CHAPTER 15

Remoteness and Maize Price Volatility in Burkina Faso

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Overview

Common wisdom: *Price volatility in Africa arises mainly from international markets.*

Findings:

- *Markets located far from the major urban centers (Ouagadougou, Bobo-Dioulasso, or Koudougou) register the highest levels of price volatility. This result is robust to alternative measures of remoteness.*
- *Maize surplus markets and markets bordering Côte d'Ivoire, Togo, and Ghana have experienced more volatile prices than maize-deficit and nonbordering markets have.*
- *There is evidence of seasonal patterns in maize price volatility across Burkinabe markets. Maize price volatility is greater at the harvest season around October to December and in the lean period (June to September).*
- *External factors, such as exchange rates and international maize prices, do not seem to influence maize price volatility, running counter to conventional wisdom.*

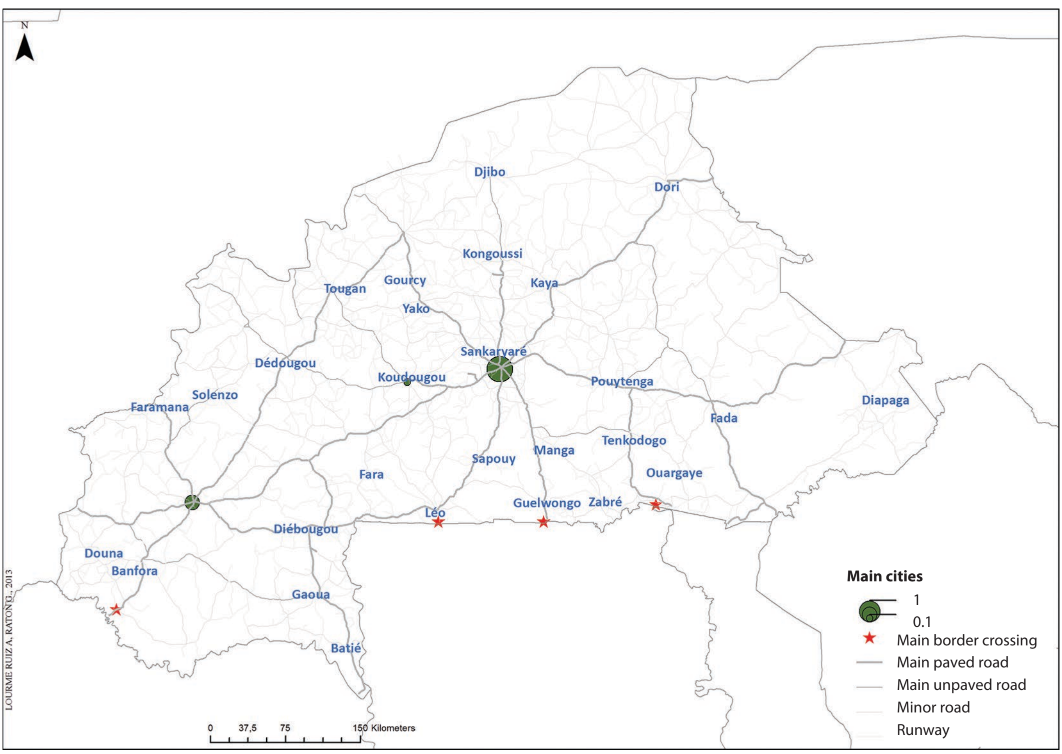
Policy message: *Maize price volatility is greatest in remote markets. Given poor road quality and low storage capacity, these markets have limited capacity to access demand from urban markets. Enhanced road infrastructure would strengthen the links between rural and urban markets, thereby smoothing maize price volatility.*

The Issue: Does Remoteness Imply Greater Maize Price Volatility?

Burkina Faso is a landlocked and agriculture-dependent economy, with limited transportation infrastructure. As a result, transport costs (TCs) are high, which hampers farmers' participation in markets. Distance and a lack of appropriate infrastructure reduce rural smallholders' ability to sell their goods on the markets, while traders from urban areas are discouraged from purchasing food items directly from rural farmers located in remote areas. Both (supply and demand) forces may combine to increase price volatility. So far, surprisingly few studies have theoretically or empirically explored this issue. Building on the literature, the distance to major cities (expressed in kilometers and hours) and road quality are used here as proxies for TCs between markets.

The study examines the effect of market remoteness on maize price volatility in Burkina Faso. Maize is widely consumed throughout the country. The production of maize has significantly increased recently, rising at a faster pace than sorghum, millet, and rice. Almost 15 percent of maize production is marketed, with an annual per capita average consumption of approximately 108 kilograms per capita per year. Although most of millet and sorghum production tends to be consumed by farmers, maize is mostly sold on markets. Thus, maize is one of the main sources of agricultural income in Burkina Faso, ranking second after cotton. As volatility may hinder investment in agricultural production, understanding the determinants of maize price volatility is of strategic importance in Burkina Faso, for food security as well as for rural development more broadly. Map 15.1 shows how the various maize markets are distributed geographically,

Map 15.1 Location of Maize Markets



Note: The green dots indicate the main cities.

in relation to the major urban centers—namely, Ouagadougou, Bobo-Dioulasso, and Koudougou—and the border-crossing points for maize trade.

Burkina Faso is an interesting and informative country to study because of the nature of its maize market. Maize production is mostly located in the western and southern parts of the country (such as Fara, Faramana, and Solenzo), where pedo-climatic conditions are more favorable. Maize is mainly traded within the country, flowing from maize-surplus to maize-deficit regions. Depending on the level of national production, small amounts of maize exports can be recorded toward Niger and Mali, and even smaller amounts can be imported from Côte d'Ivoire, Ghana, and Togo.

The Analysis: Understanding the Links between Remoteness and Price Volatility

There are two major components to the analysis. The first is the theory—how might remoteness in principle have an effect on price volatility? The second is empirical—estimating the relationship between remoteness and maize price volatility in Burkina Faso.

The Theory

The study simplifies matters by considering two markets: an urban market, which is the predominant consumer (rather than producer) of maize, and a rural market, which is the principal supplier of maize. A trade model between a rural area and an urban area is used to show that TCs increase volatility in the rural market when the volatility is due to local supply or demand shocks in the rural area. The study then analyzes the role of TCs on the properties of an unexpected price shift occurring in a rural area (resulting from an unexpected supply shock). The analysis extrapolates the outcome to the relation between TCs and a succession of unexpected price shocks that produce price volatility. Excess demand for maize will characterize the urban market, and excess supply the rural market. In equilibrium, the excess supply in the rural market should equal the excess demand in the urban market. The existence of TCs between these markets will imply a gap in market-clearing prices, equivalent to the TCs per unit. Using this simplified specification of the real world, the study shows that:

- An increase in maize production in the rural area (such as a good harvest season) will reduce the maize price in both markets.
- The higher are the TCs between the rural market and the urban market, the lower is the price in the rural market.
- In general, farmers with no liquidity and no carryover sell more in the first month after the harvest, a bit less in the second month, and so forth. Thus, sales decrease with time, which induces an increasing trend in prices from the harvest to the lean season. Prices are lower in the harvest season, characterized by the abundance of products on the market, and higher in the lean season, featuring product scarcity.

- A positive supply shock generates an unexpected local price decrease, especially because TCs are high. Negative supply shocks generate an unexpected local price increase, especially because TCs are high. Thus, successive unexpected shocks produce a series of unexpected price shifts, which fuel rural price volatility. The magnitude of this volatility increases with TCs between this market and the related urban center.

The Empirical Estimation

The analysis relies on historical price data collected by the National Society for the Management of Food Stocks (Société Nationale de Gestion du Stock Alimentaire), which has managed its own market information system since 1992. The prices of the main agricultural commodities are collected weekly in 48 markets, and price averages are computed monthly. The study analyzes 28 markets with available data from July 2004 to November 2013. It sets aside markets where there are discontinuities in the price series. For each market, monthly maize prices are expressed in Communauté Financière d'Afrique francs per kilogram, and then deflated by the Burkinabe Consumer Price Index (2008 = 100), which is calculated monthly by the National Institute of Statistics and Demography (Institut National des Statistiques et de la Démographie).

- The methodology relies on an autoregressive conditional heteroskedasticity (ARCH) model to investigate the determinants of spatial price volatility (box 15.1).
- Spatial price volatility across markets is examined through time distance to major cities and maize border-crossing points, and considering that the market is in a deficit or surplus production area.

Box 15.1 Applying ARCH Models to Maize Price Series in Burkina Faso

ARCH Models

The autoregressive conditional heteroskedasticity (ARCH) model (after Engel 1982) assumes that the conditional variance depends on the lagged squared residuals of a price series over time. By including variables as regressors, the model can be used to identify potential determinants of the price level and volatility. The ARCH structure is given by:

$$Y_t = X_t\beta + \varepsilon_t \tag{B15.1.1}$$

with

$$\varepsilon_t|\Omega_{t-1} \sim N(0,h_t) \tag{B15.1.2}$$

$$h_t = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + v_t \,;\, v_t \sim N(0,\sigma) \tag{B15.1.3}$$

box continues next page

Box 15.1 Applying ARCH Models to Maize Price Series in Burkina Faso *(continued)*

where Y_t is the dependent variable; X_t denotes the vector of explanatory variables; ε_t is the error component; h_t is the time-varying variance of the error; Ω_{t-1} is the information set available at $t-1$; and β, α_i, and ω are parameters. In the ARCH model, only recent errors have an impact on the time-varying variance. Equation B15.1.1 gives the conditional mean; equation B15.1.3 describes the evolution of the conditional variance. These equations are adapted to investigate the determinants of maize price volatility in Burkina Faso.

Model Specification

The study involves a two-step empirical approach. First, 28 maize markets are pooled to estimate the average effect of market remoteness (that is, transport cost and time distance between market *i* from Ouagadougou, Bobo-Dioulasso, and Koudougou (the major consumption centers) on the price level (equation B15.1.4). Second, the average effect on price volatility is estimated (equation B15.1.5):

$$\begin{aligned} lnP_{it} &= \beta_0 + \beta_1 lnP_{it-1} + \beta_2 lnIP_t + \beta_3 lnER_t + \beta_4 lnBorder_i + \beta_5 lnTC_i \\ &\quad + \beta_6 Surplus_i + \beta_7 Trend_t + \beta_8 Harvest_t + \beta_9 Lean_t + \sum_{j=1}^{28} \mho_j M_j \\ &\quad + \varepsilon_{it}; \varepsilon_{it} \sim N(0, h_t) \end{aligned} \tag{B15.1.4}$$

$$\begin{aligned} h_{it} &= \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 lnP_{it-1} + \alpha_3 lnIP_t + \alpha_4 lnER_t + \alpha_5 lnBorder_i + \alpha_6 lnTC_i \\ &\quad + \alpha_7 Surplus_i + \alpha_8 Trend_t + \alpha_9 Harvest_t + \alpha_{10} Learn_t + \sum_{j=1}^{28} \phi_j M_j + \upsilon_{it}; \\ &\quad \upsilon_{it} \sim N(0, \sigma) \end{aligned} \tag{B15.1.5}$$

Explanatory variables have been introduced in both the mean and variance equations. $Ln\ P_{it}$ and $Ln\ P_{it-1}$ are the natural logarithms of real maize price in market *i* at months *t* and *t*–*1*, respectively. *Trend*, *ER*, and *IP* represent the monthly trend, nominal exchange rate, and real international maize price, respectively. *Harvest* is a seasonal dummy variable that indicates the harvest time (October to December); *Lean* is a dummy variable that indicates the harvest season (June to September); M_j denotes the maize market dummy variables; and ε_{it} is the heteroscedastic error term. *Border* is the travel time between market *i* and the nearest cross-border maize point with Ghana, Côte d'Ivoire, or Togo. Transport cost is captured through three measures: time distance, kilometer distance, and road quality (whether the road is paved). *Surplus* is a dummy variable that indicates whether the market is in a surplus production area (= 1 for maize-surplus areas).

Predicted Effects

The estimated coefficient β_5 tests whether mean prices are different between remote markets and markets close to the main urban centers, and α_6 tests to what extent maize price series in remote markets are more volatile. Given the theory, maize prices are expected to be lower in remote markets ($\beta_5 < 0$), and theory would also suggest $\alpha_6 > 0$, that is, remote markets exhibit greater maize price volatility than markets located close to main consumption centers.

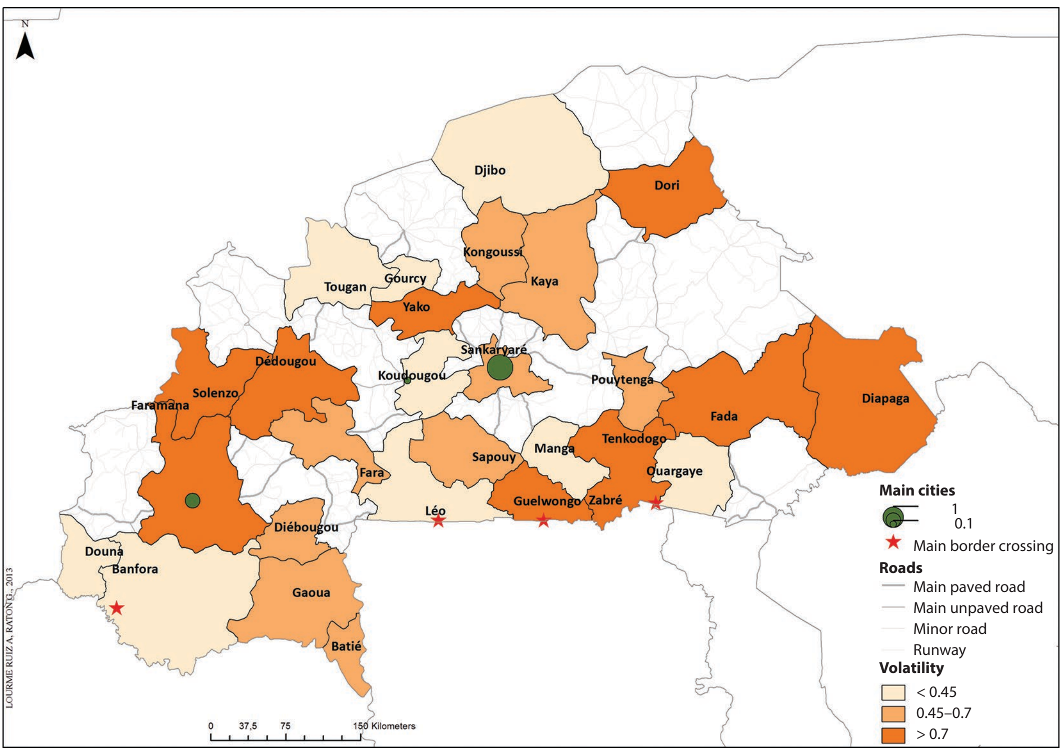
- The robustness of the results is assessed in three ways. First, alternative measures of market remoteness are used; second, the same analysis is carried out using nominal prices; and third, an alternative (generalized ARCH) estimator is used.

The Results: Remoteness Affects Price Volatility

Domestic prices in Burkina Faso are essentially disconnected from international prices. The Johansen cointegration test is used to determine whether international and domestic maize price series are cointegrated, meaning that there is a long-run relationship between the two variables. The results reject the null equation of cointegration between domestic and international maize prices in Burkina Faso. The explanation for the low transmission of international maize price variations to domestic markets in Burkina Faso may be related to poor regional integration, low import dependence (less than 1 percent of domestic production), and the existence of maize substitutes among the other cereals produced in the country.

Clearly, remoteness is an important factor. Map 15.2 presents the level of maize price volatility in each of the 28 Burkinabe markets over 2004–13. The map suggests that there are spatial differences in maize price volatility across markets.

Map 15.2 Spatial Volatility of the Price of Maize in Burkina Faso, 2004–13



Markets located far from the closest urban center—Ouagadougou, Bobo-Dioulasso, or Koudougou—register the highest levels of price volatility. Markets close to the main cities, where quality road infrastructure is available, display less volatile price series. Markets that are located in maize-surplus regions and close to maize border-crossing points show more volatile prices than maize-deficit and nonbordering markets. The empirical challenge is to assess whether remoteness influences maize price volatility when all other factors are taken into account.

Several factors influence average prices. There is a strong autocorrelation in the monthly price series. On average, a 1 percent increase in the maize price in a market leads to a 0.9 percent increase in price the following month. The results also confirm a seasonal pattern in average maize prices—these being low during the harvest time and high during the lean season. There is no significant effect of the exchange rate and international maize prices on price levels in Burkina Faso, suggesting that such external factors are less important: maize prices are driven by domestic factors. Geographic location has a statistically significant (at the 5 percent level) effect on the domestic maize price level. For example, prices in maize-surplus markets are on average 9 percent lower than those prevailing in maize-deficit markets.

Several factors influence price volatility. Estimates from the variance equation confirm that the ARCH model is an appropriate empirical specification, which indicates that greater values of recent shocks produce higher present volatility. This result is statistically significant at the 1 percent level. Maize prices tend to be *more* volatile in:

- Maize-surplus markets, mainly because maize-deficit and -surplus markets are not well integrated.
- Remote markets, which tend to exhibit higher price volatility. Market isolation results in more volatile maize prices.
- Markets near border maize crossing points.

Market isolation should not only be viewed as simple geographic remoteness from domestic urban centers. Remoteness is also expressed through high transport costs, export prohibitions, and nontariff barriers to crossing the border, which all hamper maize marketing abroad.

Robustness checks. Given the significance of remoteness in determining maize price volatility, the study checks whether the way remoteness was defined influenced this finding. Two alternative measures of market remoteness are tested. The first is the distance in kilometers between a selected market and the nearest main consumption center. The second is the quality of the roads (whether paved) connecting the market with its main consumption center. The results are very similar. The positive and significant impact of travel time on maize price volatility holds when these alternative measures of remoteness are used.

In summary, the fact that prices in remote and disconnected markets are more volatile than in urban centers means that price volatility in rural areas is mainly generated locally. This contradicts the common wisdom that price volatility mainly arises from international markets.

The Implications

The case of Burkina Faso shows that physical constraints, such as a large distance to major consumption centers or main roads, are fundamental factors influencing maize price volatility across markets. These findings suggest that policies targeted toward infrastructure development and better regional integration and economic development within the Economic Community of West African States area would reduce maize price volatility. For instance, the authorities could support remote markets by linking them through (better) road access to major consumption centers across the country, as well as in neighboring countries. Other studies have come to a similar policy conclusion about the importance of rural roads for rural development and poverty reduction (Kilima et al. 2008). This will be key to improving the commercialization of agricultural products in remote areas and reducing price volatility across markets in Burkina Faso.

Additional Reading

This chapter draws on:

Ndiaye, Moctar, Maître d'Hôtel Elodie, and Le Cotty Tristan. 2015. "Maize Price Volatility: Does Market Remoteness Matter?" Policy Research Working Paper 7202, World Bank, Washington, DC. doi: 10.1596/1813-9450-7202.

Other key references:

Abdulai, A. 2000. "Spatial Price Transmission and Asymmetry in the Ghanaian Maize Market." *Journal of Development Economics* 63: 327–49. doi:10.1016/S0304-3878(00)00115-2.

Badiane, O., and G. E. Shively. 1998. "Spatial Integration, Transport Costs, and the Response of Local Prices to Policy Changes in Ghana." *Journal of Development Economics* 56: 411–31. doi:10.1016/S0304-3878(98)00072-8.

Engel, R. F. 1982 "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation." *Econometrica* 50: 987–1007. doi:10.2307/1912773.

Kilima, F. T. M., C. Chanjin, K. Phil, and R. M. Emanuel. 2008. "Impacts of Market Reform on Spatial Volatility of Maize Prices in Tanzania." *Journal of Agricultural Economics* 59: 257–70. doi:10.1111/j.1477-9552.2007.00146.x.

Minot, N. 2014. "Food Price Volatility in Sub-Saharan Africa: Has It Really Increased?" *Food Policy* 45: 45–56. https://doi.org/10.1016/j.foodpol.2013.12.008.