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Farm Input Subsidies and Commodity Market Trends in Ghana

An analysis of market prices during 2012–2020

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ACRONYMS AND ABBREVIATIONS

CPI	Consumer Price Index
FSP	Fertilizer Subsidy Program
GDP	Gross Domestic Product
GFDC	Ghana Food Distribution Corporation
JSE	Johannesburg Stock Exchange
MoFA	Ministry of Food and Agriculture
NAFCO	National Buffer Stock Company
PFJ	Planting for Food and Jobs
SRID	Statistics Research and Information Directorate

ABSTRACT

Ghana has a long history of intervening in food markets to balance consumers' expectations of low and stable food prices, farmers' demands for high farmgate prices, and traders' demand for predictability in seasonal price patterns. However, government interventions may also alter the behavior of markets and alter incentives or risks for all market actors. The Planting for Food and Jobs (PFJ) initiative, launched in 2017, signaled a renewed commitment from government to agriculture and is Ghana's flagship strategy for boosting smallholder production, strengthening market linkages, and developing value chains. Given this significant policy shift, we examine agricultural commodity price patterns before and after 2017 to identify potential structural shifts in price behavior in maize, tomato, and onion markets, three key sectors targeted by PFJ. Results show maize and tomato prices drop below their long-term trend under PFJ, but not onion prices. Tomato and onion prices exhibit smaller seasonal price variations. These results are indicative of a structural shift in food markets, although further analysis is required to conclusively attribute these changes to PFJ.

1. INTRODUCTION

Survey data shows that the average Ghanaian household allocates 46.4 percent of its budget to food (GSS 2018). Food budget shares range from 38.8 percent in the wealthiest urban quintile to 55.5 percent in the poorest rural quintile. Consumer welfare, especially among poorer households, is therefore sensitive to food price levels and fluctuations. Survey data also reveals that over three-quarters of the rural population – or 37.9 percent nationally – derives at least some income (including the value of own consumption) from farming activities (GSS 2018). Agricultural commodity prices are therefore also an important determinant of farm household incomes (Cedrez, Chamberlin and Hijmansa 2020). Fair farmgate prices are an incentive for farmers to invest in modern inputs and expand output. This gives rise to the classic food policy dilemma: keeping food prices low protects poor consumers from food insecurity, but they create disincentives for agricultural production (Timmer, Falcon and Pearson 1983).

A related challenge is that of seasonality in agricultural prices. Seasonality reflects abundant supply and low prices after the harvest and limited supply and high prices in the lean season. The seasonal price spread tends to be higher in countries with single cropping cycles or poor road and storage infrastructure. Seasonality makes it hard for consumers to smooth food consumption over the year. If harvest season prices are severely depressed, farmers may also be reluctant to grow a surplus. On the other hand, seasonality encourages temporal arbitrage, i.e., the trading practice of buying when prices are low and selling when prices are high. Temporal arbitrage helps regulate market prices over the season and should, in theory, result in an equilibrium seasonal price spread that compensates traders for the cost of transport and storage. Kaminski et al. (2014) find that 40 percent of overall price volatility in African food markets is explained by relatively predictable seasonal movements. The rest is associated with unanticipated price behavior. Departures from normal seasonal price patterns impart major risks to seasonal storage, resulting in fewer actors who are willing to engage in temporal arbitrage (Chapoto and Jayne 2009).

Governments have an incentive to intervene in food markets when they do not result in desirable or equitable outcomes for their constituents. Several policy tools are available to influence price levels or reduce volatility. Market efficiency can be increased through investments in transport and storage infrastructure, while policy or regulatory reforms may reduce transactions costs. Some policy instruments directly influence prices (e.g., price subsidies) or indirectly via their impact on supply or demand. The latter may include supply-side measures such as farm input subsidies, demand-side measures such as social cash transfers, or direct procurement and distribution of food stocks by government, to mention a few. Of course, if these market interventions are themselves implemented in an ad hoc or unpredictable manner, they may exacerbate unpredictability in markets, which may crowd out private sector participation (Jayne 2012).

State-sponsored farm input subsidies and direct market transactions by governments were common elements of agricultural policies throughout the 1960s and 1970s, including in Ghana (Benin, et al. 2013). Such measures were effective at lowering consumer prices and reducing price variability in Ghana (Badiane and Shively 1998). However, governments rolled back food policies during the 1980s and 1990s under Structural Adjustment Programs. The 2000s saw their gradual reintroduction. For example, Ghana launched its national Fertilizer Subsidy Program (FSP) in 2008 and established the National Buffer Stock Company (NAFCO) in 2010 with a mandate to stabilize grain prices. NAFCO had a minimal impact given its small market footprint (CUTS International 2016). FSP was arguably more impactful, but the program was inconsistently implemented and poorly funded (Pauw 2021).

The launch of the Planting for Food and Jobs (PFJ) initiative in 2017 signaled a renewed commitment from the Ghanaian government to agriculture. PFJ is the flagship strategy for boosting agricultural production on smallholder farms, facilitating market linkages, and creating jobs along priority agricultural value chains through a wide range of support measures and investments (MoFA 2017). Compared to FSP, its predecessor program, PFJ is better funded and has seen a significant expansion in terms of subsidized inputs supplied and beneficiary households targeted. It also covers a wider range of crops, and the crop production response has reportedly been significant, especially in maize and rice (MoFA 2020). Although PFJ includes on-farm and off-farm components, with the latter including support for marketing, trade, and processing, the bulk of resources are dedicated to supporting smallholder production. A concern is that this apparent neglect of the off-farm or demand-side components could result in oversupply and suppressed farmgate prices as the economy is unable to absorb excess supply.

This study extends on and synthesizes findings from three earlier market briefs (IFPRI 2020a, 2020c, 2020b). We examine agricultural commodity price patterns before and after 2017 to identify potential structural shifts in price behavior following the significant policy shift. We focus on three commodity markets, namely maize, tomato, and onion, all of which are prioritized under the PFJ program and widely consumed in Ghana. As described further below, the markets for these three crops are very distinct, thus making for an interesting comparison. The paper is structured as follows. Section 2 provides the economic, policy, and market context for our analysis. Sections 3 and 4 introduce the methods and discuss the results, respectively. Finally, section 5 draws conclusions.

2. STUDY CONTEXT

Macroeconomic Context

Ghana has experienced volatile economic growth over the past decade. While the discovery of crude oil and gas and the gradual rise of the gold mining sector boosted economic output, it has also exposed the economy to fluctuations in global commodity markets. Growth in gross domestic product (GDP) exceeded ten percent between 2011 and 2013 as the country began extracting oil (Aragie, Artavia and Pauw 2019), but the subsequent decline in global oil and gold prices, coupled with domestic oil production challenges, caused growth to slow down significantly. Ghana's rebased national accounts series, currently available for 2013–2020 (GSS 2021a), reveals that the economy expanded only 2.8 percent per year during 2013–2016 (Table 1). This was followed by a strong recovery during 2017–2020 with average annual growth of 5.3 percent. Although there have clearly been two distinct subperiods as far as economic growth is concerned, average growth during 2013–2020 was still a respectable 4.2 percent per year, with the industrial sector contributing a disproportionate share of growth (42.4 percent) relative to its GDP share (37.5 percent in 2020).

Table 1. GDP growth rates and contribution to growth, by sector: 2013–2020

	2013-2016		2017-2020		2013-2020		GDP shares (%)	
	Growth rate (%)	Growth share (%)	Growth rate (%)	Growth share (%)	Growth rate (%)	Growth share (%)	2013	2020
Agriculture	1.9	14.7	5.8	22.6	4.1	20.6	21.4	21.2
Industry	2.2	28.5	7.0	47.0	4.9	42.4	35.9	37.5
Services	3.6	56.8	3.8	30.3	3.7	37.0	42.7	41.3
National	**2.8**	**100.0**	**5.3**	**100.0**	**4.2**	**100.0**	**100.0**	**100.0**

Source: GSS (Rebased 2013-2020 Annual Gross Domestic Product 2021a)

The recovery during 2017–2020 was also characterized by strong growth in agriculture (5.8 percent). As the largest employer of the active workforce, growth in agriculture is important for the welfare of Ghanaian households. This recovery period follows a prolonged period of weak and volatile agricultural growth, linked to low adoption of modern technologies, an inability to compete in regional or global markets, and limited public investments in the sector (Ragasa, Lambrecht and Kufoalor 2018, Ragasa, et al. 2021, Aragie, Artavia and Pauw 2019). As we elaborate next, it also reflects a renewed commitment from government to prioritize output growth and job creation in agriculture and the broader agri-food system.

Food Policy Context

Prior to market liberalization in the 1980s, government interventions in Ghana's food markets were reasonably effective at suppressing retail prices and reducing price variability (Badiane and Shively 1998). Direct procurement and distribution of grains was a one mechanism for influencing prices. For example, during the 1970s and 1980s the Ghana Food Distribution Corporation (GFDC) was mandated to buy maize at a guaranteed minimum price, and stocks were distributed later in the season to reduce price variability. However, towards the latter part of the 1980s, untimely and inadequate purchases, coupled with a commitment to liberalization, led to GFDC activities being phased out (CUTS International 2016). Following a period of limited market engagement, government returned to a direct procurement model in 2010 with the establishment of NAFCO. As with the GFDC, NAFCO's mandate was to protect farmers against low prices associated with overproduction and to stabilize prices over the course of the season. However, NAFCO had minimal impact on market behavior, with procurement accounting for only 2 to 5 percent of marketed maize in Ghana (CUTS International 2016).

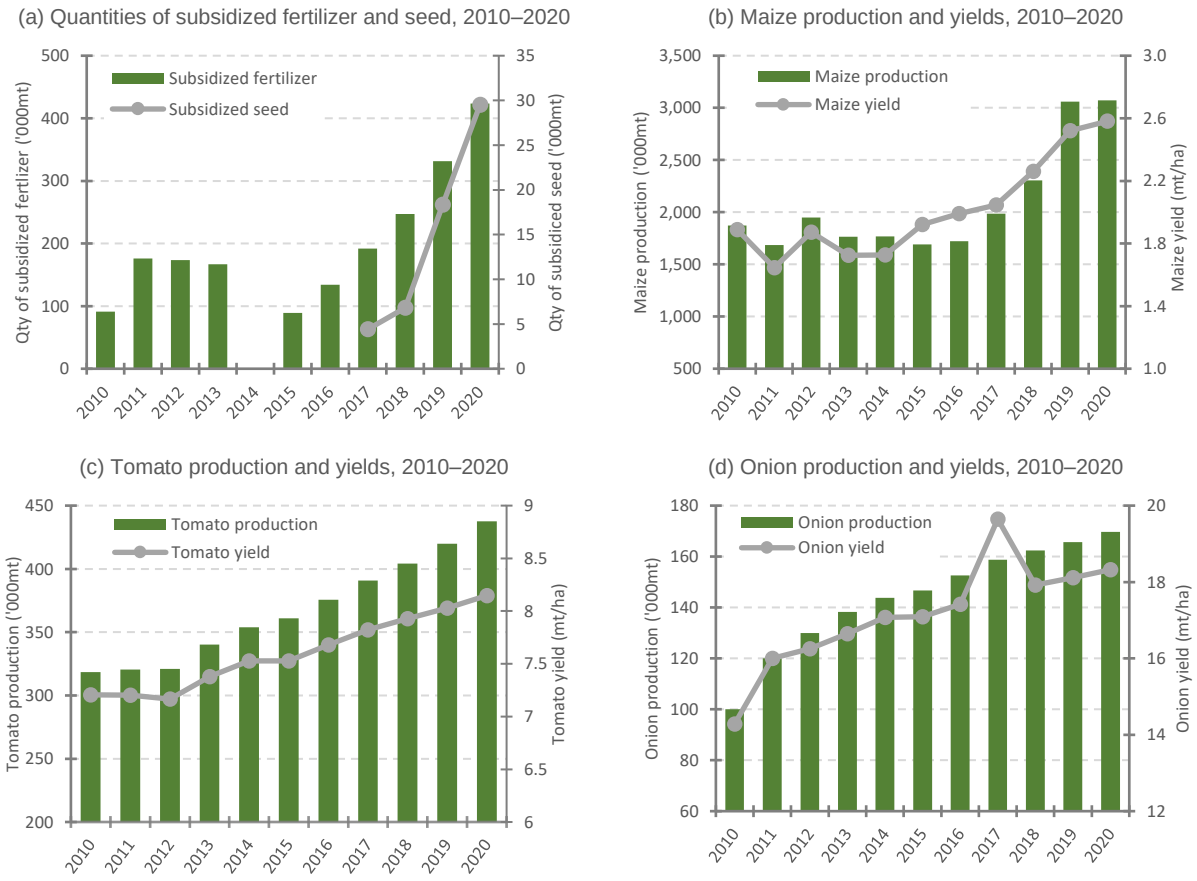
Input subsidies are a common policy response to supply-side constraints in agriculture. Following the suspension of subsidy programs in the 1980s, a new wave of subsidy programs emerged in developing countries in the 2000s, including in Ghana (Jayne and Rashid 2013). These emphasized more deliberate beneficiary targeting and the development of private input supply systems alongside measures that reduce costs and increase access to modern inputs (Dorward and Morrison 2015). Ghana launched the FSP in 2008 in response to low input use and with specific objectives of raising crop output and reducing poverty (Benin, et al. 2013, Fearon, Adraki and Boateng 2015). The program helped increase fertilizer use, but also faced implementation challenges, including late delivery on inputs (Yawson, et al. 2010) and inappropriate beneficiary targeting (Banful 2011, Houssou, et al. 2019). The program was also criticized for adopting blanket fertilizer recommendations despite varying soil conditions in Ghana (Chapoto and Tetteh 2014). Ultimately, inconsistent implementation and policy uncertainty – subsidy rates and fertilizer quantities supplied varied substantially from year to year – led to poor performance of the program (Pauw 2021).

The PFJ initiative was launched in 2017 (MoFA 2017), formally replacing FSP. In contrast to its predecessor program, PFJ was billed as a more holistic approach to agricultural development, with program components that provide on-farm production support, such as extension services and subsidized seed and fertilizer, combined with components that provide off-farm support, such as investments in marketing and processing infrastructure and the development of market information systems (MoFA 2017). In essence, however, it remains primarily a farm input subsidy program. For instance, in 2019, 59 percent of the budget was spent on fertilizer and 22 percent on seeds, leaving minimal resources for the various off-farm program components (Ibrahim 2020).

Despite having a narrower focus than first envisioned, PFJ has been well funded and has seen a rapid expansion in beneficiary numbers and quantities of inputs supplied. By 2020, 1.74 million of Ghana's 2.6 million farm households participated in the program (MoFA 2020). PFJ now supplies

more than double the quantity of fertilizer supplied at the peak of FSP (see Figure 1, panel a). It also features seed subsidies as a core component of the program, something that was absent from FSP. PFJ covers a broader range of subsectors than previous programs: in the first year, maize, rice, sorghum, soya, onion, tomato, and chili pepper were targeted, while in 2018 and 2019 groundnut, cowpea, various root crops, and several additional vegetable crops were added.

Figure 1. Maize, tomato, and onion production and yield estimates, 2010–2020



Source: Compiled from MoFA (2019, 2020), FAO (2021), and Africa Fertilizer (2020).

Since most fertilizer in Ghana is applied to maize and rice, the bulk of program resource are implicitly targeted at these sectors. Maize and rice seeds also account for the bulk of seeds disseminated under the program. As such, PFJ had a significant impact on maize production, which grew from 1.7 million in 2016 to over 3.1 million metric tons by 2020, an increase of 78.3 percent in just four years (Figure 1, panel b). Simulation results project that maize output would have been only 2.2 million metric tons by 2020 in the absence of PFJ (Pauw 2021). Although tomatoes and onions are also prioritized under PFJ, output growth was not as impressive as for maize. Tomato production expanded by 16.5 percent in the four years between 2016 and 2020 (or 3.9 percent per annum), somewhat higher than the population growth of 2.6 percent per annum (panel c). Onion output expanded 2.7 percent per annum over the same period, seemingly following historical trends (panel d). The spike in onion yields in 2017 appears to be a data error rather than a sustained effect of PFJ.

Importantly, during the PFJ period, yield growth accounted for only 39.8 percent of output growth in tomatoes, 44.8 percent in maize, and 47.8 percent in onions (Pauw 2021). Output growth was mostly driven by land expansion, which is associated with additional land preparation and production costs compared to intensification on existing lands. These costs need to be considered alongside the unsubsidized portion of PFJ inputs when farmers contemplate participating in PFJ.

Commodity Market Context

Several of the key commodity markets in Ghana are controlled by associations of traders that, under the leadership of so-called Market Queens, control market access, quantities supplied, and prices (Van Asselt, Masias and Kolavalli 2018, CUTS International 2016). While this may be suggestive of imperfect competition, markets have been found to function without any systematic, uncompetitive behavior by traders (Abdulai 2000). Market integration studies in maize, rice, soybean, and tomato sectors all conclude that markets are well integrated, exhibiting efficient price transmission between producer and consumer markets (Badiane and Shively 1998, Ihle and Amikuzuno 2009). Likewise, local markets are integrated with regional and global ones (Cudjoe, Breisinger and Diao 2010, Martey, Gattib and Goldsmith 2020), although cross-border integration is not uncommon in modern day developing markets (Baquedano and Liefert 2014). Some studies have found asymmetric price transmission, i.e., where price increases in producer markets are passed on to consumers faster than price reductions, but this not believed to be indicative of an unusual degree of market power on the side of producers or traders (Abdulai 2000, Amikuzuno and Ihle 2010).

The objective in this study is to examine agricultural commodity price patterns before and after the significant policy shift in 2017 to identify potential structural changes in market behavior. Since markets are well integrated, our analysis focuses on national average wholesale prices, i.e., the emphasis on average seasonal price trends across all markets rather than the correlation of prices between markets. We further limit the analysis to maize, tomato, and onion, three of the original six priority sectors under PFJ.

The three sectors are quite distinct, and thus make for an interesting comparison. Maize is a widely cultivated and consumed staple crop in Ghana. It accounts for more than one-quarter of calories consumed, about double that of the second largest crop, cassava (GSS 2018). Three-quarters of maize consumption is from own production, resulting in a relatively thin traded market (Gage, et al. 2012). Although Ghana is self-sufficient in maize, and wealthier consumers display a preference for rice, maize consumption is expected to continue to rise due to population growth (FAO 2016), while demand from the expanding animal feed sector is robust (Andam, et al. 2017). As such, there is potential for growth in the maize market. Spatial differences in production create arbitrage opportunities for traders (Abdulai 2000), with the northern parts of the country serving as important feeder markets for consumer markets in the south.

Tomatoes are an important component in Ghanaian diets, accounting for 40 percent of household vegetable expenditure (GSS 2018). Although official statistics suggest formal tomato imports are insignificant, up to one-quarter of supply is estimated to come from imports, often through informal channels (Van Asselt, Masias and Kolavalli 2018). Imports originate primarily from Burkina Faso during the first part of each calendar year (Gonzalez, et al. 2016, Robinson and Kolavalli 2010). Although yields are much higher in Burkina Faso (FAO 2021), tomato cultivation is profitable in Ghana (Van Asselt, Masias and Kolavalli 2018). The fragility and perishability of tomato imposes significant costs and risk on all actors in the value chain, with post-harvest losses comprising around half of production each year (Ridolfi, Hoffmann and Baral 2018).

Onion is the third largest vegetable crop after tomato and chili. It is also widely consumed, accounting for approximately one-fifth of vegetable expenditure by households (GSS 2018). Between 80 and 90 percent of annual supply comes from imports, reflecting a strong preference for imported onions, but also significant potential for expansion of the domestic market through import substitution (Van Asselt, Masias and Kolavalli 2018). Three-quarters of domestically produced onion is grown under rain-fed conditions. At around 12 metric tons per hectare, Balana et al. (2020)

find that yields under irrigation are over three times higher than under rainfed conditions. The national average reported yield is 18 tons per hectare (MoFA 2020), which lags far behind the 34 tons per hectare achieved in Niger, the source of most onion imports (FAO 2021).

3. METHODS AND DATA

Price Decomposition Methods

Price movements can either be predictable or unpredictable. Predictability implies regular and repeated price movements over time, linked to anticipated seasonal price variations and the longer-term trend. Value chain actors continuously form expectations of future prices given information about past market behavior. For example, the expected price at time $(t+1)$ is denoted by $E_t(P_{t+1})$, an expectation formed at time t that considers all the information about price behavior in previous periods up until time t. The unpredictable element in prices, e_{t+1}, is the difference between expected price and the observed price, P_{t+1}. Market actors perceived this as price risk.

$$P_{t+1} - E_t(P_{t+1}) = e_{t+1} \quad [1]$$

Decomposition methods assume prices consist of several components, typically including a long-term trend, a seasonal component, a cyclical component, and an irregular (or random) component. In some models the cyclical component is incorporated into the trend component. Mathematically speaking, decomposition models are either additive or multiplicative, but the basic principle remains the same, namely that these models decompose observed deviations from a long-term trend into predictable (seasonal) and unpredictable (cyclical or random) components.

Our analysis adopts a multiplicative model described in Tschirley (1995) whereby price (P_t) at time t is the product of trend (T_t), seasonal (S_t), cyclical (C_t), and random (R_t) components. For a dataset with *m* sub-annual timesteps (e.g., daily, monthly, or quarterly frequency) spanning n years, t will range from 1 to $(m \times n)$. For example, in the case of monthly data, $m = 12$.

$$P_t = (T_t \times C_t) \times (S_t \times R_t) = CMA_t \times SF_t \quad \text{for} \quad t = 1, \dots, (m \times n) \quad [2]$$

The trend and cyclical components are derived from a centered moving average (CMA_t) of the price series, which defines price movements in the longer term. The seasonal and random components, on the other hand, represent short-term or intra-annual price movements. The product of these components is known as the seasonal factor (SF_t).

The first step in decomposing a price series is de-seasonalizing the data. This removes the short-term seasonal and random fluctuations so that the trend and cyclical components are isolated. The product of the trend and cyclical components is assumed to be the centered moving average, which, in the case of monthly data, is computed as the average of two twelve-month moving averages (MA_t).

$$CMA_t = (MA_t + MA_{t+1})/2 \quad \text{where} \quad MA_t = (P_{t-6} + \cdots + P_t + \cdots + P_{t+5})/12 \quad [3]$$

The next step is to estimate a simple linear regression on the centered moving average series. The trend component is the predicted value of the centered moving average $(\widehat{CMA_t})$, while the cyclical component is obtained by dividing the centered moving average by the trend.

$$CMA_t = \alpha + \beta.t + \varepsilon_t \quad [4]$$

$$T_t = \widehat{CMA_t} = \hat{\alpha} + \hat{\beta}.t \quad \text{and} \quad C_t = CMA_t/T_t \quad [5]$$

The seasonal factor can now be calculated by dividing the price by the centered moving average. The seasonal factor is also the product of the seasonal and random components. The seasonal component is an index that has the same value for each sub-annual period $i = 1, \dots, m$ across all years $j = 1, \dots, n$. The seasonal component is obtained by calculating the average of the seasonal factors for each sub-annual period across *n* reporting years. The seasonal factor is subscripted over i and j to differentiate sub-annual periods from years. Once the seasonal component is known, the random component is calculated by dividing the seasonal factor by the seasonal component.

$$SF_t = P_t / CMA_t \quad [6]$$

$$S_i = \frac{1}{n}\sum_{j=1}^{n}\left(SF_{ij}\right) \quad \text{for} \quad i = 1, \dots, m \quad \text{and} \quad R_t = SF_t / S_t \quad [7]$$

One advantage of using an econometrically estimated trend component is that it can be used in forecasting. Forecasted values (F_t) for future time periods are generated by multiplying the trend with the seasonal index.

$$F_t = T_t . S_t \quad [8]$$

The seasonal component provides information on price troughs and peaks and the expected price spread over marketing season. Prices tend to be lowest at the beginning of the marketing season, and peak towards the end of the marketing season before the next harvest enters the market. In agroecological zones with a single cropping season, prices will likely peak once a year, while prices in zones with two cropping seasons will likely have a bimodal distribution. Knowledge about seasonal patterns is useful to market actors who engage in temporal arbitrage.

Of course, temporal arbitrage is not without risk. The random component provides additional information on how prices might deviate from anticipated seasonal movements. The standard deviation in the seasonal factor (σ_i^{SF}), within each sub-annual period can be used to generate a confidence interval (CI_i) around the mean value of the seasonal component (note, the monthly mean of the seasonal component is simply the seasonal factor, SF_t). For example, for a z-score of 1.96, a 95 percent confidence interval will be produced. This provides market actors with 95 percent certainty that prices in a particular sub-annual period will remain within a specific price range given the price level at the start of a season and the long-term trend.

$$\sigma_i^{SF} = \sqrt{\sum_{j=1}^{n}(SF_{ij} - S_i)^2 / n} \quad \text{for} \quad i = 1, \dots, m \quad [9]$$

$$CI_i = S_i \pm z . \sigma_i^{SF} / \sqrt{n} \quad \text{for} \quad i = 1, \dots, m \quad [10]$$

Data and Analytical Approach

This study is based on agricultural commodity prices in wholesale markets during 2012 to 2020, which are obtained from the Statistics Research and Information Directorate (SRID) of the Ministry of Food and Agriculture (MoFA 2021). SRID collects daily wholesale and retail prices from three to five randomly selected traders in 164 markets across Ghana. Average monthly prices are constructed for each commodity in each market and averaged across markets to obtain national average wholesale and retail prices. We focus on three commodities, namely maize, tomato, and onion, all of which are prioritized under the PFJ program and widely consumed in Ghana. Since markets are well integrated, national average wholesale prices adequately represents price movements in individual markets – our emphasis is on seasonal price trends rather than the correlation of prices across markets – as well as in retail markets.

Since the data spans the periods before and after 2017, the year in which PFJ was launched, the analysis can identify possible structural breaks in price trends following this significant policy shift. We first decompose monthly wholesale commodity prices (P_t) into trend (T_t), seasonal (S_t), cyclical (C_t), and random (R_t) components using a censored dataset for 2012 to 2016. This model characterizes price trends and patterns prior to the introduction of PFJ in 2017. A market actor making investment decisions at the beginning of 2017 could plausibly use this model to project prices (F_t) for 2017 to 2020 under the assumption that historical trend and seasonal patterns will prevail. We also observe market prices (P_t) for 2017 to 2020. A comparison of projected and observed prices reveals the extent to which observed prices deviate from expected ones (see equation 1) and can flag potential structural changes in the seasonal patterns or price trends.

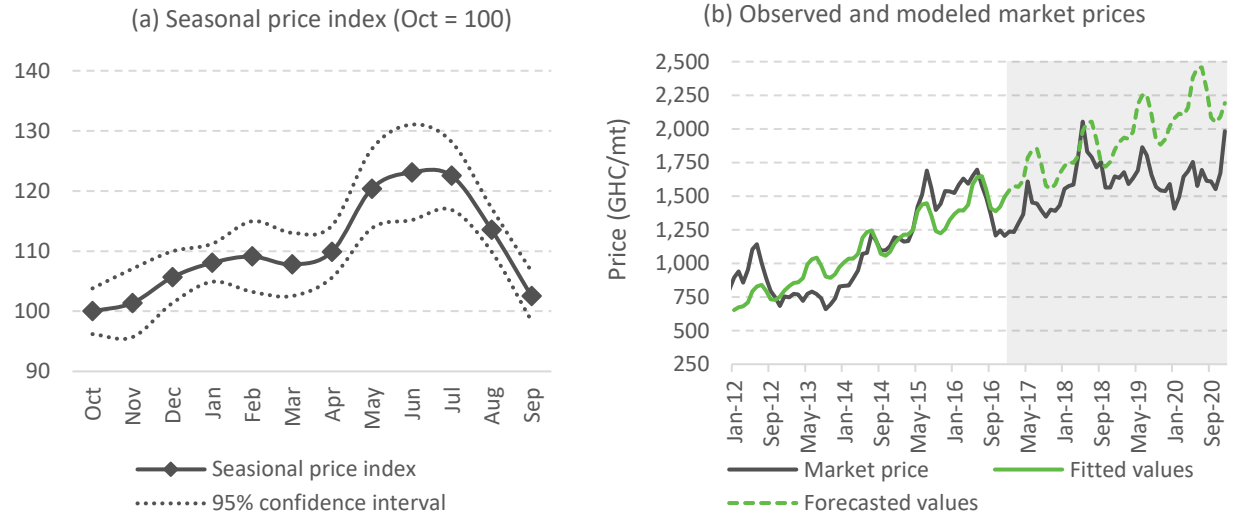
4. RESULTS AND ANALYSIS

Seasonal Price Analysis

Figures 2, 3 and 4 each plot the seasonal index over the course of a season (panel a) and the observed and modeled prices over the analysis period (panel b) for maize, tomato, and onion, respectively. The seasonal index in the left panel is derived from seasonal component (S_t) (equation 7), proportionately scaled in this instance to an index value that assumes a value of 100 in the month that prices are at their lowest. The 95 percent confidence interval plotted around the seasonal index is estimated from standard deviation of the seasonal factor (σ_i^{SF}) (equation 10). The second panel plots observed prices (P_t) and modeled prices (F_t) (equation 8). Since the model components are estimated from 2012–2016 data, the modeled prices during the pre-PFJ period provide an indication of the goodness of fit of the model, while those for 2017–2020 are forecasted prices over the PFJ period.

Figure 2 shows that maize prices are lowest in October and rise gradually through March as new stock continues to enter the market (panel a). Price increases begin to accelerate from April onwards, peaking at an index value of 123 in June. Therefore, a trader who procures maize in October can reasonably expect to achieve a premium of 23 percent if the maize is sold in June. However, the 95 percent confidence interval suggests that there is a 5 percent chance that the June price will be lower than 115 or higher than 131. Current storage costs and interest are estimated at around 28 percent of the value of maize over a nine-month period (IFPRI 2020a). Temporal arbitrage may therefore not be profitable in Ghana, a finding echoed by Miranda et al. (2018).

Figure 2. Seasonal analysis of the wholesale maize market in Ghana, 2012–2020

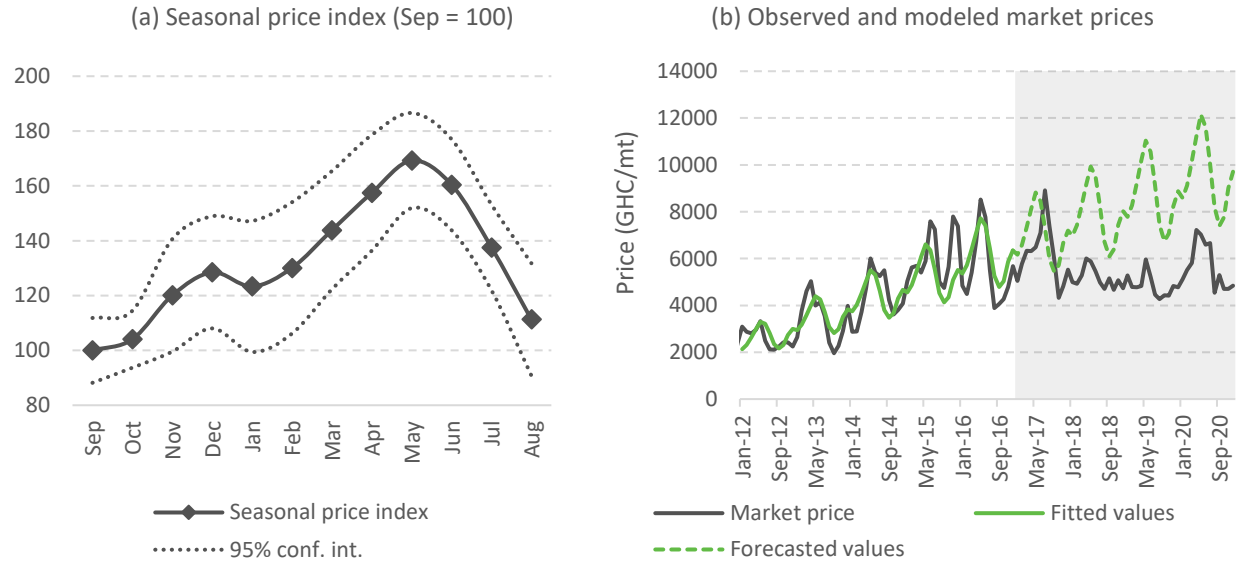


Source: Authors' analysis based on MoFA (2021).

The comparison of forecasted and observed prices is revealing (panel b). While observed maize prices continued exhibiting a regular seasonal pattern after the launch of PFJ, they trended below forecasted prices. This likely reflects the substantial growth in maize supplies following the introduction of PFJ (Figure 1). It may also reflect an inability of the economy to absorb such a large surplus in such a short space of time, thus highlighting the importance of addressing demand-side bottlenecks when supply-side subsidies are introduced in a market that is already self-sufficient. Reorienting supply towards export markets presents one marketing option that would prevent an oversupply in domestic markets, although maize does not immediately spring to mind as the type of high value agricultural crop that should be prioritized for exports.

Figure 3 presents the tomato results. Although tomato is produced year-round, prices exhibit a strong seasonal pattern with some evidence of a bimodal distribution (panel a). Rainfed production peaks in the Accra and the Brong Ahafo regions around August, resulting in low prices in September when crops are harvested (Robinson and Kolavalli 2010). From January through March, local supplies are primarily from the Upper East, and are supplemented by imports from Burkina Faso, causing prices to remain relatively low early in the calendar year. Imports and local production across all regions dwindle from April onwards, causing prices to peak at 69 percent above September levels in May each year. The perishability of tomatoes exacerbates the seasonal price spread as temporal arbitrage opportunities are mostly absent.

Figure 3. Seasonal analysis of the wholesale tomato market in Ghana, 2012–2020



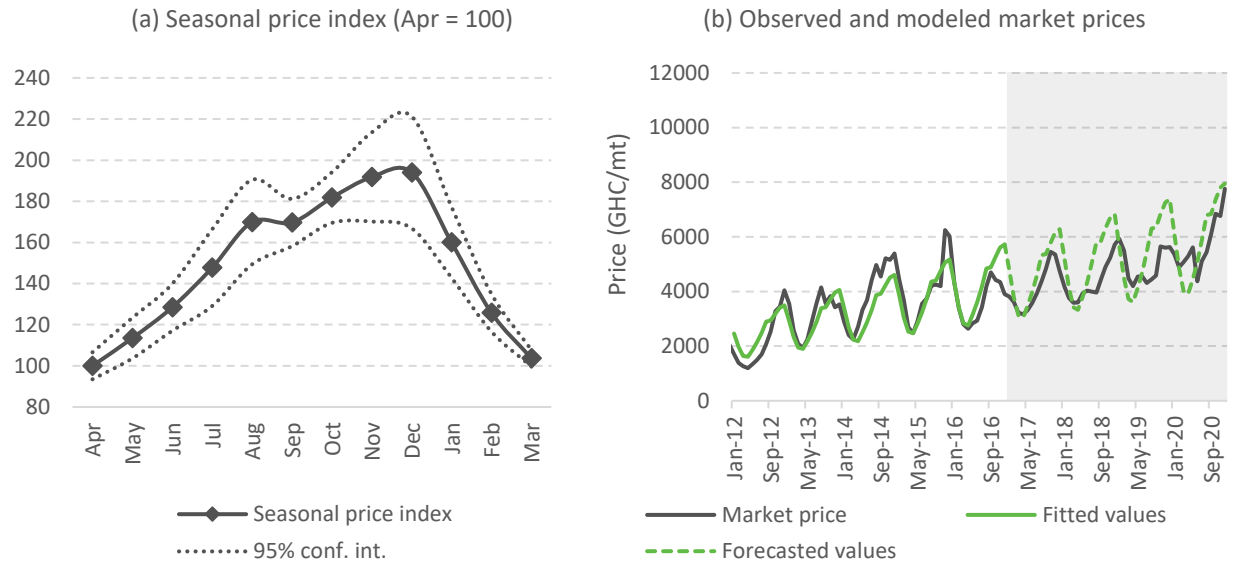
Source: Authors' analysis based on MoFA (2021).

Whereas modeled prices closely track historical prices during 2012 to 2016, the price behavior is significantly altered after the introduction of PFJ (panel b). Not only does the trend appear to level out – as with maize – but prices exhibit much lower seasonal variation. While reduced seasonality and lower prices are clearly good news for consumers, the result is somewhat surprising considering that the increase in output was modest (Figure 1). Further analysis is required to understand recent dynamics in the tomato sector, particularly with respect to possible substitution of tomato imports and year-round availability of tomatoes to help lower the seasonal price spread.

Figure 4 turns to the onion market. This market exhibits a very strong seasonal price pattern (panel a). Most local production is rainfed and occurs during January to April, resulting in onion prices being lowest in April and peaking in November each year at 94 percent above harvest season prices. Over four-fifths of onion supply is from imports, which means the seasonal price pattern

also reflects strong seasonality in import quantities and prices. With the small footprint of domestic production in the local market, and the relatively weak production response under PFJ (Figure 1), projected prices do not deviate substantially from observed prices during the PFJ period (panel b). However, there is evidence of a small decline in the seasonal price spread.

Figure 4. Seasonal analysis of the wholesale onion market in Ghana, 2012–2020

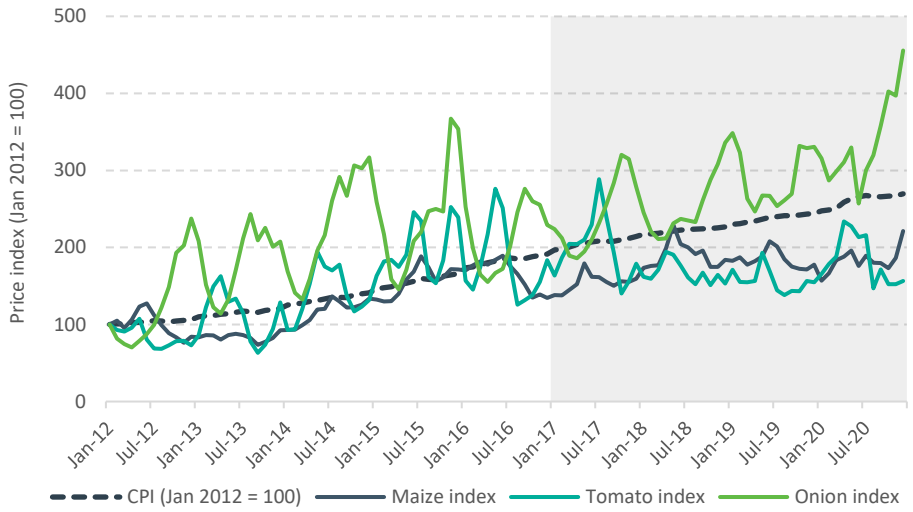


Source: Authors' analysis based on MoFA (2021).

Potential Caveats

The results presented above are indicative of a shift in price behavioral patterns since the launch of PFJ. Both maize and tomato prices trend below their expected price levels, while tomato and onion prices exhibit lower levels of volatility. While this is indicative of a PFJ effect, further analysis is required to conclusively attribute the policy shift. One useful exercise is to compare nominal commodity prices against the Consumer Price Index (CPI) to determine whether the lower prices for maize and tomato simply reflect a general decline in prices or a decline in real maize and onion prices. Figure 5 confirms that maize and tomato prices drop below the CPI series from 2017 onwards. Onion prices, on the other hand, appear to continue along the same path as the CPI. Our results therefore confirm not only a deviation in maize and tomato prices from their own long-term trends, but also a decline in real maize and tomato prices as compared to the CPI.

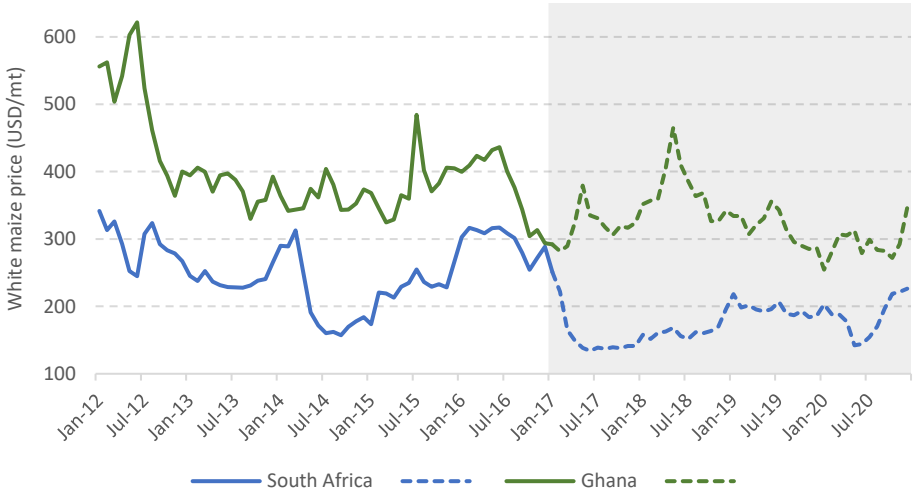
Figure 5. Commodity market prices and headline inflation, 2012–2020



Source: MoFA (2021) and GSS (2021b).

Another possibility is that price adjustments seen in local commodity markets are not (only) due to local policy effects but reflect shifts in world markets that are transmitted to the local market. Ghana's maize market, for example, is well integrated with world markets (Cudjoe, Breisinger and Diao 2010). Figure 6 compares white maize prices on the Johannesburg Stock Exchange (JSE) against Ghanaian wholesale maize prices. Both series are expressed in USD per metric ton. Although there is limited maize trade between these countries, the difference in price levels implicitly reflect transport margins. Prices in both countries show a similar downward adjustment after 2017. Compared to 2012–2016, maize prices during 2017–2020 declined by an average of USD 78 per metric ton in South Africa and USD 72 in Ghana. Even though Ghana is self-sufficient in maize and cross-border maize trade is minimal, it is likely that at least some of the price adjustment in Ghana during the PFJ era reflects a similar adjustment in international markets.

Figure 6. South African and Ghanaian maize market prices, 2012–2020



Source: JSE (2021) and MoFA (2021).

5. CONCLUSIONS

Ghana has a long history of intervening in food markets to balance consumers' expectations of low and stable food prices with farmers' demands for high and predictable farm gate prices. While interventions in the form of farm input subsidies and direct procurement and distribution in food markets were scaled back under the Structural Adjustment Program in the 1980s and 1990s, they were gradually reintroduced again in the 2000s. For example, FSP was launched in 2008, but this program was inconsistently implemented and poorly funded. NAFCO, in turn, was formed in 2010 to provide a mechanism for direct procurement and distribution of grains, but its impact was minimal given its small market footprint.

The PFJ initiative launched in 2017 signaled a significant policy shift and renewed commitment to the agricultural sector from the government of Ghana. PFJ is the country's flagship strategy for boosting smallholder production and developing market linkages and value chains. Although PFJ is essentially a continuation of FSP, the program is better funded and has seen a significant expansion in subsidized inputs supplied and beneficiary households targeted compared to its predecessor. The crop production response has also been significant. Between 2017 and 2020, maize output growth averaged 15.6 percent per year, while tomato and onion output grew at a more subdued 3.9 and 2.7 percent per year, respectively.

This study examines agricultural commodity price patterns before and after 2017 with the aim of identifying potential structural shifts in price behavior within key markets after 2017. National average wholesale prices for maize, tomato, and onions are decomposed into trend, seasonal, cyclical, and random components using data for 2012 to 2016. We use the model to project prices for 2017 to 2020. A comparison of projected and observed prices reveals whether there have been any structural changes in the expected seasonal patterns or price trends after 2017. While any structural change we identify using this approach does not conclusively prove a causal effect of PFJ on market behavior, it is suggestive of an impact considering the significance of the policy shift at the time.

Results show that maize prices continue exhibiting a regular seasonal pattern after 2017, but prices are significantly lower than the forecasted trend. This may reflect the substantial growth in maize output in a market that is already self-sufficient. Tomato prices also drop below the expected trend and exhibit a lower degree of seasonal variation. A comparison with CPI data confirms that maize and tomato prices also decline in real terms. With the small footprint of domestic production in the local onion market, projected onion prices do not deviate substantially from observed prices, but there is evidence of a decline in seasonal price variations. Since Ghana's markets are well integrated with regional and global ones, at least some of the price adjustment during the PFJ era reflects price movements in international markets. These results are strongly indicative of an impact of PFJ on market behavior, but further analysis is needed to attribute the impacts to PFJ.

Input subsidies are generally expected to reduce costs of production, which will invariably lead to lower farmgate, wholesale, and retail prices. They may also encourage farmers to increase production given access to cheaper inputs. In Ghana, for example, land expansion has been the most important driver of output expansion under PFJ. However, as prices decline, the incentives to expand production – including through extensification – diminish as farm profits are squeezed. This effect can be countered by introducing additional measures alongside subsidies, including, for instance, marketing support for farmers and traders, developing agroprocessing capacity, and enabling value chain actors to better compete against imports or in export markets. Although by design PFJ is a holistic program that supports on- and off-farm actors along value chains, the off-farm components of the program appear to have been neglected.

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