CHAPTER 3

The Impact of COVID-19 on Staple Food Prices: Location Matters

Mbaye Yade, Greenwell Matchaya, Joseph Karugia,
Anatole Goundan, Paul Guthiga, Maurice Taondyandé,
Sunday Odjo, and Sibusiso Nhlengethwa

Introduction

This chapter summarizes the findings from analyses conducted by AKADEMIYA2063 on local staple food market dynamics during the COVID-19 pandemic in Africa. With the outbreak of the highly contagious virus in Africa in March 2020, various measures were implemented by African governments to contain its spread. These measures included bans on public gatherings and markets; restrictions on movement within and between countries; closures of schools, restaurants, and hotels; and curfews. All these measures were likely to cause market disruptions and revenue losses for vulnerable groups by disrupting supply and demand of agricultural staples, either directly or indirectly. The objective of these analytical studies is therefore to generate evidence on how the various COVID-19 response measures have affected food supply and demand patterns in Africa, taking into account the locational characteristics (that is, whether an area is urban or rural, has a surplus or deficit of the commodity in question, and is in a coastal or landlocked country) and whether the commodity is perishable or nonperishable. Such evidence can then be used to inform efforts to anticipate and respond to food crises arising from infectious disease outbreaks and the measures implemented to limit their spread.

Although pandemics like COVID-19 are not common, other major infectious disease outbreaks have been experienced in the recent past, including, for example, Ebola, severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and HIV/AIDS, among others (Verikios et al. 2011). Whenever they occur, they disrupt human lives and livelihoods, especially those of rural populations that depend heavily on agriculture and other primary sectors of the economy (Cabore et al. 2020; Phillipson et al. 2020). Sickness associated with pandemics affects the ability of rural populations to carry out normal agricultural activities that contribute to production. In addition, disease containment measures such as restrictions on movement of people and goods, restrictions on market operations, social distancing, and self-isolation, which are common during pandemics, curtail labor mobility, reduce productivity, disrupt supply chains, depress demand for agricultural commodities, impede the proper functioning of agricultural markets for inputs and outputs, and affect prices (Sumo 2019; Awotide et al. 2015; Boisvert, Kay, and Turvey 2012). Studies conducted on the impacts of the Ebola outbreak in West Africa, for example, showed that farms experienced shortages of agricultural labor for planting and harvesting as communities stayed away from agricultural fields, resulting in reduced yields and production (Bowles et al. 2016; de la Fuente, Jacoby, and Lawin 2020). In addition to constraining labor supply, movement restrictions also affect the timely supply of agricultural inputs and the movement of agricultural commodities from points of production to points of consumption. In urban areas, closures of hotels and restaurants and restrictions on agricultural market operations also affect demand. These effects are transmitted and expressed through changes in the demand for and the supply and prices of agricultural commodities.

The emergence and spread of COVID-19 and the measures implemented to contain it have raised concerns regarding the pandemic's effects on food security at the global, regional, and local levels. There is a growing body of literature globally on the impact of the COVID-19 pandemic on agricultural systems. However, most of these studies have focused on the global level or on select countries, the majority of which are outside Africa. At the global level, these studies report that food consumption has remained unchanged during the pandemic due to the inelastic demand for most agricultural commodities (Elleby et al. 2020; World Bank 2020; Ezeaku, Asongu, and Nnanna 2020; Falkendal et al. 2021).

In many developing countries, however, the pandemic has led to supply disruptions, agricultural commodity price disruptions due to interrupted supply and depressed demand, income losses, and rising food insecurity (Elleby et al. 2020; World Bank 2020; Varshney, Roy, and Meenakshi 2020; Aday and Aday 2020; Tamru, Hirvonen, and Minten 2020; Singh et al. 2020; Surni et al. 2021). The impact of COVID-19 on agricultural markets is highly dependent on local conditions in a country, the commodity in question, the status of the market systems, the capacity of local and national governments to respond to the pandemic, and the trade flows between countries, among other factors. Location characteristics—such as whether the area is urban or rural, surplus or deficit—determine the impact of the pandemic on agriculture prices. Furthermore, commodity characteristics (whether perishable or nonperishable) also determine the direction and magnitude of the price effect of the pandemic. As shown by Varshney, Roy, and Meenakshi (2020) in a study conducted in India, the impact of COVID-19 on agricultural markets differs by commodity (whether perishable or nonperishable) and period of analysis. This finding highlights the need to situate the studies in a local context, to capture nuances that could influence how a pandemic affects agricultural markets and ultimately food security.

Against this background, this chapter assesses the findings of analyses conducted in Benin, Burkina Faso, Kenya, Lesotho, Malawi, Mali, Mozambique, Nigeria, Rwanda, Senegal, Uganda, and Zambia that examined the effects of COVID-19-related market disruptions on staple food prices in different contexts. The analyses focused on domestic markets for local staple foods such as millet, cassava, white maize, and local rice, which tend to behave differently during times of crisis than global markets for major commodities such as imported rice, wheat, or yellow maize. Local staple food markets tend to be rather segmented from global food markets and are therefore less affected by global market shocks (Minot 2011). However, in some cases the local commodities examined are also extensively traded with neighboring countries, meaning that their prices are affected by disruptions to cross-border as well as domestic markets and transport. The analyses focused on price data at a granular, community level. They included descriptive analyses of the data, characterizing trends over time, assessing volatility, identifying spikes, comparing actual with predicted prices, examining geographic differences within and between countries, and investigating price transmission between markets.

The rest of this chapter is organized as follows: the next section describes the methodology and the data used for the analyses, while the third section provides a summary of the main findings of the analyses grouped by urban versus rural areas, deficit versus surplus areas, coastal versus landlocked countries, and perishable versus nonperishable food products. The fourth section draws conclusions and provides recommendations.

Methodology and Data

The COVID-19 pandemic has affected almost all countries, with varied consequences. To limit these impacts, different governments have implemented a variety of policies, including the closure of markets, hotels, schools, and borders. These actions are not without effect on the supply and demand of food. Indeed, these policy measures will have a direct impact on the price of these products, given the deficit or surplus situation of each market. In surplus areas, one would expect that various lockdown measures would negatively affect agricultural commodity prices, mainly due to a decrease in demand. In deficit locations, in contrast, staple food prices would be expected to increase due to limited supply locally. However, prices in cities may not increase if the decreases in demand due to the closure of schools and hotels and reductions in exports are large enough compared to the demand from households. Therefore, market connection and typology and policy options may influence price behavior. Only empirical investigation can help identify how various measures have impacted staple food prices in various contexts.

To analyze staple food price behavior before and during the COVID-19 pandemic, we modeled price trends in the absence of the pandemic and compared them to the actual prices observed during early and mid-2020, when many countries had instituted lockdowns and movement restrictions in response to the disease. As usual in a time series framework, seasonal autoregressive integrated moving average (SARIMA)[1] models were considered to extract price trends and to predict their dynamics over the lockdown period. A seasonal model was preferred since price data used were collected on a weekly or monthly basis. Therefore, there was a need to account for seasonal effects in order to obtain more accurate price forecasts. Interested readers can refer to the brief description of SARIMA models in the appendix. More technical details are available in Box et al. (2015) and Hyndman and Athanasopoulos (2018).

The use of SARIMA models to predict future prices of agricultural goods is not new. Various authors have used this approach to model agricultural commodity price trends in order to anticipate their future dynamics. For example, Marchezan and Souza (2010), Ohyver and Pudjihastuti (2018), and Darekar and Reddy (2017a) used these models to study rice prices. Similarly, Punitha (2007), Badmus and Ariyo (2011), and Kibona and Mbago (2018) have analyzed the future trend of maize prices using ARIMA models. Other commodities analyzed by the ARIMA models are tea (Ansari and Ahmed 2001), cotton (Özer and İlkdoğan 2013; Darekar and Reddy 2017b), onion (Darekar et al. 2015; Darekar, Pokharkar, and Datarkar 2016), wheat (Darekar and Reddy 2018), palm oil (Razali and Mohamad 2018), and green gram (mung bean) (Chaudhari and Tingre 2014).

For the empirical part of this work, we consider a set of 12 African countries from three subregions: eastern, southern, and western Africa. For each country,

---

[1] When there are not enough price observations (less than five consecutive years of observations), the double difference approach is used to test whether observed prices in 2020 were different from what had been observed in the past.

up to two commodities were analyzed. The choice of countries was driven by data availability. For most of the countries, retail price data used in the study were obtained from the country's market information system. For Nigeria, we used data from the Famine Early Warning Systems Network (FEWSNET) created by the United States Agency for International Development (FEWSNET 2020). For each country, we selected one of the most important locally produced and consumed commodities. Table 3.1 presents the list of countries, commodities, and periods considered in the analysis. For a majority of countries, maize is one of the most important staples for the population's consumption. Maize or maize flour was considered for 9 of the 12 countries: Benin, Burkina Faso, Kenya, Lesotho, Malawi, Mali, Mozambique, Rwanda, and Zambia. We analyzed rice prices in Mali, while millet was the focus staple studied in Senegal. In Nigeria, we considered gari, which is roasted cassava granules. The last commodity considered in this study is the cooking banana (plantain) locally named matooke in Uganda.

TABLE 3.1—COMMODITIES, NUMBER OF MARKETS, AND PERIODS CONSIDERED BY COUNTRY

Country	Commodity	Number of markets considered	Period considered
Benin	Maize	12	2010–2020
Burkina Faso	Maize	27	2010–2020
Kenya	Maize	10	2011–2020
Lesotho	Maize flour	10	2015–2020
Malawi	Maize	23	2016–2020
Mali	Maize	22	2010–2020
Mali	Rice	15	2014–2020
Mozambique	Maize	11	2016–2020
Nigeria	Gari	8	2012–2020
Rwanda	Maize	5	2013–2020
Senegal	Millet	28	2010–2020
Zambia	Maize	10	2017–2020
Uganda	Matooke	4	2010–2020

Source: Authors.

For each country, price data were available for a set of representative markets. However, only markets with sufficient data points to satisfy the requirements of the models were considered in our analysis. The number of markets considered in each country is reported in Table 3.1. For each market for which enough observations were available, the best SARIMA model was selected among candidate models using a variety of forecast accuracy measures (further details are provided in the Appendix).

Finally, due to the number of countries and markets, we needed to find an easy way to communicate our findings, especially for policymakers. Therefore, we considered the average discrepancy (percent) between observed prices and the in-sample price prediction. The average percentage absolute error was around 5 percent. Therefore, we assumed that a price deviation of 5 percent or less, in absolute terms, is not significantly different from zero. Whenever the price gap is between –5 and 5 percent, we conclude that there is no difference between actual and predicted prices.

Main Findings and Lessons Learned

The results from these analyses are summarized in the sections that follow. Results are grouped according to whether the markets are rural or urban, located in deficit or surplus areas, and located in coastal or landlocked countries, and whether the commodities are perishable or nonperishable. The authors' local knowledge of the markets as well as responses from the in-country contacts who facilitated data access were useful in understanding which areas were generally deficit or surplus areas.

Urban Versus Rural Areas

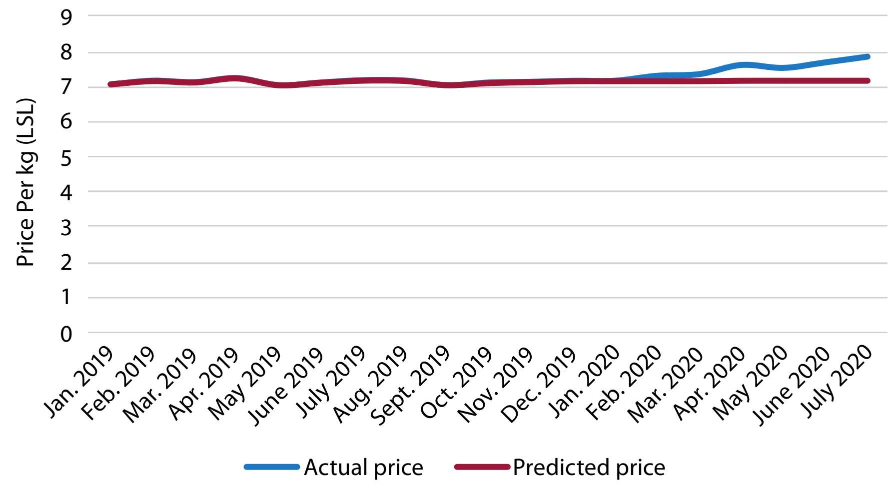
An analysis of price trends for various commodities in urban and rural areas under COVID-19 is important for purposes of intervention planning. The differentiation is necessary because COVID-19 responses may affect prices in urban and rural areas differently owing to various factors (income per capita, own production of commodities, population, availability of substitute commodities, etc.) related to demand and supply of the commodities. This section presents price dynamics for urban and rural markets for maize flour (Lesotho), maize (Malawi, Kenya, Rwanda, and Mali), and millet (Senegal). This analysis provides insights into the differential effects of COVID-19 responses on price dynamics in those markets.

In Lesotho, the study focused on prices of maize flour in the following rural markets: Butha-Buthe, Mafeteng, Mohale's Hoek, Mokhotlong, and Qacha's Nek. It also focused on the following urban markets: Berea, Leribe, Maseru, and Quthing. The results presented in this chapter are for Butha-Buthe (a rural market) and Maseru (an urban market). Figure 3.1 shows the average observed prices for maize flour in the rural areas and those forecasted by the model. The prices observed were higher than expected (implying that COVID-19 restrictions led to a price increase in rural markets). The effect of COVID-19 restrictions also led to price increases in urban markets (Figure 3.2). For food import–dependent Lesotho, the general price increase speaks to the effect of a slowdown in commodity flows from South Africa. The differential effect between urban and rural markets is likely due to the effects of Lesotho's own movement restrictions during the COVID-19 pandemic, as rural areas must import maize food commodities from the urban centers, which receive the products first from abroad.

Although Lesotho produces maize locally, it is a net importer. During the COVID-19 crisis, informal cross-border trade was restricted,[2] which may have contributed to increased transaction costs for transporting maize to rural areas, leading to higher prices. There is a role for food policy to facilitate rural and urban market integration in order to reduce transaction costs and ensure that commodities reach the rural poor at affordable prices. The price increases seen in urban and rural areas of Lesotho during the COVID-19 pandemic are in line with previous findings by the High Level Panel of Experts on Food Security and Nutrition (HLPE 2020) as well as Espitia, Rocha, and Ruta (2020), who noted that there had been localized positive price changes due to the pandemic, especially in countries that depend on food imports to meet food requirements.

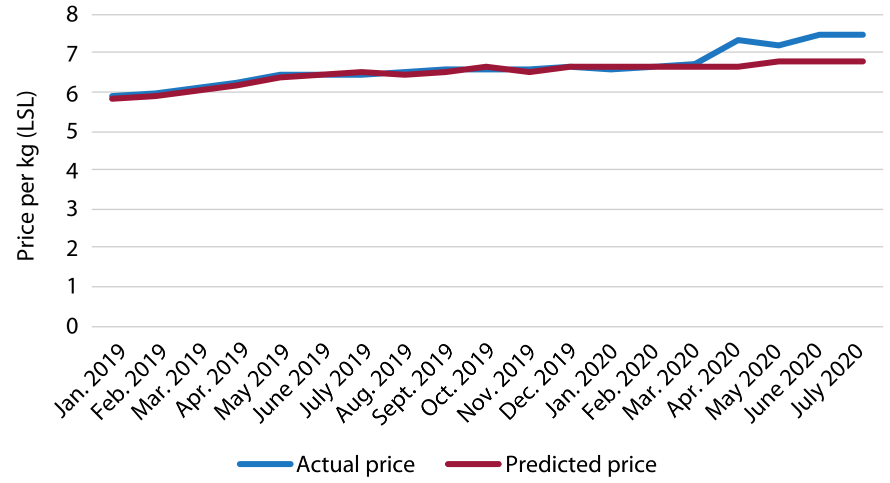
Malawi is a net exporter of maize grain. It is clear from Figures 3.3 and 3.4 that price forecasts differed from average observed prices for both urban and rural markets. The international travel restrictions announced toward the end of March and in April 2020, as well as the increase in awareness about the dangers of COVID-19 among many consumers and producers, reduced the movement of food within and across borders, leading to too much supply of food at low demand over that period. Awareness of the dangers of COVID-19

FIGURE 3.1—ACTUAL AND PREDICTED MAIZE FLOUR PRICE TRENDS IN RURAL MARKETS, LESOTHO (PRICE PER KG)



Source: Authors' computation based on data from Lesotho Bureau of Statistics.
Note: LSL = Lesotho loti.

FIGURE 3.2—ACTUAL AND PREDICTED MAIZE FLOUR PRICE TRENDS IN URBAN MARKETS, LESOTHO (PRICE PER KG)

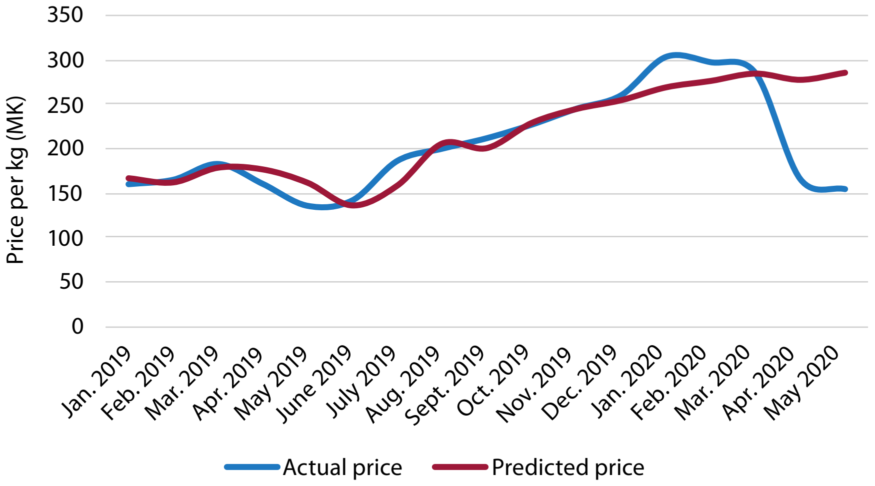


Source: Authors' computation based on data from Lesotho Bureau of Statistics.
Note: LSL = Lesotho loti.

---

[2] https://www.maserumetro.com/news/business/informal-cross-border-trade-severely-injured/

FIGURE 3.3—ACTUAL AND PREDICTED MAIZE PRICE TRENDS IN URBAN MARKETS, MALAWI (PRICE PER KG)



Source: Authors' computation based on data from WFP (2020).

Note: MK = Malawi kwacha.

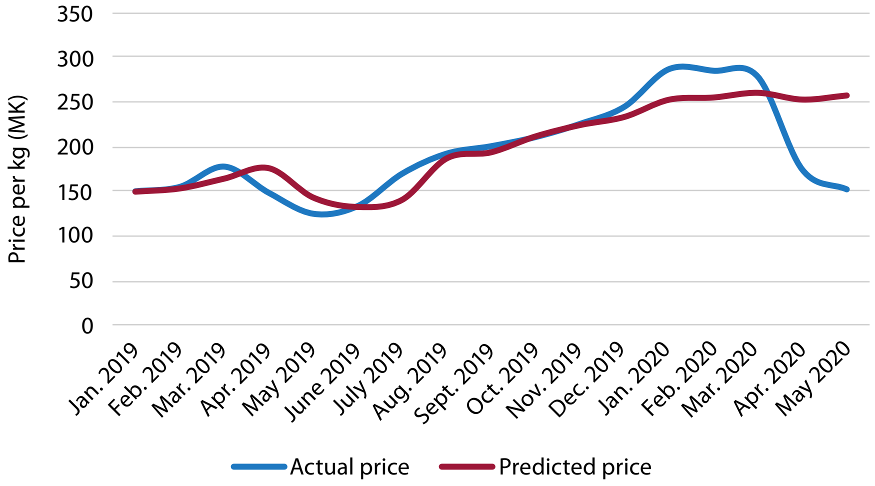
led consumers and food suppliers to reduce the number of times they visited markets to purchase or sell goods.

After March 2020, the observed prices were much lower than the prices predicted by our models, despite adjusting for seasonality. The price drop in urban centers appeared to be more than the decrease in prices in rural centers over the period, perhaps because the (demand reducing) internal travel restrictions were likely to be experienced first and more in urban centers than in rural areas, leading to surpluses of food in urban centers and depressing prices more.

In Kenya, a comparison of the observed prices and those predicted by our models for an urban market in Nakuru (Figure 3.5) suggests that measures taken to control the spread of COVID-19 may have depressed prices, especially during the months of March and April and after June, where the observed prices trended lower than predicted prices. This result concurs with the findings from Malawi.

Again, within Kenya's rural market in Kipkaren (Figure 3.6), the prices of maize during the COVID-19 period trended slightly below those predicted by our models between January and June 2020, again implying that COVID-19 restrictions had depressed demand for maize. Unlike in the urban market of

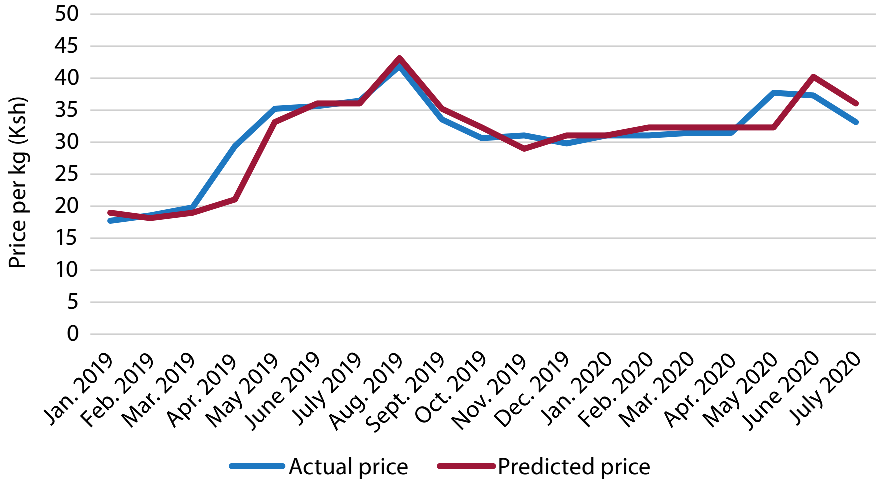
FIGURE 3.4—ACTUAL AND PREDICTED MAIZE PRICE TRENDS IN RURAL MARKETS, MALAWI (PRICE PER KG)



Source: Authors' computation based on data from WFP (2020).

Note: MK = Malawi kwacha.

FIGURE 3.5—ACTUAL AND PREDICTED MAIZE PRICE TRENDS IN NAKURU (URBAN MARKET), KENYA (PRICE PER KG)



Source: Authors' computation based on data from WFP (2020).

Note: Ksh = Kenyan shillings.

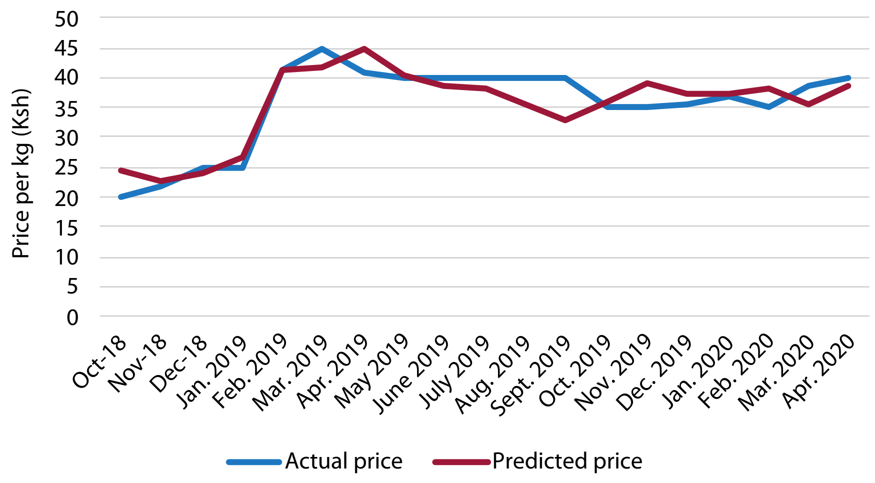
Nakuru, prices nevertheless seemed to recover in Kipkaren, perhaps as restrictions eased and demand recovered as well.

In both the urban and rural markets analyzed in Kenya, there was a general downward trend in maize prices that was more persistent in the urban market of Nakuru than in the rural market of Kipkaren. This finding also concurs with the findings in Malawi and Lesotho, where urban markets appeared to be associated with lower prices as compared to rural markets during the COVID-19 period. This is likely a manifestation of the speed with which (demand depressing) restrictions were enforced in urban areas as compared to rural areas.

In Rwanda, maize prices were analyzed for Kibungo (a rural market) (Figure 3.7) and Kimironko (an urban market located in Kigali) (Figure 3.8). There was a clear difference in the effect of COVID-19 restrictions on prices in the urban market compared to the rural market. The rural Kibungo market saw a larger decline in the price of maize compared to expected prices over the same period. It is likely that the Kibungo market experienced a reduction in demand for its maize, leading to price reductions.

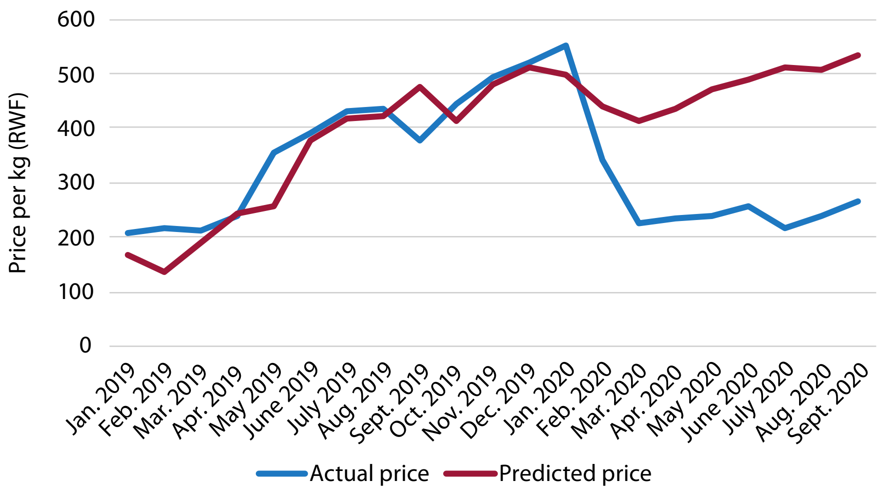
By contrast, the urban Kimironko market in Kigali, in the center of the

FIGURE 3.6—ACTUAL AND PREDICTED MAIZE PRICE TRENDS IN KIPKAREN (RURAL MARKET), KENYA (PRICE PER KG)



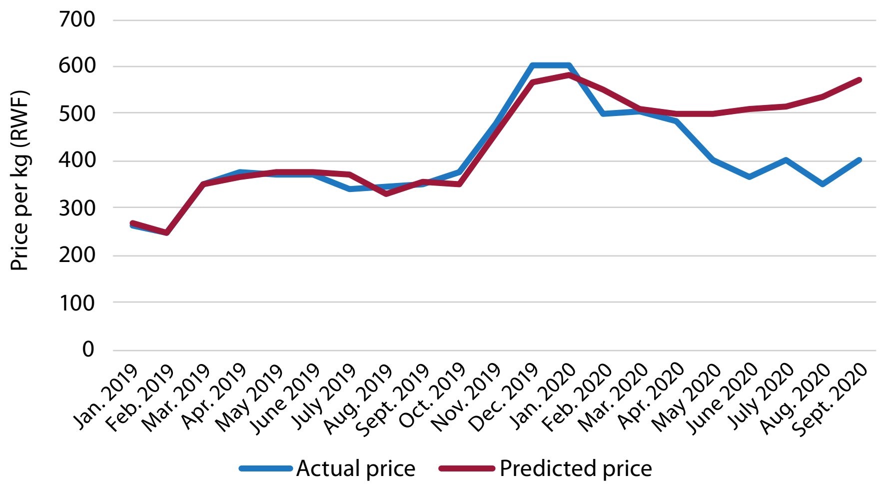
Source: Authors' computation based on data from WFP (2020).
Note: Ksh = Kenyan shillings.

FIGURE 3.7—ACTUAL AND PREDICTED MAIZE PRICES IN KIBUNGO (RURAL MARKET), RWANDA (PRICE PER KG)



Source: Authors' computation based on data from the Ministry of Agriculture and Animal Resources, Rwanda.
Note: RWF = Rwandan francs.

FIGURE 3.8—ACTUAL AND PREDICTED MAIZE PRICES IN KIMIRONKO (URBAN MARKET), RWANDA (PRICE PER KG)



Source: Authors' computation based on data from the Ministry of Agriculture and Animal Resources, Rwanda.
Note: RWF = Rwandan francs.

country, recorded a decline in maize prices relative to predicted prices from March onward (Figure 3.8), but the reduction was markedly smaller than that observed in the rural Kibungo market.

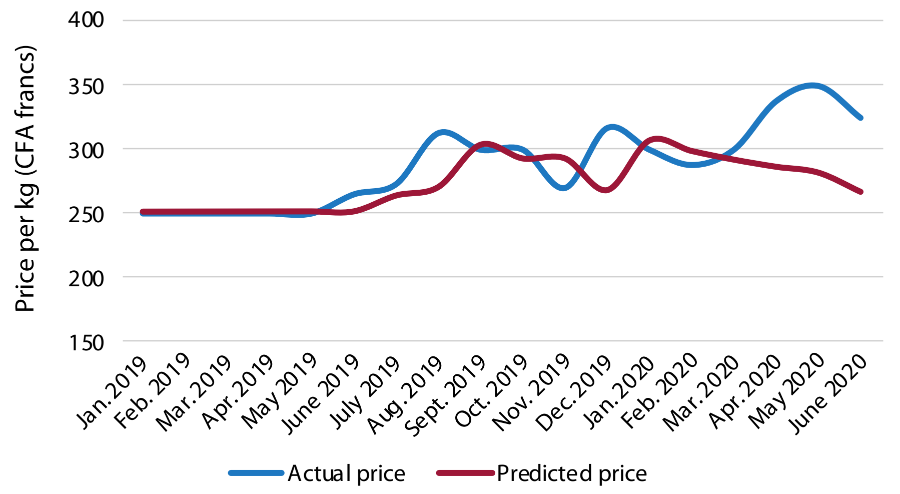
In Senegal, many of the markets registered sharp price increases compared to the prices that would have held in the absence of COVID-19 restrictions. For example, following the imposition of COVID-19 restrictions, the actual prices in St. Louis, an urban market located in a millet deficit area, increased until June 2020 (Figure 3.9). This suggests that market restrictions denied urban centers the needed stocks of millet, leading to price increases.

By creating an artificial shortage of staple foods, the restrictions imposed in response to COVID-19 disrupted the arbitrage mechanism across markets, resulting in a more generalized upward trend in prices, not just in deficit areas but also in some surplus areas. To the extent that some markets registered price increases, these results corroborate the findings by Elleby et al. (2020) and the World Bank (2020), which found that the pandemic had led to supply disruptions, agricultural commodity price disruptions, income losses, and rising food insecurity in a number of African countries.

In Mali, maize prices in Niono, a rural surplus market, increased compared to predicted prices after August 2020 but were not markedly different from predictions between January 2020 and July 2020 (Figure 3.10).

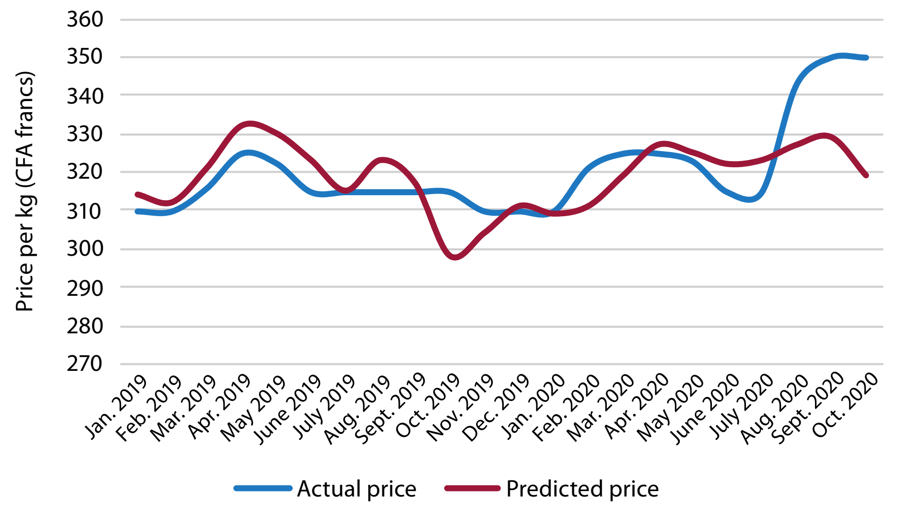
This increase in prices after August cannot be attributed solely to the COVID-19 pandemic, especially since the restrictive measures had been lifted at the beginning of June. It can be explained by both an increase in demand and an anticipation of reduced harvests. Indeed, the disruptions on the international market caused by climatic phenomena led neighboring countries (Guinea, Mauritania, and Senegal) to increase their imports of maize from Mali after the lifting of the sanctions imposed by the Economic Community of West African States during Mali's August 2020 coup d'état. The rise in prices was also influenced by the introduction of maize into the national food security stock and government purchases to support vulnerable households. On the supply side, the boycott of cotton cultivation by producers resulted in lower fertilizer quantities provided by the government-owned cotton enterprise to the producers, and this in turn reduced the availability of fertilizer for maize.[3] The reduced availability of

FIGURE 3.9—ACTUAL AND PREDICTED MILLET PRICES IN ST. LOUIS (URBAN MARKET), SENEGAL (PRICE PER KG)



Source: Authors' computation based on data from the Senegalese Market Information System of the Food Security Commission (SIM/CSA).

FIGURE 3.10—ACTUAL AND PREDICTED MAIZE PRICES IN NIONO (RURAL MARKET), MALI (PRICE PER KG)

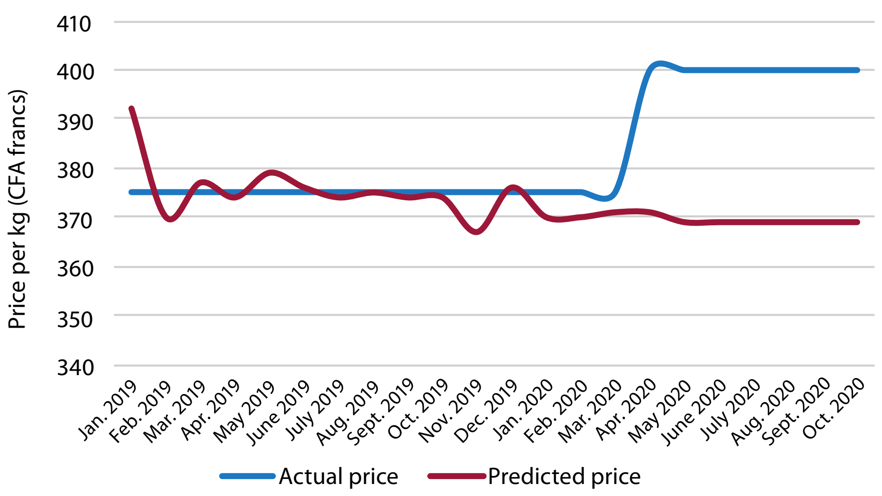


Source: Authors' computation based on data from Agricultural Market Watch (OMA).

---

[3] In Mali, there is no input distribution facility for maize production. However, cotton producers divert a part of the fertilizer distributed by the cotton company for maize production. Thus, a high share of the fertilizer used for maize originates from the cotton company.

FIGURE 3.11—ACTUAL AND PREDICTED MAIZE PRICES IN KOULIKORO BA (URBAN MARKET), MALI (PRICE PER KG)



Source: Authors' computation based on data from OMA.

fertilizer negatively affected maize yields, even if the cultivated area increased.

Similarly, the observed prices in the Koulikoro Ba maize market, which is located in the city of Koulikoro, were consistently higher during the COVID-19 period compared to those predicted by the model (Figure 3.11).

The consistently higher-than-expected prices again indicate that urban markets faced supply pressure as movement was restricted, such that although demand was also likely affected, the impact of restrictions on supply had a larger effect, leading to rising prices. This, again, corroborates the findings by Singh et al. (2020) and Surni et al. (2021), who found that the COVID-19 pandemic led to a disruption in agricultural commodity prices through supply chain disruptions.

Deficit Versus Surplus Areas

Another interesting grouping of the markets is based on the levels of domestic supply relative to demand for a given commodity. In this section, the prices of maize in Burkina Faso, Mali, Kenya, Malawi, Mozambique, Rwanda, and Zambia; millet in Senegal; gari in Nigeria; and matooke in Uganda are analyzed in terms of the distinction between deficit and surplus areas.

As would be expected, restrictions that emerged at the beginning of the pandemic in March 2020 to limit the movement of people affected the movement of goods, making it difficult for food products to flow uninterrupted from production areas to markets in deficit areas and across borders with neighboring countries. In theory, such market restrictions should induce a downward trend in prices, below their predicted levels, in surplus areas, as there would be too few purchasers, while the opposite would be expected in deficit areas, due to lack of supply.

Deficit Areas

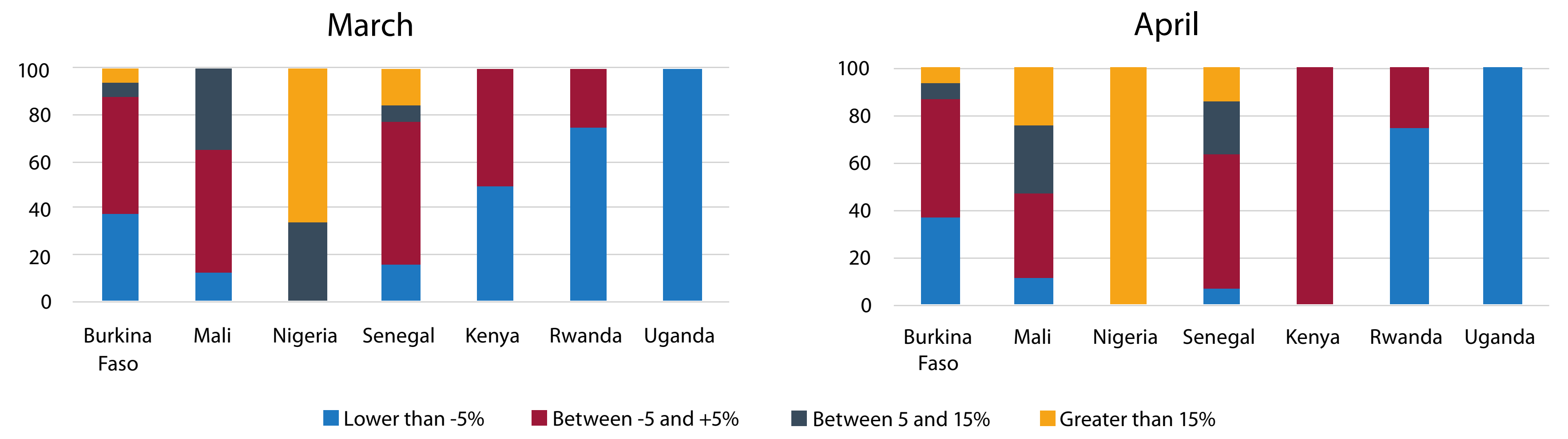
In deficit areas, the extent to which prices may change would depend on access to surplus areas and on changes in demand from particular groups like schools, universities, restaurants, and hotels, which were operating at an unusually low level during the lockdown period. A comparison of deficit-area markets in western and eastern Africa reveals a differential effect of COVID-19 restrictions on prices across the regions. For instance, it appears from Figure 3.12 that price trends in eastern Africa were in general negative or increased by less than 5 percent, while in western Africa, some markets experienced price increases of between 5 and 15 percent and even more.

In western Africa, the price increases at the beginning of the pandemic (March and April 2020) were modest in most markets (that is, below 5 percent), except in Nigeria, where substantial price increases (over 15 percent) were observed in two-thirds of the markets in March and in all markets from April to July.

It is noteworthy that price increases were more significant in Senegal than in Burkina Faso and Mali after one month of lockdown in April 2020. This might be explained by the fact that even in normal years Senegal has a deficit in millet, the staple food. This commodity is primarily imported from Mali. The situation worsened in Senegal in May, when price increases of more than 5 percent were observed in around three out of four markets (72 percent). Prices in deficit areas in the country rose steadily from March until June.

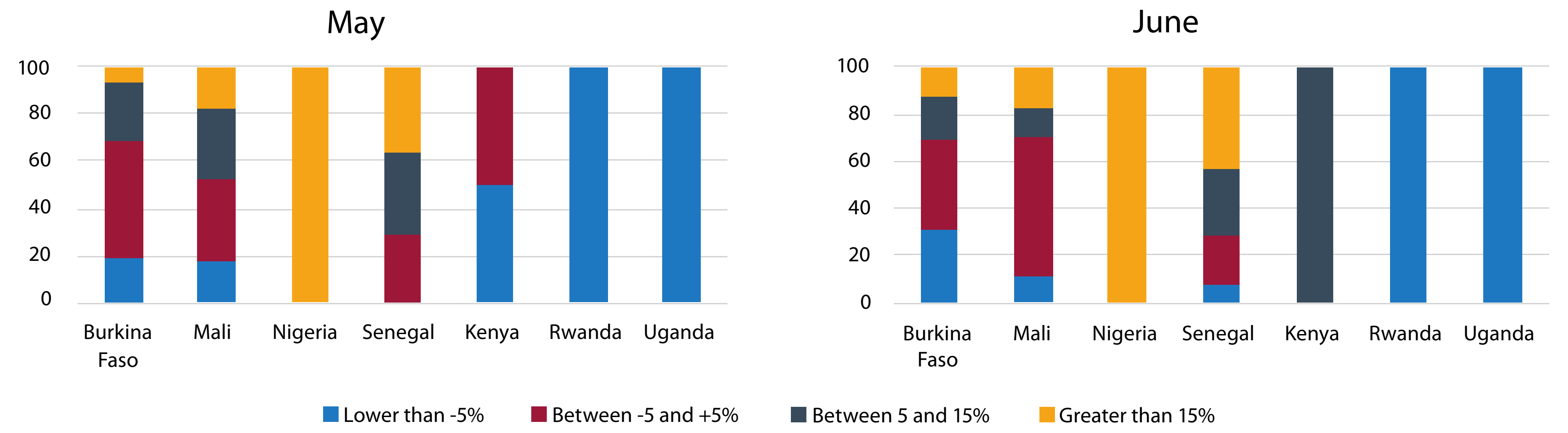
In June 2020, with the end of lockdown, price increases were less than 5 percent in around 70 percent of the markets in Burkina Faso and Mali, while in Senegal price increases of more than 15 percent were observed in nearly one market out of two (47 percent) in the deficit areas (Figure 3.13). A drop in demand caused by the economic crisis following the onset of the pandemic could explain this trend in Burkina Faso and Mali. The increased

FIGURE 3.12—PROPORTION OF MARKETS IN DEFICIT AREAS ACCORDING TO THE LEVEL OF DEVIATION FROM PRICE PREDICTIONS (IN PERCENT) IN MARCH–APRIL 2020



Source: Authors' computation based on price data from country bureaus of statistics or agricultural market information systems.

FIGURE 3.13—PROPORTION OF MARKETS IN DEFICIT AREAS ACCORDING TO THE LEVEL OF DEVIATION FROM PRICE PREDICTIONS (IN PERCENT) IN MAY–JUNE 2020



Source: Authors' computation based on price data from country bureaus of statistics or agricultural market information systems.

supply in deficit areas induced by the decrease in cross-border exports due to border closures could also explain the price drop in deficit areas. In Senegal, the concentration of millet production in the groundnut basin (the major groundnut producing area in central Senegal), the dependance on imports from neighboring countries in normal years, and the significant number of urban markets with huge demand in deficit areas might explain the longer delay in those markets' return to normality.

The behavior of staple food prices in eastern Africa is quite similar to that observed in southern African countries, but it differs from what is observed in deficit areas in western Africa.

In March 2020, in eastern Africa, price decreases of more than 5 percent were observable in 50 percent of markets in Kenya, 75 percent of markets in Rwanda, and all markets in Uganda. The same situation prevailed in Rwanda and Uganda from April to July, with price drops of more than 5 percent in almost all markets in deficit areas.

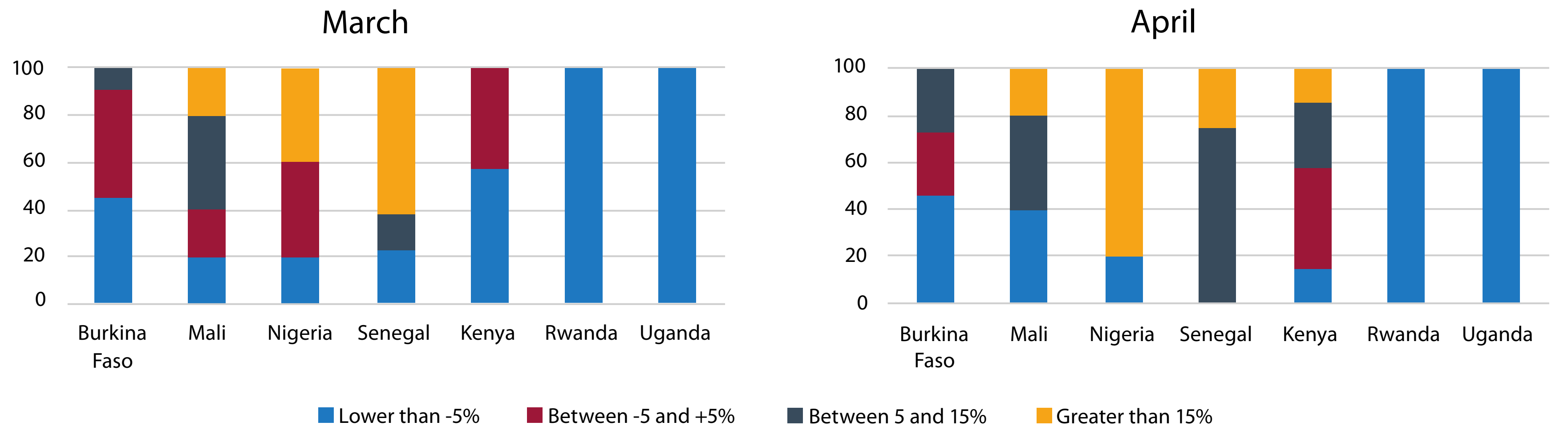
In Kenya, prices were more or less stable, with price changes between –5 and 5 percent in all considered markets in April. Only in June were the price increases higher than 5 percent in all markets. In May as well as in July, prices decreased or increased less than 5 percent.

Surplus Areas

In March 2020, prices showed normal or decreasing trends compared to predictions in Burkina Faso and Kenya. However, in Mali and Senegal, and to a lesser extent in Nigeria, most markets were already reporting prices that were higher than predicted. Indeed, the share of markets located in surplus areas with prices more than 5 percent higher than predicted was 60 percent in Mali, 77 percent in Senegal, and 40 percent in Nigeria (Figure 3.14).

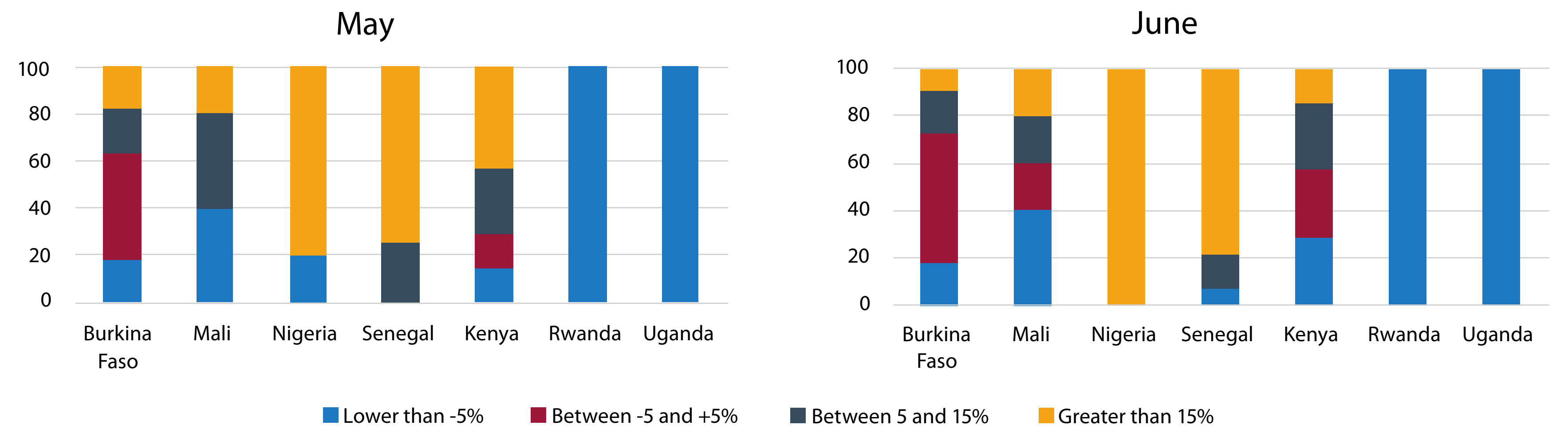
The restrictive measures implemented by the countries started impacting markets as early as April, but these effects differed. In Burkina Faso, Nigeria, Senegal, and Kenya, market prices increased despite restrictions on movement. The proportion of markets with prices at least 5 percent higher than predicted was 100 percent in Senegal (versus 77 percent in March), 43 percent in Kenya (versus 0 percent in March), and 80 percent in Nigeria (versus 40 percent in March). In Senegal, the expected imports from Mali were disrupted with

FIGURE 3.14—PROPORTION OF MARKETS IN SURPLUS AREAS ACCORDING TO THE LEVEL OF DEVIATION FROM PRICE PREDICTIONS (IN PERCENT) IN MARCH–APRIL 2020



Source: Authors' computation based on price data from country bureaus of statistics or agricultural market information systems.

FIGURE 3.15—PROPORTION OF MARKETS IN SURPLUS AREAS ACCORDING TO THE LEVEL OF DEVIATION FROM PRICE PREDICTIONS (IN PERCENT) IN MAY–JUNE 2020



Source: Authors' computation based on price data from country bureaus of statistics or agricultural market information systems.

the closure of borders, and movement restrictions in general contributed to increased prices during the lean season. In Mali, prices fell in some markets in surplus areas due to falling demand. In fact, in 20 percent of markets where prices were more or less equivalent to the predictions, prices declined by more than 5 percent compared to predictions.

In May 2020, the upward price trend in surplus areas was accentuated in Mali, Senegal, Kenya, and, to a lesser extent, Burkina Faso.

With the lifting of restrictive measures in June 2020 in most countries, the pressure observed in markets in surplus areas decreased in some countries. In Burkina Faso, 73 percent of the markets in surplus areas analyzed showed declining price trends, compared to 64 percent in April (Figure 3.15). Similar trends were observed in Mali and Kenya, with, respectively, proportions of 60 and 40 percent in April and 57 and 29 percent in June. However, prices remained high in Nigeria and Senegal. The increase in demand after the reopening of the markets or the negative expectations of traders could explain this trend. Similar price increases have also been reported by other studies. For example, a study by Mogues (2020) reported that consumer food prices saw an appreciable increase globally in the three months beginning in mid-February 2020, underscoring the negative effect on markets of the reduced supply of food commodities.

In Rwanda, measures taken by the government to control and contain the spread of COVID-19 had the unintended effect of disrupting maize prices. The containment measures made it difficult for maize to flow uninterrupted from production markets to consumption markets and across borders with neighboring countries. The closure of hotels and restaurants, which are major demand points for the staple, exacerbated the situation. The decline in actual prices relative to predicted prices continued even into the month of July 2020, despite some relaxation of the initial measures. The same measures taken by the government of Uganda also led to a decline in the price of matooke relative to predicted prices.

In Malawi, Mozambique, and Zambia, restrictions on people's movement resulted in reduced maize demand (as consumers reduced the number of trips to markets), which in turn led to a drop in prices. The price decrease is also related to the fact that COVID-19 restrictions coincided with the maize harvesting season. The price effect of decreased demand as a result of COVID-19 restrictions, along with the onset of the harvest season, led to excess supply and thus to generally lower prices. This result is understandable considering that Malawi, Zambia, and Mozambique are net exporters of maize and rely on cross-border trade. Maize harvests were not substantially reduced by the COVID-19 pandemic in 2020 because the first cases emerged long after the growth season had commenced. In Senegal, the price increase is explained by the fact that the markets were not well supplied during the lockdown period.

In summary, two different patterns appear when comparing pandemic-related staple food price trends in deficit and surplus areas across the three subregions of western, eastern, and southern Africa. In western Africa, prices increased in the deficit areas of all considered countries during the lockdown period. Prices fell with the lifting of restrictions in Burkina Faso and Mali, while the pressure on prices remained significant in Senegal and Nigeria. In contrast, in eastern and southern Africa, where cross-border trade is more important than in western Africa, a general downward trend was observed for deficit as well as for surplus areas throughout the considered period, with some exceptions. Indeed, cross-border sales to neighboring countries in these subregions may have played a significant role in determining pre-COVID-19 price behavior across the country, not just in border areas, and declines in cross-border trade due to the COVID-19 crisis may have contributed to lower prices. The potential negative impact from the observed decline in prices shows the critical importance of transborder trade for smallholder farmers and small businesses. When trade across the borders stopped, the exporting markets quickly found themselves with too much maize and low demand, leading to declining prices.

Coastal Versus Landlocked Countries

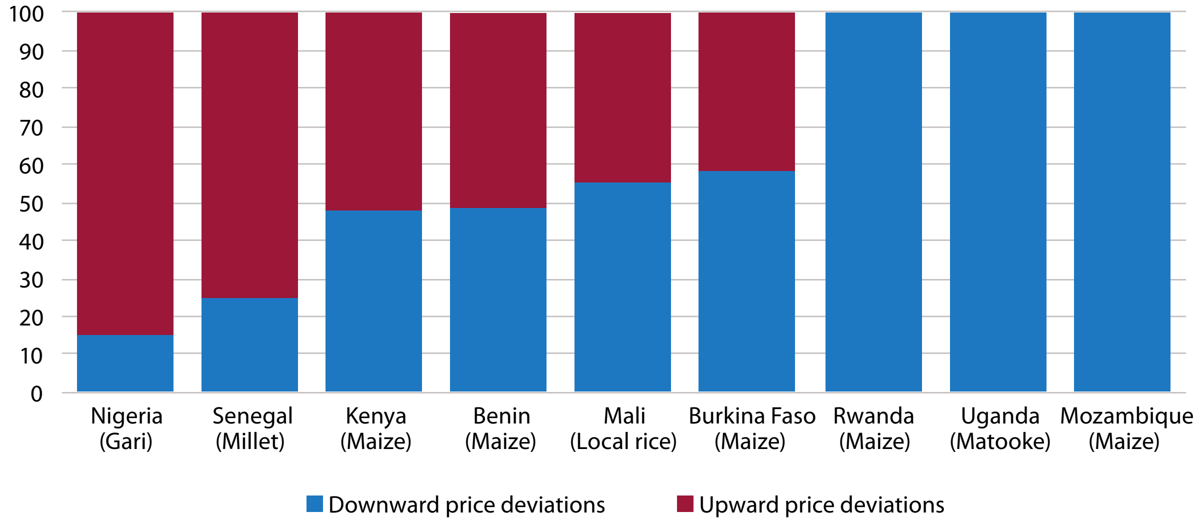
A market's location within a coastal area or far from an ocean is an important factor in determining the effects of COVID-19 restrictions on market prices. Supply chain disruptions are likely to affect coastal and landlocked African food import–dependent countries to varying degrees due to differing levels of exposure to international trade. The effects of COVID-19 on international food prices were relatively moderate (Nagle and Baffes 2020) and could have helped to stabilize local food prices in coastal countries. Landlocked countries are likely to be affected more significantly, given their less direct connections with world markets. Among the sample of countries under analysis, Benin, Kenya, Mozambique, Nigeria, and Senegal are coastal countries that trade directly with the rest of world, while Burkina Faso, Lesotho, Malawi, Mali, Rwanda, Uganda, and Zambia trade with the rest of world through the ports of neighboring coastal markets and thus incur higher trading costs than coastal countries.

Fewer price deviations attributable to COVID-19 would be expected in coastal countries, as these countries can more easily mitigate price hikes resulting from domestic production and market disruptions through direct imports. In contrast, landlocked countries would be expected to experience more price hikes due to longer delays in supplying domestic markets from world markets via regional port infrastructure.

However, this anticipated dichotomy has not been confirmed by the distribution of price deviations across the sample of countries. The highest price deviations were observed among both coastal and landlocked countries, as were the lowest price deviations. For instance, an upward price deviation as high as 113.5 percent was observed for gari in Nigeria, a coastal country, and a downward price deviation as high as 48 percent was reached for matooke in Uganda, a landlocked country. This does not imply that access to the sea is not important for trade, but it does suggest the importance of considering commodity characteristics in the analysis. The downward movement of matooke prices may be explained by the fact that Uganda is the sole major producer of this commodity, and trade restrictions led to excess supply, thus leading to low prices. The results also suggest that price deviations—both upward and downward—were highest for commodities that are less internationally traded, like gari and matooke, than for commodities that are traded across borders in higher volumes.

The actual evolution of food prices seems to have been governed by a combination of other more determining factors. Figure 3.16 shows that between March and July 2020, the prices of the commodities under analysis deviated upward from their predicted levels more often in coastal countries than in landlocked countries. However, this is also likely because many of the coastal

FIGURE 3.16—PROPORTION OF MARKETS WITH DOWNWARD/UPWARD PRICE DEVIATIONS BETWEEN MARCH AND JULY 2020 IN STUDY COUNTRIES (PERCENT)



Source: Authors' computation based on price data from country bureaus of statistics or agricultural market information systems.

areas in focus were surplus producers of the commodities. In Rwanda and Uganda (landlocked countries) but also in Mozambique (a coastal country), observed prices deviated consistently downward in all localities analyzed throughout March–July 2020. In Nigeria, in 85 percent of cases, the observed prices of gari deviated upward in the same period.

Overall, the prices of staple foods counterintuitively deviated downward in landlocked countries and upward in coastal countries during the period of COVID-19-related transport and trade restrictions. This result indicates that landlocked countries have been able to counter the cost effects associated with their remoteness and indirect connections with world import markets. However, the price increases in coastal countries seem to reflect the additional cost effects of delays and losses associated with international transport and world trade restrictions.

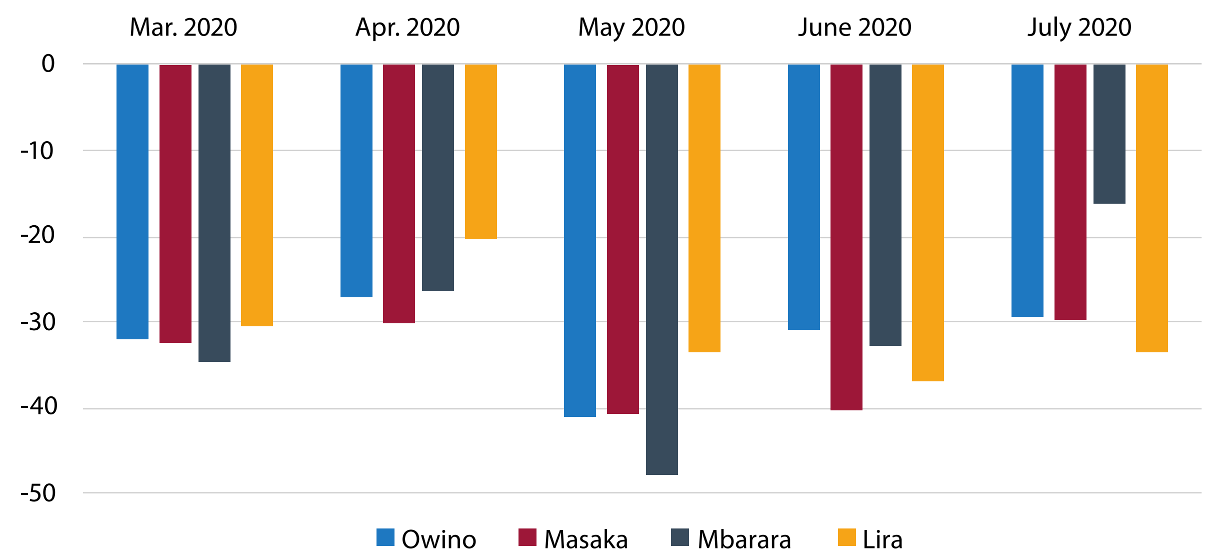
Perishable Versus Nonperishable Commodities

This section summarizes the findings of a comparative analysis of the impact of the COVID-19 pandemic and measures taken by governments to control it on the wholesale and retail prices of perishable and nonperishable staple food commodities across six countries in Africa. The nonperishable staple commodities consist mainly of cereals, including millet (in Senegal), maize flour (in Lesotho), and maize grain (in Malawi, Kenya, and Burkina Faso). The perishable staple food considered was matooke (in Uganda).

Perishable food commodities cannot be stored or hoarded because they will spoil and go to waste. In essence, the market-period supply curve of a perishable commodity is perfectly inelastic, or a vertical straight line. This implies that demand for perishables determines the price. If demand is disrupted and shifts downward, the price will consequently fall. However, the supply of a nonperishable good is elastic, and therefore the impact of disruption to supply and demand is less determinate. Sellers of nonperishable commodities can hold back and wait until the price of the good rises, but sellers of perishable commodities do not have this option.

Holding other factors constant, the COVID-19 pandemic and the restrictions that accompanied it were expected to affect prices of perishable and nonperishable staples differently. In a situation in which the disruption affects the demand side (for example, closure of hotels and restaurants), the price of perishable staples can collapse. In contrast, disruption in the flow of nonperishable staples, controlling for other factors, could have a differentiated effect: producing areas would experience declining prices due to accumulating supplies, while deficit areas would experience rising prices. In this section, we present the results of a comparison between actual monthly prices and predicted prices (prices that we expect would have prevailed in the absence of the pandemic), based on seasonal patterns and historical price data.

FIGURE 3.17—PERCENTAGE DIFFERENCE BETWEEN ACTUAL AND PREDICTED MATOOKE PRICES IN UGANDA (MARCH–JULY 2020)



Source: Authors' computation based on data from Farmgain Africa (2020).

Matooke is the primary staple food commodity in Uganda. It is highly perishable and hence vulnerable to any market disruption. Analysis conducted in five markets across the country showed that COVID-19-related restrictions led to a sharp decline in matooke prices (Guthiga, Kirui, and Karugia 2020). As shown in Figure 3.17, prices in retail markets were observed to range between 16 and 48 percent below the predicted long-term prices over the March–July 2020 period. The closure of main demand centers (restaurants, educational institutions, etc.) led to a decline in demand and a sharp drop in prices. The restrictions on movement and partial closure of borders also affected the export of matooke to neighboring countries. The dynamics of local matooke prices are illustrated in Figure 3.18 for one of the markets in Kampala (Owino), which shows actual prices falling below long-term predicted prices in both production and consumption areas.

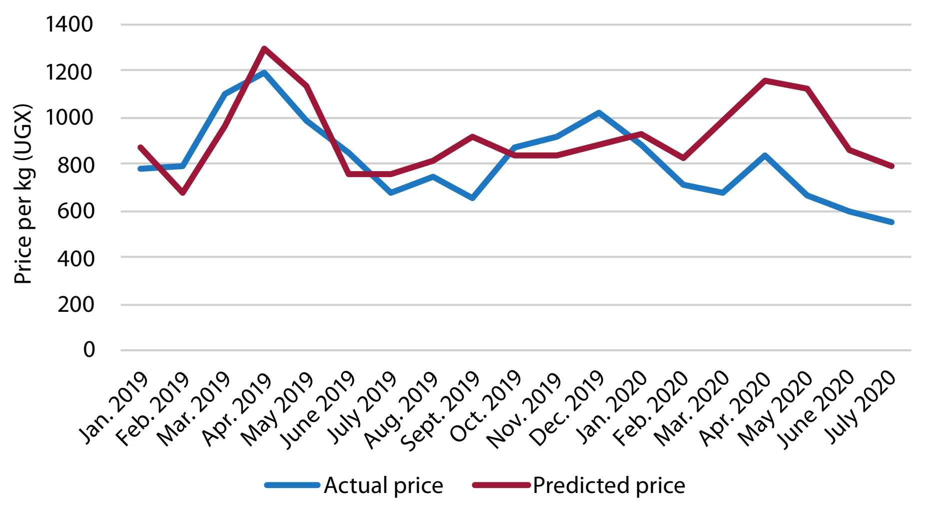
The impact of COVID-19-related restrictions on the price behavior of nonperishable cereals varied across countries in southern, eastern, and western Africa. Millet and maize surplus markets in western Africa experienced decreases in prices, while deficit markets experienced increased prices (Taondyande et al. 2020). Maize markets in southern Africa (Malawi and Mozambique) exhibited similar trends of depressed prices, primarily in border area markets, albeit with more variation across markets (Matchaya et al. 2020). The differential effects of COVID-19 containment measures and restrictions on perishable and nonperishable commodities are also supported by other empirical studies, including Varshney, Roy, and Meenakshi (2020), who found that the impact of COVID-19 on agricultural markets differed depending on whether the commodity was perishable or nonperishable. Similarly, Mogues (2020) found that the magnitude and the direction of price changes differ depending on many factors, including product storability.

Figure 3.17 shows that in all markets studied in Uganda, the prevailing matooke prices were much lower than the predicted prices, underscoring the fact that COVID-19 containment measures disrupted demand and led to low prices for surplus matooke markets.

Figure 3.18 presents evidence in support of the findings presented in Figure 3.17. The overwhelming conclusion from this analysis is that prices for matooke declined significantly during the COVID-19 pandemic.

In Senegal, government measures to control the spread of COVID-19 pushed millet prices in deficit areas far above their predicted levels. The same increase was observed in surplus area markets and was sustained even in June, following

FIGURE 3.18—ACTUAL AND PREDICTED MATOOKE PRICES IN OWINO MARKET, UGANDA (PRICE PER KG)



Source: Authors' computation based on Farmgain Africa (2020).
Note: UGX = Ugandan shillings.

the easing of restrictions. A similar pattern was observed with maize prices in Burkina Faso. The general upward trend in prices means that poor and vulnerable households experienced an erosion of purchasing power and pressure to adjust staple food demand and consumption (Figures 3.19 and 3.20).

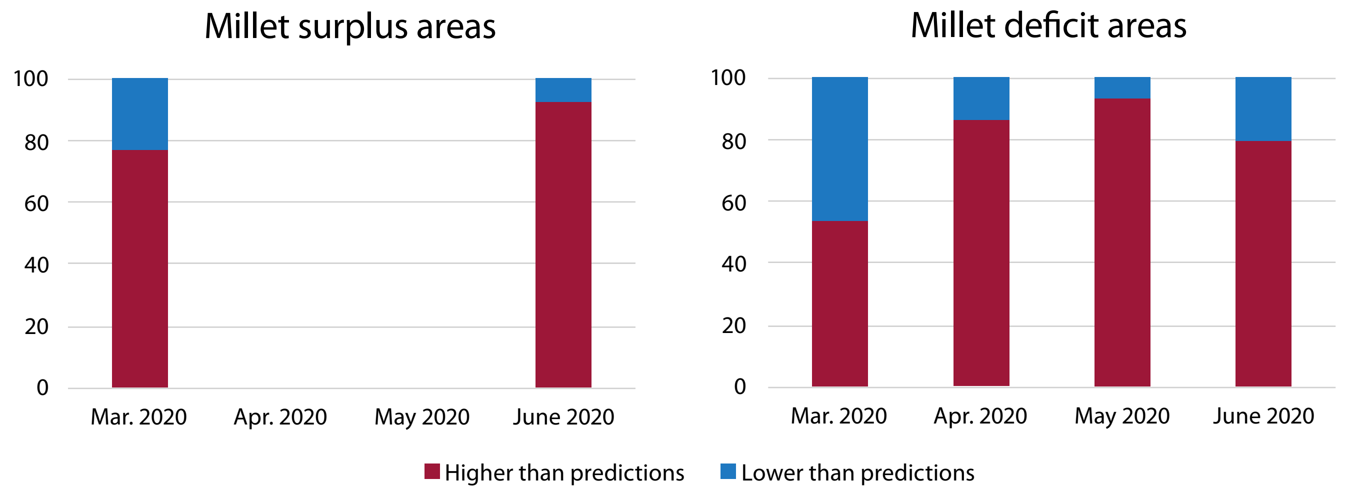
In southern Africa, the behavior of maize prices over the COVID-19 restriction period differed notably between countries. For countries that are generally maize deficit and depend on imports from neighbors, there was a general increase in maize prices due to reduced supply caused by the closure of borders. For example, the restrictions on movement within Lesotho and South Africa may have reduced the supply of food commodities in Lesotho, leading to price increases above the long-term predicted levels in both rural and urban areas (Figures 3.1 and 3.2). This is because Lesotho relies heavily on maize imports from South Africa.

In Malawi, a different pattern of behavior was observed for maize prices; at the onset of the harvesting period in the first quarter of the year, market demand for food commodities was dampened by increased supplies of food in markets, combined with government actions taken domestically and in neighboring countries in response to COVID-19 spread. As shown in Figure 3.21, maize prices were lower in both urban and rural markets compared to the predicted prices.

In Kenya, restrictions enacted to limit the movement of people led to a higher-than-predicted increase in maize prices in the majority of retail markets, as maize supply was restricted over that period. Figure 3.22 shows that the proportion of markets recording higher-than-predicted prices increased steadily from March to July 2020.

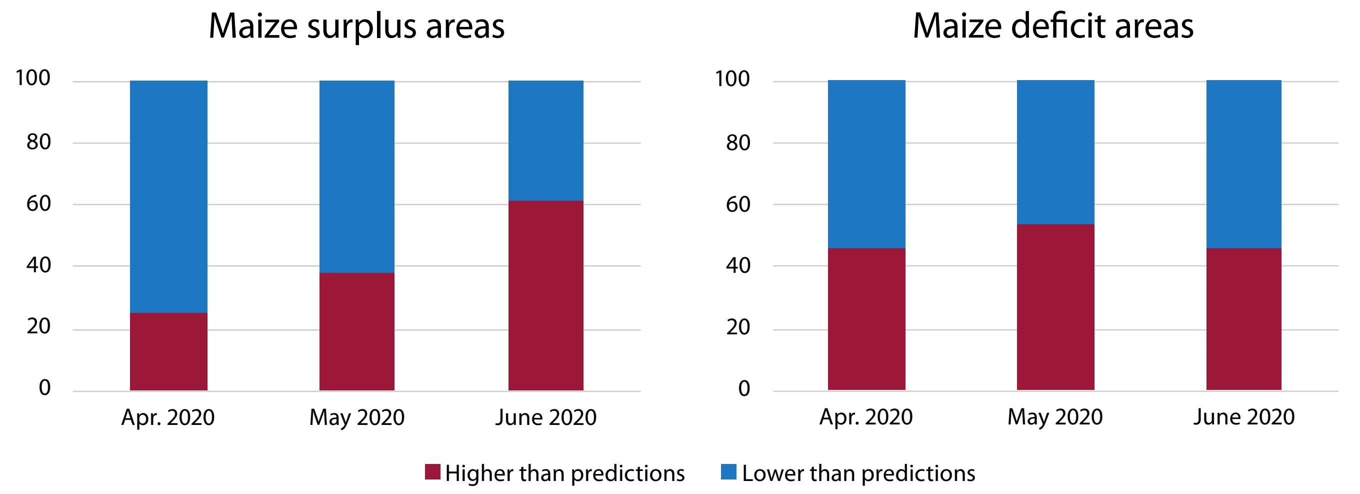
In theory, disruptions in supply and demand would be expected to have different impacts

FIGURE 3.19—SHARE OF MARKETS WITH HIGHER-THAN-PREDICTED MILLET PRICES IN DEFICIT AND SURPLUS AREAS IN SENEGAL (PERCENT)



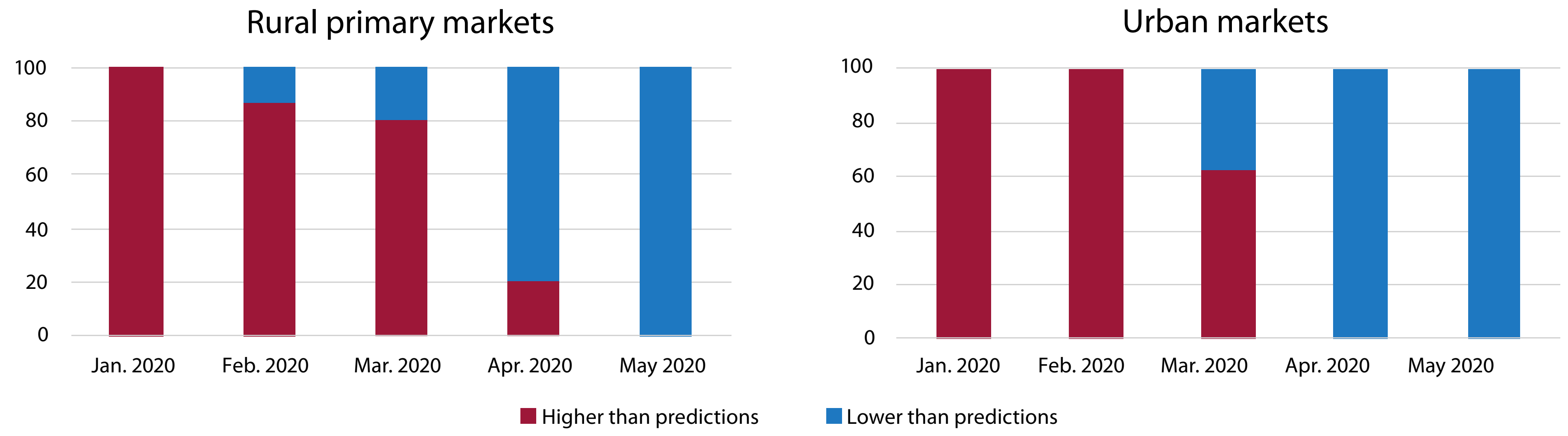
Source: Authors' computation based on data from SIM/CSA.

FIGURE 3.20—SHARE OF MARKETS WITH HIGHER-THAN-PREDICTED MAIZE PRICES IN DEFICIT AND SURPLUS AREAS IN BURKINA FASO (PERCENT)



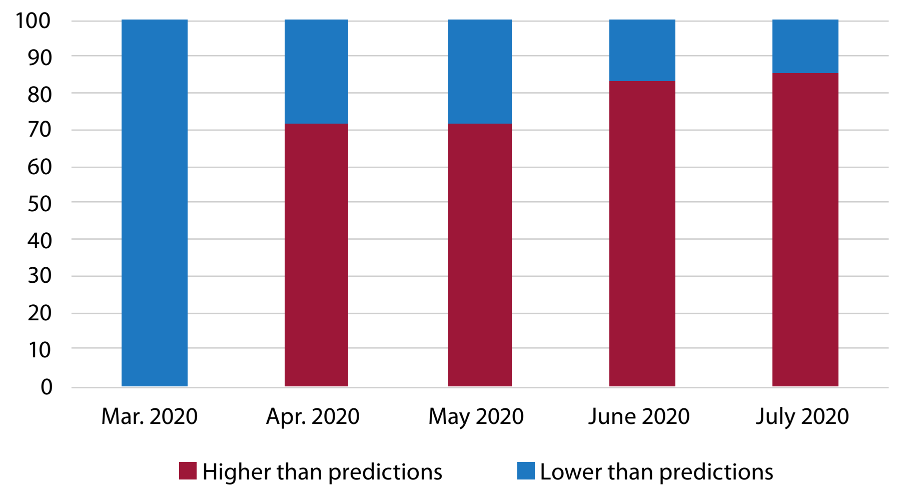
Source: Authors' computation based on data from the Agricultural Market Information System of the National Food Security Stock Management Society of Burkina Faso (SIM/SONAGESS).

FIGURE 3.21—SHARE OF MARKETS WITH HIGHER-THAN-PREDICTED MAIZE PRICES IN RURAL AND URBAN AREAS IN MALAWI (PERCENT)



Source: Authors' computation based on data from WFP (2020).

FIGURE 3.22—SHARE OF RETAIL MARKETS WITH HIGHER-THAN-PREDICTED MAIZE PRICES IN KENYA (PERCENT)



Source: Authors' computation based on WFP (2020).

on the price behavior of perishable and nonperishable commodities. In practice, however, the effects are less distinct due to confounding factors. In this section, we observed that disruption of demand for perishable matooke led to a near collapse of its price in Uganda. The impact of disruption on cereals was, however, a bit more nuanced across countries. In general, these results appear to be supported by literature on restrictions imposed for COVID-19 and other diseases, such as Ebola. For example, in a study in Liberia, Sumo (2019) also found that diseases that require social distancing and other containment measures to limit their impact reduce productivity, disrupt supply chains, depress demand for agricultural commodities, impede the proper functioning of agricultural markets for inputs and outputs, and affect prices.

Conclusions

The objective of this chapter was to present evidence on the effects of COVID-19 restriction measures on food systems by studying the dynamics of food prices over time. The findings reveal that the crisis has exposed the structural vulnerabilities of food import–dependent countries linked through food price dynamics. After the pandemic's onset, many markets in western Africa experienced noticeable price increases due to the impact of lockdown restrictions on supply. In southern and eastern African markets, however, prices were generally lower than expected (except in Lesotho). Prices were also generally lower in urban markets than in rural ones, even in countries that experienced a general increase in prices. Analyzing specific commodities adds further complexity: for example, while maize prices generally declined in both urban and rural markets in Kenya and Malawi, this downward trend was more persistent in urban markets. In Rwanda, however, maize prices declined more in the rural market under observation than the urban one.

A comparison of staple food prices across deficit and surplus areas within different African subregions also illustrates distinct patterns. During the lockdown period, prices increased in deficit areas in western Africa. Prices remained high in Senegal and Nigeria after restrictions were lifted, but fell in Burkina Faso and Mali. In eastern and southern Africa, where cross-border trade is more important, prices instead declined in both deficit and surplus areas (with some exceptions). Trade with neighboring countries may have significantly affected price behavior across the country, not just in border areas. The decline in prices and subsequent potential for negative impacts also highlights the importance of transborder trade for smallholder farmers and small businesses.

Due to higher costs and longer procurement delays for delivering goods inland, prices were expected to increase more in importing, landlocked countries than in coastal ones. However, this assumption was disproven by the finding that prices of local staple foods trended downward in landlocked countries and upward in coastal ones. This result does not refute the importance of coastal access for trade, but it highlights the need to consider commodity characteristics. For example, in landlocked Uganda, where the price of matooke fell by as much as 48 percent, excess supply resulting from lower demand and export restrictions may explain the significant price deviation.

In theory, the prices of perishable and nonperishable foods would be affected differently by disruptions to supply and demand. However, the analysis shows that the effects on price behavior are less distinct than expected due to confounding factors. While disruption to demand in Uganda for perishable matooke led to a near collapse in its price, the impacts on nonperishable cereals were more nuanced across countries.

Policy Implications

This study has demonstrated that during crises, a good understanding of how local staple food markets behave and close tracking of changes in food prices at the community level must be key elements of any strategy to protect livelihoods, especially those of the poor and most vulnerable members of society. The following recommendations are suggested by the study:

1. Blanket policy responses and interventions will not be effective in addressing the effects of crises such as the COVID-19 pandemic. Interventions should be based on a good understanding of how different factors compound to affect staple food price behavior at the local level.
2. Countries should institute a mechanism to track and analyze food prices to avoid large-scale market disruptions by enabling early identification of affected areas.
3. Countries must put measures in place to facilitate intra-regional trade, especially during crises or shocks. This study shows the importance of intra-regional trade in stabilizing local food prices.
4. Policy responses to control a pandemic such as COVID-19 must consider the differentiated effects on staple food demand and supply. Measures should ensure that producer prices remain remunerative to safeguard continued supply while consumer prices allow the poor and vulnerable to access food. Targeted support to food production and distribution services, accompanied by consumer support interventions, can stabilize food prices. These interventions were especially critical after the disruptions experienced in the early days of COVID-19, when countries were still learning how to cope with the crisis.
5. Measures implemented by countries to control the spread of a disease such as COVID-19 should be designed and implemented in ways that avoid large-scale disruptions of market operations, especially of essential commodities such as staple foods. Infection-control protocols could be enforced while allowing market operations to continue unhindered.
6. Large-scale disruption of market activities can be avoided by engaging with local market players to design interventions that help control the spread of the disease but also allow intra-regional trade and movement of food commodities from surplus to deficit regions within a country.
7. The response to outbreaks such as COVID-19 should include carefully considered commodity price stabilization as well as a drive toward building food system resilience (for instance, through diversification). Such an approach would have limited the micro- and macroeconomic effects of the pandemic in each of the countries studied.

Appendix

SARIMA Model

The objective of this section is to briefly describe the model used to extract trends in commodity prices in order to forecast their future values. The seasonal autoregressive integrated moving average (SARIMA) models were considered for this exercise.

These models have six components and are expressed as ARIMA(p,d,q)(P,D,Q)$_m$, where

- p is the number of autoregressive terms,
- d is the number of nonseasonal differences needed for stationarity, and
- q is the number of lagged forecast errors in the prediction equation (moving average part).
- P is the number of the seasonal autoregressive terms,
- D is the number of seasonal differences needed for stationarity, and
- Q is the number of seasonal moving average terms.

Let Y be the time series of interest.

- If $d = 0$: $y_t = Y_t$.
- If $d = 1$: $y_t = Y_t - Y_{t-1}$.
- If $d = 2$: $y_t = (Y_t - Y_{t-1}) - (Y_{t-1} - Y_{t-2}) = Y_t - 2Y_{t-1} + Y_{t-2}$.

The general mathematical formulation of an ARIMA(p,d,q) is

$$y_t = \mu + \sum_{i=1}^{p} \varphi_i y_{t-i} + \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} + \varepsilon_t,$$

where y_t denote the d^{th} difference of Y, ε_t is an error term and μ is a constant, φ are the autoregressive parameters, and θ stand for the moving average's parameters.

Once the model order has been identified (that is, the values of p, d, and q), its estimation can be performed using the maximum likelihood estimator. Due to differences in the algorithms implemented in the software used, results are likely to differ from one software program to another.

A seasonal ARIMA (SARIMA) model is an extension of the usual ARIMA to include additional seasonal terms. For monthly data, an ***ARIMA(1,1,1)(1,1,1)$_{12}$*** should look as follows:

$$(1-\varphi_1 \boldsymbol{B})(1-\delta_1 \boldsymbol{B}^{12})(1-\boldsymbol{B})(1-\boldsymbol{B}^{12})Y_t = (1-\theta_1 \boldsymbol{B})(1-\vartheta_1 \boldsymbol{B}^{12})\varepsilon_t,$$

where ***B*** stands for time lag operator.

The first step to identify the most reasonable ARIMA is to visualize various representations of the series at hand. The most popular graphs are those of the autocorrelation function (ACF) and partial autocorrelation function (PACF) plots. These plots are a useful visual tool in choosing the order parameters for the ARIMA model. PACF plots can be used to identify the autoregressive (AR) part of the ARIMA, while ACF plots are useful for the moving average (MA) part of the model. Four series are of interest: (1) observed data, (2) first difference data, (3) first seasonal difference data (Y_t - Y_{t-12} for monthly data), and (4) both trend and seasonality difference. The visualization of the ACF/PACF plots of these various series helps to identify whether there is a need to differentiate the observed data regarding trend or seasonality, or what will be the right order for the nonseasonal/seasonal AR and MA parts of the model.

From the previous step, several models are eligible. Once those models have been estimated, it is important to conduct further steps to find the best model to use for forecasting. Two properties are crucial for any time-series forecasting models: (1) residuals must be uncorrelated, and (2) residuals should have zero mean. ACF and PACF plots can be used to test whether residuals are uncorrelated. If they are not, the model needs to be improved by adding additional terms in the AR part or MA part. When residuals do not have zero mean, forecasts are biased. The issue with non-zero mean of residuals is easily resolved by changing the model specification or adding the observed residuals mean to the forecasts. However, solving the autocorrelation issue is very challenging empirically. One way to solve this issue is to add AR terms when there are positive autocorrelations and to add MA terms for negative autocorrelations.

When multiple models are found, it is critical to check whether they will be accurate in forecasting. Several metrics exist in the literature to assess forecasting accuracy. Since forecasting is the main objective of time series analysis, forecast accuracy measures are preferable to information criteria measures (Akaike information criterion [AIC], Bayesian information criterion [BIC], etc.). Forecast accuracy measures include mean squared error (MSE), root mean squared error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE), mean absolute deviation (MAD), etc. More details on these measures are available in Adhikari and Agrawal (2013). For the forecasting accuracy exercise, one needs to split the sample in two parts: a training sample used for the Box-Jenkins methodology and the test sample used to compute the forecast performance metrics. The best model is the one with the best forecast accuracy.