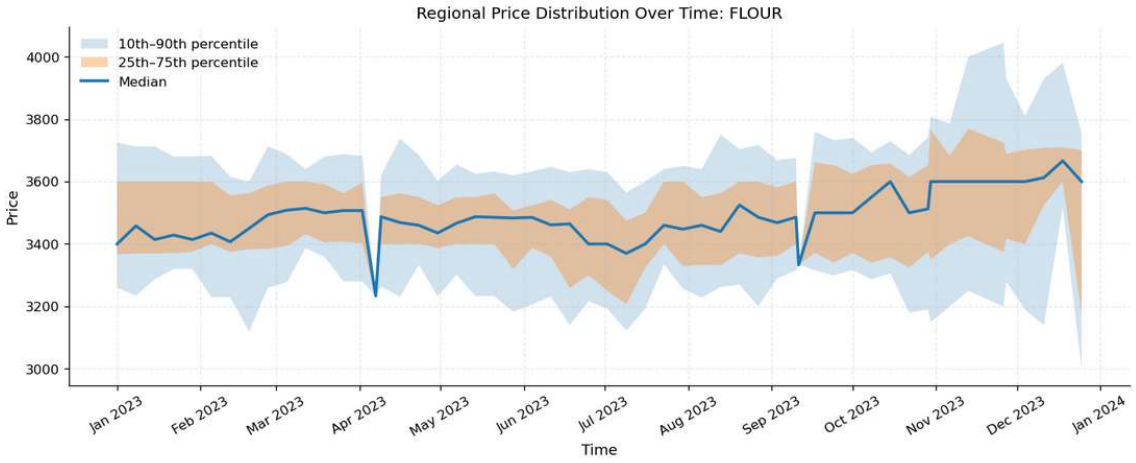


Figure 2: The evolution of the regional distribution of flour prices in Madagascar over time

Source: Author

**Interpretation**

The median price of flour remains relatively stable over the period, fluctuating around 3,400 to 3,600 MGA, indicating moderate overall variation in central price levels. However, the dispersion of prices across regions is non-negligible, as shown by the width of the percentile bands. The interquartile range (25th–75th percentile) suggests that most regional prices lie within a relatively narrow band, while the broader 10th–90th percentile range highlights the presence of more pronounced deviations in

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certain regions. Temporal variations in dispersion are also evident. Periods such as mid-year and late-year exhibit wider percentile bands, indicating increased heterogeneity in regional prices. In particular, the upper bound of the distribution occasionally exceeds 4,000 MGA, while the lower bound can fall close to 3,100 MGA, suggesting that regional price differences can exceed 900 MGA at certain points in time. The figure also reveals short-lived fluctuations in the median price, including a noticeable decline around April and another dip around early September, followed by a gradual upward trend toward the end of the year. This pattern may reflect temporary supply shocks or seasonal effects influencing market conditions.

### 4- Interregional Price Correlation Matrix for Flour in Madagascar

Figure 3 presents the interregional correlation matrix of flour prices across regions in Madagascar. The figure reports pairwise correlations of regional price series over time, providing a measure of the extent to which prices co-move across different regional markets.

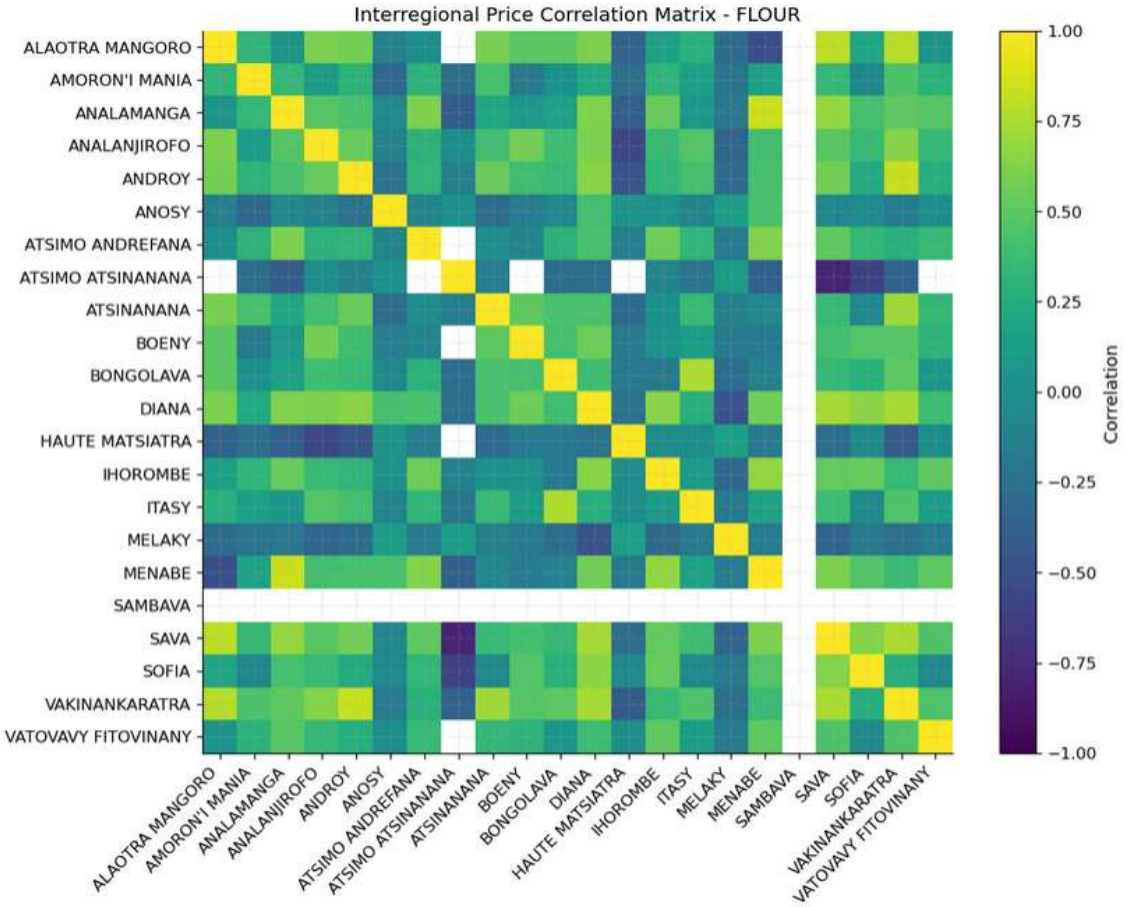


Figure 3: Interregional Price Correlation Matrix for Flour in Madagascar

Source: Author

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**Interpretation**

The results indicate a generally positive correlation structure across most regions, with many coefficients lying between 0.2 and 0.8, suggesting that regional prices tend to move in the same direction over time. In several cases, correlations exceed 0.7, pointing to strong co-movements that may reflect relatively well-integrated market linkages between certain regions. However, the matrix also reveals significant heterogeneity in correlation patterns. Some regional pairs exhibit weak or even negative correlations, with values falling below zero and, in some instances, approaching −0.5 or lower. These negative or low correlations suggest that price movements are not synchronized across all regions, indicating the presence of localized shocks or structural differences in market conditions. The coexistence of high and low correlations across regions highlights uneven market integration within the country. While certain regions appear closely connected through trade and price transmission mechanisms, others remain more isolated, possibly due to transportation constraints, geographic barriers, or differences in local supply and demand conditions. Overall, the correlation structure provides evidence of partial market integration in Madagascar. Although prices tend to co-move across several regions, the persistence of weak or negative correlations suggests that price transmission is incomplete, reinforcing the importance of spatial frictions in shaping regional price dynamics.

## DISCUSSION

The empirical findings of this study provide strong evidence of significant regional disparities in flour prices across Madagascar. The descriptive statistics indicate substantial variation in price levels, with a mean price of approximately 8,750 MGA and a high standard deviation exceeding 11,000 MGA. This dispersion reflects pronounced heterogeneity across regions, which is further confirmed by the graphical analysis. In particular, the fan chart reveals that while the median price remains relatively stable, the distribution of prices widens during certain periods, suggesting fluctuations in regional market conditions. The heatmap analysis highlights persistent deviations from the national average price, with some regions consistently exhibiting higher or lower price levels. These findings suggest that spatial price convergence is limited in the short run. Regions with persistent positive deviations may be characterized by higher transportation costs or limited local supply, whereas regions with negative deviations may benefit from proximity to production areas or more efficient market access.

The correlation matrix further supports the existence of partial market integration. While many regional price series display positive correlations, indicating some degree of co-movement, the presence of weak and even negative correlations between certain regions suggests that price transmission is not uniform across the country. This heterogeneity implies that local shocks, infrastructure constraints, and market segmentation play an important role in shaping price dynamics. From an econometric perspective, the relatively low mean of price growth rates, combined with the persistence observed in lagged price variables, suggests that prices evolve gradually over time. However, the presence of extreme variations in growth rates indicates that occasional shocks can lead to abrupt adjustments. This pattern is consistent with markets characterized by imperfect integration, where price adjustments are neither instantaneous nor uniform. Overall, the results point to incomplete market integration in Madagascar's flour market. Although some degree of price co-movement exists, the persistence of regional price gaps and the variability in dispersion suggest that spatial frictions remain significant. These frictions may be linked to inadequate transportation infrastructure, high transaction costs, and differences in regional supply and demand conditions.

## CONCLUSION

This study examined the regional price dynamics of flour in Madagascar using a combination of descriptive, graphical, and econometric approaches. Based on data from the National Institute of Statistics of Madagascar (INSTAT), the analysis provided new empirical evidence on price dispersion, convergence, and market integration across regions. The results reveal substantial regional heterogeneity in flour prices, both in levels and in dynamics. While the average price remains relatively stable over time, significant dispersion persists across regions, with deviations from the national average reaching considerable levels. The graphical

analysis further highlights that price variability is not constant over time, with periods of increased dispersion suggesting the presence of localized shocks or structural constraints. The econometric findings indicate that price movements exhibit some degree of persistence and co-movement across regions, but the evidence of incomplete convergence suggests that market integration remains limited. The coexistence of strong and weak correlations across regions points to uneven price transmission mechanisms, reflecting the influence of spatial frictions such as transportation costs, infrastructure limitations, and differences in regional supply conditions.

Overall, the study underscores the importance of improving market connectivity to enhance price efficiency and reduce regional disparities. Policies aimed at strengthening transportation infrastructure, facilitating trade flows, and improving market information systems could contribute to more integrated markets and more uniform price dynamics across regions. Future research could extend this analysis by incorporating additional products, longer time series, and more advanced econometric techniques to further explore the determinants of market integration in Madagascar.

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