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THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
POLICY STUDIES INSTITUTE

STRATEGY SUPPORT PROGRAM | WORKING PAPER 157

JUNE 2021

Prices of Vegetables and Fruits in Ethiopia

Trends and implications for consumption and nutrition

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ABSTRACT

We study price behavior of vegetables and fruits in Ethiopia over the 15 year period from 2005 to 2019 based on large-scale retail and producer price datasets. This is an important topic given the importance of prices for consumption decisions for these nutritious crops. A number of notable findings come from the analysis. First, prices are rapidly increasing both in real terms and when compared to cereals. At the end of the study period in 2019, vegetables and fruits in real terms were significantly more expensive than 15 years earlier. Especially green leafy vegetables show a significant price rise, likely because few high-yielding varieties of these vegetables have been made available and adopted by producers. Second, part of the rise in prices is explained by increased marketing margins. To understand what accounts for these increases in the marketing margins for fruits and vegetables requires more research, as they contrast with stable or declining margins seen for other food crops over the study period. Third, we see significant seasonality in vegetable prices that is mostly driven by supply factors, but also by demand shifts due to increased demand in fasting periods. Fruit prices do not show such high seasonal variation, however. Fourth, there is significant spatial price variation in the country – vegetable prices are 60 percent more expensive in lowland regions than in the Amhara region, where vegetables are cheapest. Fruit prices in the lowlands are double the prices in the major producing area, the Southern Nations, Nationalities, and Peoples' (SNNP) region.

1. INTRODUCTION

Policymakers have long focused on eliminating malnutrition given the associated high human and economic costs and its strong link with poverty (Hoddinott et al. 2013). Given global antipoverty efforts, such as the Millennium Development Goals, and rapid economic growth in some economies where many of the poor and malnourished reside, there have been significant improvements in reducing poverty and malnutrition in the last two decades. However, there still remains significant malnutrition in most sub-Saharan African countries (Alonso et al. 2021; Worku et al. 2017; Fanzo 2012). While inadequate access to basic food is critical to survival, there also is increasing awareness that improved access to protein and micronutrients is important for physical growth, cognitive development, and overall health (Alonso et al. 2021; Gebru et al. 2016). In addition to these intrinsic values, access to complete nutrition contributes towards increasing human capital, which is an important determinant of labor productivity, increases in which lie at the heart of the future economic success of developing countries (Hoddinott 2016).

Complete nutrition requires regular consumption of a wide range of foods and food groups that can deliver those nutrients. Consequently, recent nutritional research has emphasized the importance of achieving a diverse diet that includes livestock and dairy products and vegetables and fruits (Alonso et al. 2021; Gebru et al. 2017; Hoddinott 2016). Transitions into diverse diets have traditionally occurred subsequent to per capita income growth (Worku et al. 2017). Increased urbanization is also contributing to increasingly diversified diets, although it also has been linked to increased consumption of foods associated with overweight and obesity (Cockx et al. 2018; Worku et al. 2017; Pingali 2007; Popkin 1999).

This shift towards more diversified diets has far reaching implications for policymaking in developing countries. The overarching implication is the need for a harmonized rethinking of previous nutrition, agricultural, food system, and health policies that had emphasized meeting caloric requirements towards those that would provide more diverse diets complete with calories, protein, and micronutrients (Alonso et al. 2021; Worku et al. 2017; Hoddinott 2016, Fanzo 2012, Popkin 1999). This in turn implies that policymakers, who hitherto may have focused on increasing productivity of starchy staples, will need to design policies to increase the productivity and, thereby, to improve consumer access to diverse categories of food items. Food production systems will need to be increasingly diversified and commercialized and meet food quality and safety standards (Worku et al. 2017; Gebru et al. 2016; Pingali 2007). Investments, innovations, and changes in incentive systems are also needed to transform traditional food systems to accommodate the storage, marketing, transportation, and processing requirements of easily-perishable livestock products, vegetables, and fruits (Alonso et al. 2021, Gebru et al. 2016; Hoddinott 2016; Pingali 2007). Finally, increased nutritional education will be needed. While this is particularly important in urban areas where the occurrence of obesity is high, nutritional education can also expand access to the information on the health benefits of diverse diets in rural areas, which are also not immune from the dangers of obesity consequent to increases in income levels (Cockx et al. 2018). In addition to productivity losses and reduced quality of life, chronic diseases associated with obesity also have been shown to have important implications for health care costs because their management requires intensive medical interventions (Popkin 1999).

We study the prices, production, and marketed output of vegetables and fruits in Ethiopia between 2005 and 2019, a period in which the country recorded remarkable economic growth. The rapid growth in income coupled with policies aimed at improving cereals productivity and availability (Bachewe et al., 2018) and addressing poverty contributed to the decline in malnutrition and poverty observed in the country (Worku et al. 2017). However, malnutrition is still widespread, particularly among children (Gebru et al. 2016; Headey, 2014), and Ethiopian children consume

among the least diverse diets in sub-Saharan Africa (Hirvonen 2016, 2014). There is widespread concern about the slow change in nutritional status and diet quality in Ethiopia. Consequently, improving nutritional outcomes is an important item on the policy agenda of the government of Ethiopia and for researchers as well (Alonso et al. 2021). Recent research attributes poor diet quality in Ethiopia, among other factors, to rising prices for nutritious food items (Alonso et al. 2021; Worku et al. 2017; Gebru et al. 2016; Bachewe et al. 2020, 2019). This study contributes to these efforts to transform the food systems in Ethiopia by informing ongoing policy discussions on recent trends in the prices of nutritious food items, specifically vegetables and fruit.

We mainly use descriptive analyses to study patterns and trends in vegetable and fruit prices. We also study spatial patterns of prices, price seasonality, retail-producer price margins, and relative prices of vegetables and fruits. Furthermore, we investigate the supply side of vegetable and fruits whereby we study trends in vegetable and fruit production and marketed output and spatial and seasonal patterns in vegetable production. For this purpose, we use nationally representative price, production, and marketed output datasets. We use monthly data from CSA's Consumer and Producer Price Surveys (2020a; 2020b). We also use CSA's data on land use and production (CSA 2007a-2019a; CSA 2020d) and, and data on marketed outputs (2009c-2019c). This study contributes to the literature by documenting the temporal and spatial variation, seasonality, and relative prices of vegetables and fruits, and trends in vegetables and fruits production, productivity, and marketed output. In so doing the study contributes towards the ongoing discussion on the food system transformation required in Ethiopia to reduce the double burden of undernutrition and micronutrient deficiencies on the one hand and the prevalence of overweight/obesity, particularly in urban areas, on the other.

We find that output of vegetables and fruits nearly doubled during the period. Moreover, the area devoted to producing vegetables and fruits and its share in total crop area grew as fast. Consequently, there was little to no growth in yields. Less than half of fruit and considerably lower proportion of vegetable outputs are marketed, and the proportion of marketed output has grown slowly. In real terms, average vegetable and fruit prices in 2019 were at least 40 percent higher than 2005 prices. Prices of vegetables and fruits also increased relative to staple cereals. Price seasonality is generally higher for vegetables than for other foods, including fruit and animal-source foods. Vegetable prices are higher in predominantly pastoralist Somali and Afar regions as well as Dire Dawa and lower in the Southern Nations, Nationalities, and Peoples' (SNNP), Amhara, and Oromiya regions. Prices in markets located in vegetable and fruit producing areas co-move strongly with prices in urban area markets and the price-gap (birr/kg) increased for both items. However, the price-gap, when expressed as a ratio of prices in the two areas, declined for both items, which implies increased integration of the markets. Nevertheless, that the price-gap in 2019 between high price and lower price areas exceeds the prices in lower price areas for almost all vegetables and fruits may indicate that there still remains a large price gap that needs bridging.

These findings have important policy implications. Policymakers in Ethiopia need to seek nutrition sensitive agricultural growth that includes productivity growth in noncereal crop and livestock subsectors; further invest in physical infrastructure, introduce and invest in newer technologies, and improve the incentive structure to stimulate investment in agricultural marketing and processing of such food crops; and capitalize on experiences from urban areas to transfer technology and provide technical, logistical, and financial support for nutrition sensitive small and medium scale rural agro-processing enterprises.

The remainder of this paper is organized as follows. Major datasets used in the study are discussed and a brief description of the retail price dataset provided in the next section. Section 3 describes vegetable and fruit production in Ethiopia and the marketed outputs. In section 4 we describe seasonal and spatial patterns in vegetable and fruit prices, including co-movements of

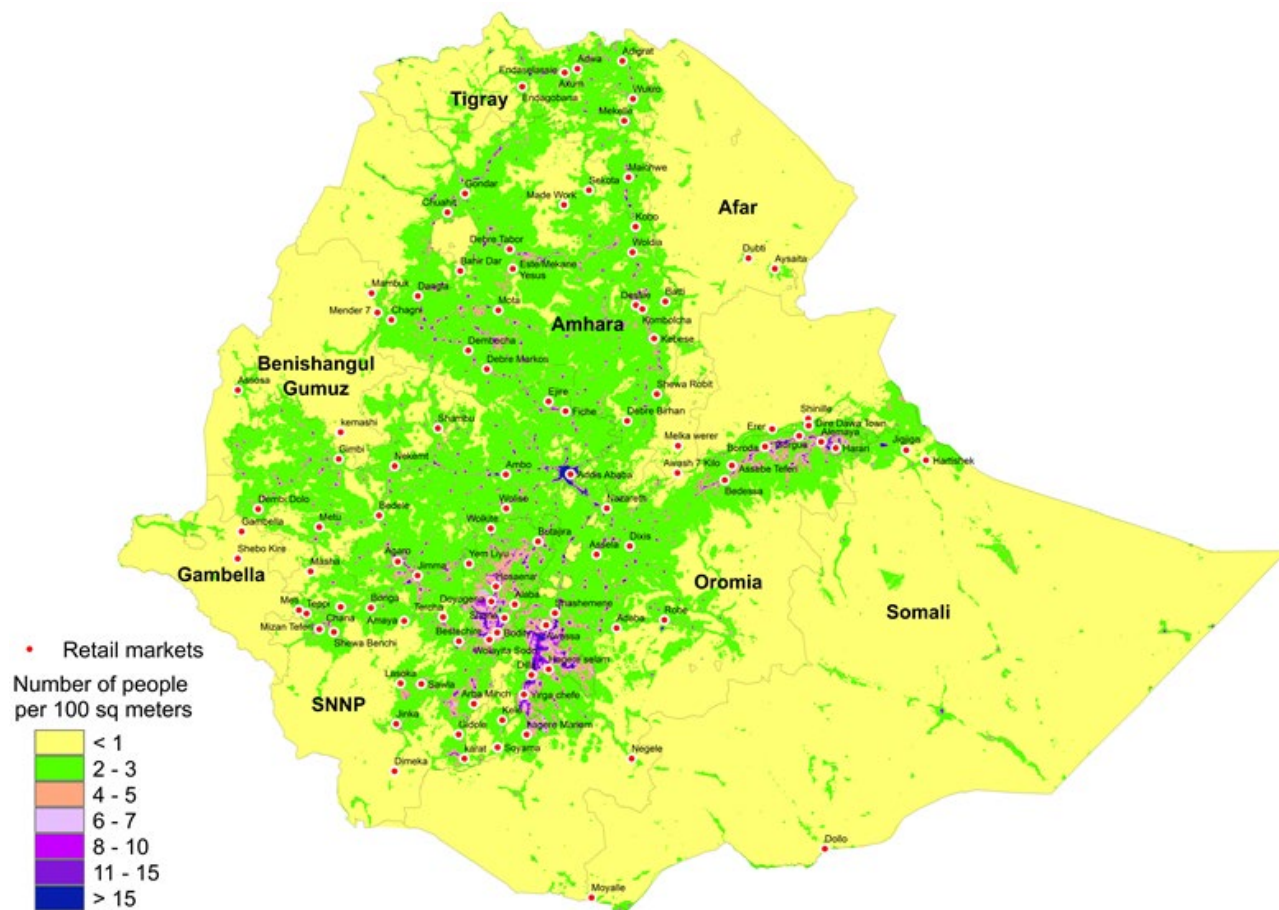
prices supplying and demanding areas and trends in retail-producer price margins. This is followed by a discussion of the evolution of vegetable and fruit prices. Conclusions and policy implications are provided in section 6.

2. DATA AND DESCRIPTIVE STATISTICS

2.1. Data

The retail price data used in this study were collected as part of the Consumer Price Survey of the Central Statistical Agency of Ethiopia (CSA) (CSA 2020a). About 360 items were included in the surveys between when CSA started them in July 1996 until June 2017. However, the number then increased to nearly 700 items. Our analyses include 11 types of vegetables – Ethiopian kale, cabbage, lettuce, spinach, carrot, tomato, onion, garlic, green pepper, pumpkin, and beet root – and six types of fruits – banana, orange, lemon, papaya, avocado, and mango.¹

Figure 2.1: Markets covered by Central Statistical Agency retail price data



Source: Authors' mapping using CSA retail price data (CSA 2019a)

The retail price data cover 116 urban retail markets in all regions of Ethiopia (Figure 2.1). To ensure a sufficient degree of national representativeness, the number of markets in each region is approximately proportional to the region's share of the total urban population. Thirty-one markets were surveyed in SNNP, 24 in Oromia, and 19 in Amhara, the three largest regions, while 12 markets were surveyed in Addis Ababa, which is the largest urban center by far with officially about 4 million residents. Only a handful of markets were surveyed in each of the smaller regions.

¹ Out of vegetables and fruits included in CSA surveys we exclude six – leek, green pea, cauliflower, grape, cactus, and mandarin (tangerine) – from the analyses because they lack data for most of the period covered in the study.

CSA enumerators who reside permanently in areas close to these markets collect price and weight or volume data from traders, retailers, and consumers. For each item, a maximum of three price quotations are collected from three different retailers in the first 15 days of each month in the Gregorian calendar, though enumerators are encouraged to survey the same retailers across months if possible.² While most of our descriptive analyses rely on retail price data, we complement these with descriptions of real producer prices of all 17 vegetable and fruit items using CSA's Producer Survey data (CSA 2020b). The producer price surveys are also conducted monthly and mostly in the same manner as the retail price surveys, but they include only 110 primary agricultural outputs, although the number of markets included in these producer price surveys is considerably higher at about 630.

We express all prices in December 2011 Ethiopian birr by deflating nominal prices using the regional general consumer price index (CPI) calculated by CSA (CSA 2020c). We use a de-seasonalized general CPI, since one of our interests is studying seasonal patterns of prices that typically characterize the agricultural and food sectors.

2.2. Descriptive statistics

Table 2.1 summarizes the number of observations and real retail prices of vegetables and fruits included in the analyses. The number of observations vary widely across items. Green pepper and tomato prices are observed in almost all 116 markets and 174 months during the January 2005 to June 2019 period, while lettuce, pumpkin, and spinach prices are observed in less than 60 percent of the 20,184 market-month (116*174) combinations. The higher number of observations for green pepper, tomato, and onion, which are ubiquitous in most Ethiopian dishes, is consistent with the wider presence of these items in the markets.

Overall vegetable prices weighted by per capita consumption averaged 6.1 birr per kilogram (birr/kg) (in December 2011 prices) or 0.36 USD/kg.^{3, 4} Pumpkin is the cheapest vegetable with an average real price of about 2 birr/kg or about 0.12 USD/kg. Ethiopian kale and cabbage are the next cheapest items, at about 4 birr/kg (0.26 USD/kg). At an average price of 28 birr/kg (1.70 USD/kg) garlic is by far the most expensive vegetable, followed by green pepper, although the latter is on average about half the price of garlic at 0.92 USD/kg. Garlic prices varied widely, ranging between 6 and 70 birr/kg and have the highest standard deviation (SD) of vegetable prices. Comparison of median and mean prices in Table 2.1 as well as normality tests indicate that prices of all vegetable types are skewed to higher values.

Orange is the highest priced fruit at 11.7 birr/kg (0.70 USD/kg) followed by lemon at about 10.4 birr/kg, while banana and papaya prices are the lowest at about 8 and 7 birr/kg, respectively. Relative to the range between the highest and lowest vegetable prices, the range in fruit prices is considerably lower with fruit generally being priced higher than vegetables. Consequently, the per capita consumption weighted overall fruit price (about 8 birr/kg) is over 30 percent higher than the real overall vegetable price.

² Since July 2017, CSA has collected data from only two sources. This change was made apparently to compensate for the considerable increase in the number of items included in the surveys and perhaps because the quotations from the three sources in the period preceding July 2017 had been close or identical to each other.

³ Prices in USD are calculated by dividing average nominal prices to the average monthly USD to Ethiopian birr exchange rate during the period covered in the study, 16.67 birr per 1 USD. The exchange rate, which had a median value of 17.38, increased throughout of the period from the lowest value of 8.65, observed in the first month, to the highest 28.69, observed in the last month.

⁴ See notes to Table 2.1 on construction of weighted prices.

Table 2.1: Descriptive statistics of retail price data, January 2005-June 2019

	Real prices per kg (in December 2011 birr)				
	Observations	Mean	Median	Standard deviation	Coefficient of variation
Vegetables					
Ethiopian kale	17,646	4.1	3.7	2.3	0.57
Cabbage	19,684	4.3	4.0	1.8	0.41
Lettuce	10,951	9.3	7.8	5.7	0.62
Spinach	11,645	4.5	4.1	2.2	0.49
Carrot	19,408	6.7	6.3	2.8	0.41
Tomato	19,760	8.5	8.2	3.2	0.37
Onion	19,707	8.9	8.6	2.7	0.31
Garlic	18,745	28.3	26.3	11.6	0.41
Green pepper	20,007	15.4	14.8	6.1	0.40
Pumpkin	11,727	2.1	1.8	1.2	0.59
Beet root	19,601	5.5	5.2	2.2	0.41
Overall vegetables*	19,930	6.1	5.8	2.5	0.41
Fruit					
Banana	19,721	8.2	8.5	3.2	0.40
Orange	17,800	11.7	11.8	5.6	0.48
Lemon	19,615	10.4	9.3	6.0	0.58
Papaya	14,753	7.2	6.7	4.3	0.60
Avocado	14,789	8.6	8.7	3.1	0.36
Mango	14,565	8.9	9.2	3.6	0.41
Overall fruits*	17,665	8.1	8.2	3.9	0.48
Cereals					
Teff	19,532	10.3	10.1	2.1	0.20
Wheat	19,106	7.7	7.4	1.8	0.23
Barley	18,878	7.5	7.3	1.9	0.25
Maize	19,410	4.7	4.5	1.5	0.33
Sorghum	17,851	5.8	5.6	2.0	0.35
Overall cereals*	19,819	6.3	6.0	2.1	0.34

Source: Authors' computations using CSA price data.

Note: * Overall vegetables, fruits, and cereals real price/kg are a weighted sum of real prices of the items in each group, whereby we use as weights the items' share in total per capita consumption of vegetables, fruits, and cereals consumption, respectively. These weights are computed using zonal level data from CSA Household Consumption Expenditures Survey (HCES) in 2011 (CSA 2011). Accordingly, the weighted overall vegetables price of market j in month t is: $Overall\ vegetables\ price_{jt} = \sum_{i=1}^{11} Real\ price_{ijt} * PCCW_{ij}$ where $i = 1, 2, \dots, 11$ and $PCCW_{ij}$ is the share of item i in total per capita vegetables consumption.

At the bottom of Table 2.1 we provide a similar summary for five staple cereals. We will later investigate whether the relative prices of cereals to vegetables and fruits has changed over the period studied. Teff is the highest priced cereal at 10.3 birr/kg (0.62 USD/kg), while maize has the lowest price at 4.7 birr/kg (0.28 USD/kg). At 6.3 birr/kg, an average cereal was cheaper than the cheapest fruit, papaya. Indeed, excluding papaya and teff from the comparison, the cheapest fruit is on average more expensive than the most expensive cereals. In contrast, the overall cereals price was higher than the overall vegetables price and the prices of a number of vegetable types.

3. VEGETABLE AND FRUIT PRODUCTION AND MARKETED OUTPUT

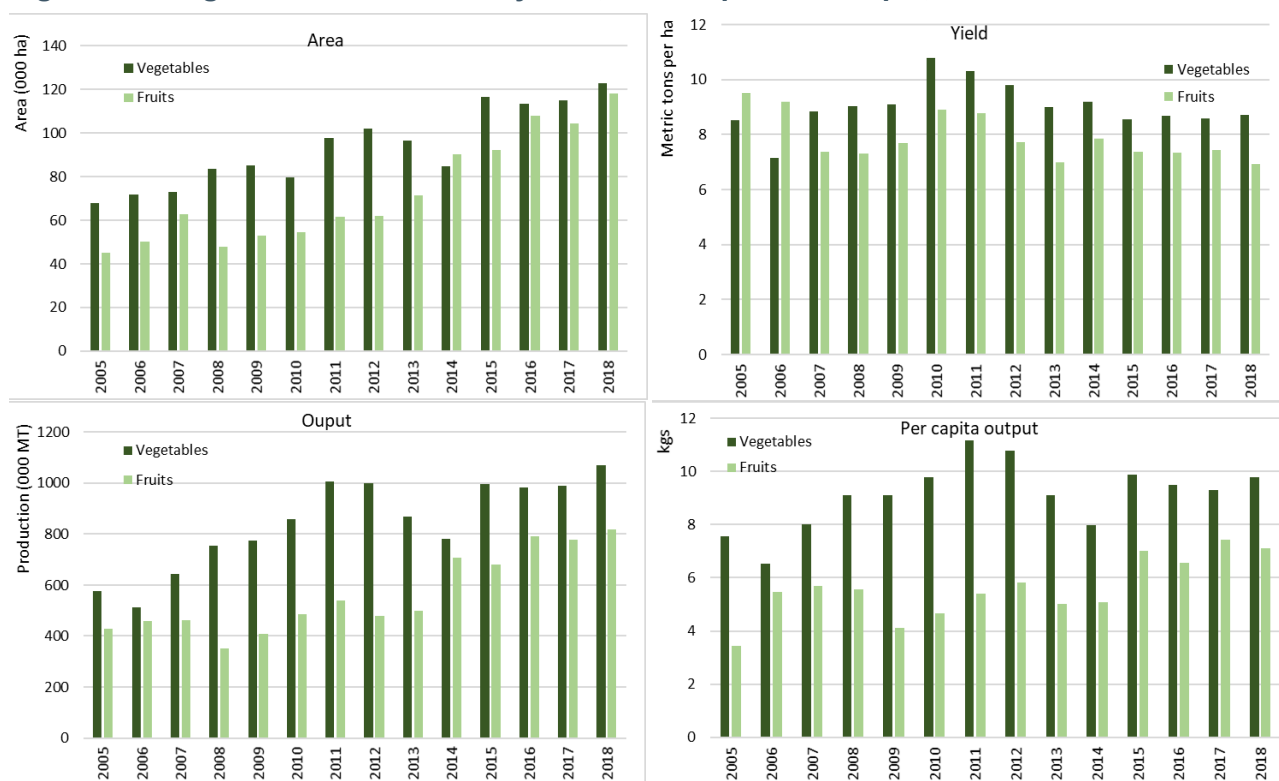
In this section, we first describe trends in vegetable and fruit area, production, and productivity. We also highlight the importance of different items and administrative zones in total production. For this purpose, we use CSA Agricultural Sample Survey (AgSS) administrative zone level (CSA 2007a-2019a) and farmer level (CSA 2020d) data. In the second sub-section we examine the proportion

of vegetable and fruit output that is marketed in Ethiopia. For this purpose, we use CSA (2009c-2019c) reports on national aggregates of crop utilization. This description is to provide context for the study of vegetable and fruit prices in the sections that follow. However, we must point out a caveat to the exposition in this section – the descriptions do not include outputs of large-scale production, particularly of vegetables, that is occurring in some commercial vegetable and fruit production corridors as well as in urban and per-urban areas (Minten et al. 2021; Bachewe and Minten 2021).

3.1. Production

Figure 3.1 depicts trends in vegetable and fruit area (top-left panel), yield (top-right panel), output (bottom-left), and per capita output (bottom-right) during the main agricultural seasons between 2005 and 2018. Annex Tables 1 to 3 provide additional summaries pertaining to vegetable and fruit production. Several observations can be made from the data presented in these tables and figure.

Figure 3.1: Vegetable and fruit area, yields, and output in Ethiopia, 2005 to 2018



Source: Authors' computations using CSA Agricultural Sample Survey data (CSA 2019d).

First, vegetable and fruit yields stagnated during the period between 2005 and 2018 – when cropped area increased relatively faster than increases in output. Figure 3.1 indicates that vegetable output grew by 85 percent from about 577,000 metric tons (MT) in 2005 to 1,069,000 MT in 2018. The area under vegetables increased by over 80 percent from 68,000 to 123,000 hectares in the respective years.⁵ Consequently, vegetable yields were only slightly (2 percent) higher at the end of the period than at the beginning. Similarly, the area cultivated to fruit increased by 163 percent from 45,000 hectares in 2005 to 118,000 hectares in 2018, while the output of fruit grew by only 91 percent, from 428,000 to 818,000 MT over this period. Consequently, fruit yields declined

⁵ The items included in the category of 'vegetables' differ from those in CSA annual reports. Carrots, onion, garlic, and beet root, categorized here as vegetables, are classified as root crops in CSA reports. Moreover, we exclude red peppers from vegetables category for two reasons. First, in Ethiopia red peppers are processed into a hot spice called '*berbere*' and not consumed as are other vegetables. Secondly, the CSA retail price data has no price quotation for a "red pepper". During 2005-2018 the area under red peppers was larger than the area under the 11 items in vegetables combined in all years except 2006.

by 27 percent from about 9.5 MT/ha in 2005 to 6.9 MT/ha in 2008.⁶ This stagnation or decline in yields has important implications for the desired growth of Ethiopia's horticultural sector, for prices of vegetables and fruit, and for improved diets and nutritional outcomes in the country.

Second, despite the stagnant or declining vegetable and fruit yields, there has been considerable growth in per capita vegetable and fruit output. We calculate per capita vegetable and fruit outputs using the output data and population numbers from the World Bank (2020), which indicate an increase of Ethiopia's population by 33 million between 2005 and 2018. The bottom-right panel of Figure 3.1 shows that per capita vegetable output in 2018 at 9.8 kg was nearly 30 percent higher relative to that in 2005, 7.6 kg. Moreover, per capita fruit output in 2018 at 7.1 kg was twice as high as in 2015 at 3.5 kg. These improvements for fruit are due to both the faster growth in output and the lower per capita fruit output to begin with.

Third, despite a rapid increase in the share of cropped area dedicated to vegetables and fruit, they together accounted for less than 1.5 percent of the area under major crops in an average year between 2005 and 2018. Annex Table 1 provides the share of cultivated area under different vegetables and fruits (and for cereals) by crop group as well as out of total cropped area for the meher (major) cropping seasons between 2005/06 and 2018/19 (CSA 2006a-2019a). In an average year over this period, vegetables accounted for about 7 percent of total crop output and about 0.9 percent of the total area under major crops (cereals, pulses, oilseeds, vegetables, root crops, fruits, and other crops). Similarly, fruits accounted for 0.6 of the total area and about 4 percent of total output. However, the shares of vegetables and fruits in total area increased during the period. The share of vegetables area increased from 0.8 percent in 2005 to over 1 percent in 2018, while the share for fruit nearly doubled from 0.42 percent to 0.82 percent during the same period. Nevertheless, the area cultivated to the five cereals, which were grown on about 70 percent of the total area in an average year during the period, sharply contrasts with the area dedicated to both vegetables and fruits. The area under barley, the crop with the smallest areal share among the five cereals, is over five times the area under all 17 vegetables and fruits combined.

Fourth, relative to the meher cropping season, vegetables production is more important in the belg (minor) cropping season, and this importance is growing over time. The foregoing discussion is likely to underestimate vegetables area and outputs because it includes vegetables production in only the meher season and in predominantly rural areas. However, anecdotal evidence suggests considerable and increasing amounts of vegetable production in the minor belg cropping season and in urban and peri-urban areas. While further research is required to assess the importance of urban and peri-urban vegetable production, in Annex Table 2 we summarize data on the importance of vegetables in the area cultivated to annual crops (cereals, pulses, oilseeds, vegetables, and root crops) during the belg agricultural seasons between 2011 and 2015 (CSA 2012b-2016b).⁷ Vegetables accounted for nearly 4 percent of the belg area under annual crops over this period. Computed out of the total area under annual crops, the share of vegetables during the meher seasons between 2011 and 2015 averaged only 1.7 percent, indicating that vegetable production is more important in the belg season. Moreover, the importance of belg vegetable production has increased. Although the five-year study period is too short to provide a full picture,

⁶ However, this decline in fruit yields appear counter-intuitive given that improved fruit varieties that produce larger-sized and a higher number of fruits per tree are being introduced in the country. We suspect two factors may have contributed to this result. First, data on tree crops area, such as for fruit trees, generally involve more errors than other crops. Ten fruit trees planted sparsely, allowing intercropping of other crops, take a considerably smaller area relative to ten trees planted side-by-side. Secondly, CSA introduced changes in data collection methods particularly involving permanent trees' area measurement during this period and this may have repercussions on yields calculated.

⁷ Recent CSA reports on belg production and area included only annual crops or exclude tree crops such as fruits, coffee, and chat. However, the reports included only grain crops (cereals, pulses, and oilseeds) prior to 2011. Moreover, we could not obtain official belg reports for the period after 2015.

the share of cropped area in the belg season devoted to vegetables grew nearly three times faster than did the share of cropped area in the meher season devoted to vegetables over the period.

Fifth, five vegetable items accounted for three-quarters of the cropped area devoted to vegetables and 94 percent of the output in an average year between 2005 and 2018, while banana is the most important fruit. Ethiopian kale, an important staple during slack season, accounted for nearly 30 percent of the area under the 11 vegetables examined and even a higher proportion of the share of the total output of the vegetables (Annex Table 1). Onion, garlic, green pepper, and tomato follow as the second to fifth most important in terms of cultivated area. The same crops are also similarly ranked in importance in terms of share of total vegetable output. For fruit, banana accounted for over 60 percent of the output and area of the six fruit types examined, while lemon was least important, accounting for less than 1.5 percent.

Sixth, a third of vegetable output came from five administrative zones, while over a third of the fruit output came from three administrative zones in SNNP region. We use CSA AgSS household level data (CSA 2019d) to identify administrative zones that are important for vegetable and fruit production. Annex Table 3 lists the ten important administrative zones in terms of total annual vegetable and fruit output between 2006 and 2018. North Shewa administrative zone in Amhara, Sidama in SNNP, and Arsi, East Shewa, and West Arsi zones in Oromiya were most important in vegetable production in that order, with these five zones accounting for 33.4 percent of national vegetable output. These zones together with five others accounted for over half of the nationwide vegetable output. Nearly 36 percent of national fruit production came from Gamo Gofa, Sidama, and Wolayta zones in SNNP. These three zones, together with four others in SNNP and three in Oromiya accounted for two-thirds of the nationwide annual fruit production during the study period.

Finally, irrigation is more important in vegetable and fruit production than it is for producing other crops. The last column of Annex Table 1 provides the proportion of vegetable and fruit area that was irrigated during the 2005 to 2018 meher seasons. Nearly half of the area planted with tomato, a third of the area under onion and lettuce, and at least ten percent of the area under the five other vegetables was irrigated. Overall, 14 percent of the area under vegetables was irrigated. Irrigation is even more common in fruit production, whereby on average 16.6 percent of the area planted to fruit was irrigated. This contrasts to the share of the area under cereals that is irrigated, which averaged less than 1 percent during the period. The share of area planted to vegetables and fruits that is irrigated is at least eight times higher than the share for the most irrigated cereal, maize.

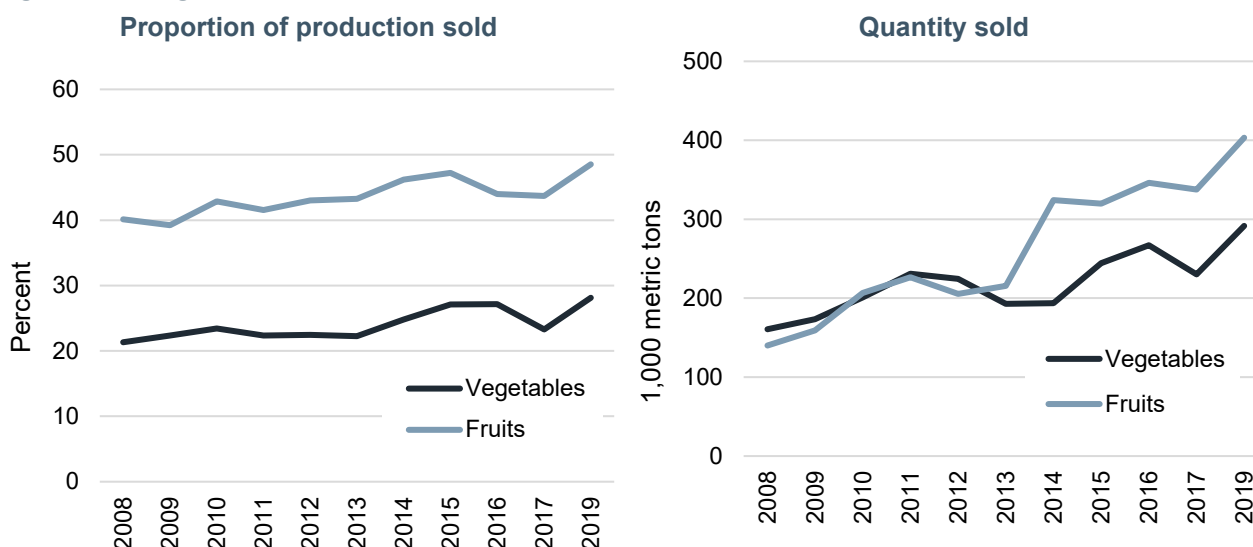
In summary, CSA data indicate that there was a significant increase in vegetable and fruit outputs and area between 2005 and 2018, while yields stagnated over this period. However, there has been considerable growth in per capita vegetable and fruit output. Despite the lower share of vegetables and fruits in total cultivated area, these shares increased rapidly during the period. Furthermore, relative to the meher cropping season, vegetable and fruit production is more important in the belg (minor) cropping season and this importance is growing over time. Banana is the most important fruit, while Ethiopian kale is the most important vegetable. A third of vegetable output came from five administrative zones while over a third of the fruit output came from three administrative zones in SNNP region. Irrigation is more important in the production of vegetables and fruits than it is for the production of cereals and other crops.

3.2. Vegetable and fruit outputs marketed

In Figure 3.2, we summarize trends in the proportion of production and the quantity of vegetable and fruit output marketed by smallholder farmers in Ethiopia during the period from 2008/09 to 2019/20 (CSA 2009d-2020d).⁸ Three observations can be gleaned from the figure.

⁸ CSA began publishing crop and livestock products utilization reports in 2009 (from the 2008/09 meher season).

Figure 3.2 Vegetable and fruit output marketed in Ethiopia, 2008 to 2019



Source: Authors' computations using CSA Agricultural Sample Survey data (CSA 2009d-2020d).
 Note: Numbers for 2018 are unavailable.

First, smallholder farmers sold less than 50 percent of their vegetable and fruit outputs in any one year between 2008 and 2019. However, there has been an increase in the proportion of output marketed, although this has been slow – the proportion of vegetable output sold increased by 7 percent and fruit by 8 percent. The data also indicate that the proportion of vegetable output marketed ranged on average from 17 percent for green pepper to 37 percent for onion. For fruit, it ranged from 24 percent for papaya to 57 percent for lemon.

Second, the proportion of fruit marketed is higher in any year by 17 to 21 percent than the proportion of vegetables marketed. This may indicate that most of the vegetables produced are intended for home-consumption, while a relatively higher proportion of the fruit produced is used as a source of cash.

Finally, the quantities of vegetable and fruit output marketed grew more rapidly than the quantities produced. The quantity of vegetable output marketed increased from 161,000 MT in 2008 to 292,000 MT in 2019, an increase of 81 percent. For fruit, the growth in output marketed was over twofold (188 percent) from 140,000 MT in 2008 to 403,000 MT in 2019. Taking a comparable period for 2007 to 2018, total vegetable output grew by 66 percent, while fruit output grew by 77 percent. In addition, the quantity of fruit output that was used for home consumption almost doubled, while the growth in use for home consumption for vegetables was lower at 29 percent.

4. SEASONAL AND SPATIAL PATTERNS IN PRICES

4.1. Seasonality

Seasonal patterns are a defining characteristic of agriculture (e.g., Sahn 1989). This is particularly important in Ethiopia where agriculture is predominantly rainfed. The country is divided into five major agroecological zones that are mainly defined on the distribution of average rainfall and temperature. In Annex Figure 1 maps show the spatial and seasonal distribution of annual total rainfall across the woredas (districts) of Ethiopia. In western half of the country where the population is concentrated, except for a few districts in the southwest and the northeast, most areas receive average annual rainfall exceeding 1300 mm. Annual total rainfall in the eastern half

is generally lower than 1,000 mm.⁹ Moreover, rainfall is unimodal in the west and north of the country with rainfall mostly falling between June and September and one main cropping season, Meher. The second cropping season, Belg, is more important in the east and southeast parts of the country. Seasonality in prices of vegetables and fruits are driven by these rainfall patterns and the consequent seasonality in production.

Tables 4.1 and 4.2 show the monthly price indices for vegetables and fruit, respectively. These indices were calculated over the January 2005 to March 2019 period using the percentage moving average method in which the real price of the item in each market is expressed as a ratio of the twelve-month moving average value of the item in that market. In addition to production patterns, prices of most vegetables are also influenced by seasonality in demand. We depict results assessing these patterns in Figure 4.1.

Table 4.1: Monthly seasonal price indices of vegetables in Ethiopia, 2005 to 2019

	Ethiopian kale	Cabbage	Lettuce	Spinach	Carrot	Tomato	Onion	Garlic	Green pepper	Pumpkin	Beet root
January	1.07	1.01	1.00	1.05	0.90	0.92	0.99	0.94	1.00	0.98	0.97
February	1.14	1.02	0.97	1.02	0.94	0.86	0.96	0.98	1.09	1.01	1.00
March	1.25	1.05	1.02	1.07	1.03	0.89	0.97	0.99	1.19	1.08	1.05
April	1.17	1.03	1.01	1.04	1.06	0.86	0.95	0.99	1.16	1.07	1.05
May	1.05	1.01	0.98	0.94	1.09	0.87	0.96	1.02	1.02	1.06	1.05
June	0.93	1.02	0.99	0.95	1.10	1.00	0.96	1.06	0.99	1.04	1.03
July	0.84	1.01	1.00	0.95	1.09	1.09	0.98	1.07	1.00	1.03	1.02
August	0.84	0.96	1.03	0.97	1.02	1.11	1.04	1.04	0.93	0.97	0.97
September	0.86	0.97	0.99	0.96	0.98	1.21	1.17	0.99	0.90	0.96	0.96
October	0.91	0.95	0.97	0.98	0.96	1.16	1.08	0.98	0.88	0.93	0.95
November	0.93	0.95	0.98	0.99	0.92	1.09	0.95	0.93	0.90	0.93	0.94
December	0.99	0.98	1.01	1.03	0.89	0.96	0.96	0.90	0.92	0.96	0.96
Amplitude	0.42	0.10	0.07	0.13	0.21	0.35	0.22	0.17	0.31	0.15	0.11

Source: Authors' computations using CSA price data.

Note: Seasonal price indices were calculated over the January 2005 to March 2019 period using the percentage moving average method. In this method, real price of the item in each market is expressed as a ratio of the twelve-month moving average value of the item in that market.

Three observations can be made. First, price seasonality is generally higher for vegetables than for other items. Prices for most vegetables are higher in the first half of the year than in the second. The monthly price indices for Ethiopian kale, green pepper, and pumpkin are considerably greater than 1.0 during most of the first half of the year. Relative to the second half of the year, median real prices of these vegetables, respectively, are 25, 17, and 13 percent higher in the first half. In contrast, tomato and onion price indices are mostly less than 1.0 in the first half of the year, being about 19 and 3 percent lower, respectively, in the first half than in the second half of the year.

This seasonal variation in vegetable prices is captured by the seasonal amplitude values presented at the bottom of Table 4.1. The three vegetables with the highest price variation across different seasons, Ethiopian kale, tomato, and green pepper, have the three highest seasonal amplitudes of 42, 35, and 31 percent. In contrast, lettuce, cabbage, beet root, and spinach have lower price variation relative to other vegetables. However, with seasonal amplitudes of 10 percent or higher for all vegetables except lettuce, seasonal price fluctuations are considerably higher for vegetables relative to other items. For example, Bachewe et al. (2017) obtained an average seasonal amplitude of 8 percent for seven types of animal-source foods (ASF), only two of which were found to have seasonal amplitudes higher than 10 percent.¹⁰ This marked difference in

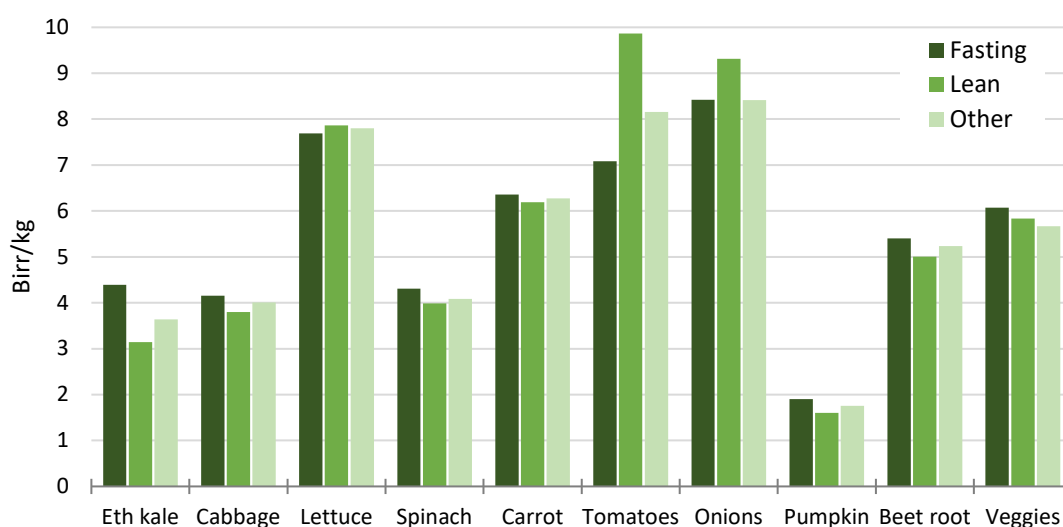
⁹ These averages and seasonal rainfall distributions are calculated using data from NASA (2019) covering the 1981-2019 period.

¹⁰ The seven animal-source food items included in Bachewe et al. (2017) study are beef, cow milk, goat milk, yoghurt, cheese, butter, and eggs. The study also finds an average seasonal amplitude of 9 percent for prices of six types of live animals.

seasonality of vegetable and ASF prices indicates the importance of seasonality in crop production relative to that of livestock and livestock products.

Second, prices of most vegetables are relatively higher during the major Orthodox Christian fasting (Lent) season, driven by the higher demand for vegetables during that season. Bachewe et al. (2017) discuss that during the major fasting period of Lent leading-up to Easter, which lasts up to 56 days in the months of February to April and during which most Orthodox Christians fast, as well as in other fasting seasons, no ASF are consumed. During such fasting seasons, vegetables are a dietary mainstay of most Orthodox Christians. Furthermore, in the northwestern predominantly grain producing parts of Ethiopia, where meher is the major cropping season, the months of August to October mark the lean season during which farmers are in short supply of grains. Vegetables, planted at the beginning of the meher season, are harvested and become an important part of household consumption during this period of the year.

Figure 4.1 Average vegetable prices during fasting, lean, and other months, 2005-2019



Source: Authors' computations using CSA price data.

In Figure 4.1 we provide a summary of real prices of nine types of vegetables across the Lent fasting period (February to April), the lean period (August to October), and other months of the year. Real prices of vegetables are highest during the lent season for six of the nine vegetable types shown.¹¹ Real prices are the lowest during the lean season for the same six types of vegetables, while prices in the remaining six months of the year are intermediate for all the vegetables examined, except onion, which has a similar price as during the fasting months.

Thirdly, seasonality of prices is low for fruit, likely because of the longer period required from planting the trees until they bear fruit. Table 4.2 reports the monthly price indices of fruit. Unlike vegetables that have considerable price variation across seasons, prices indices of most types of fruit fluctuate little. Lemon differs from this general pattern with markedly higher price indices in the first half of the year than in the second. As a result, the seasonal amplitude of lemon is the highest at 40 percent. The remaining fruits have seasonal amplitudes ranging between 14 percent for orange and 8 percent for banana.

¹¹ Prices for garlic and green pepper, which are not shown in the figure, are also highest in the fasting period.

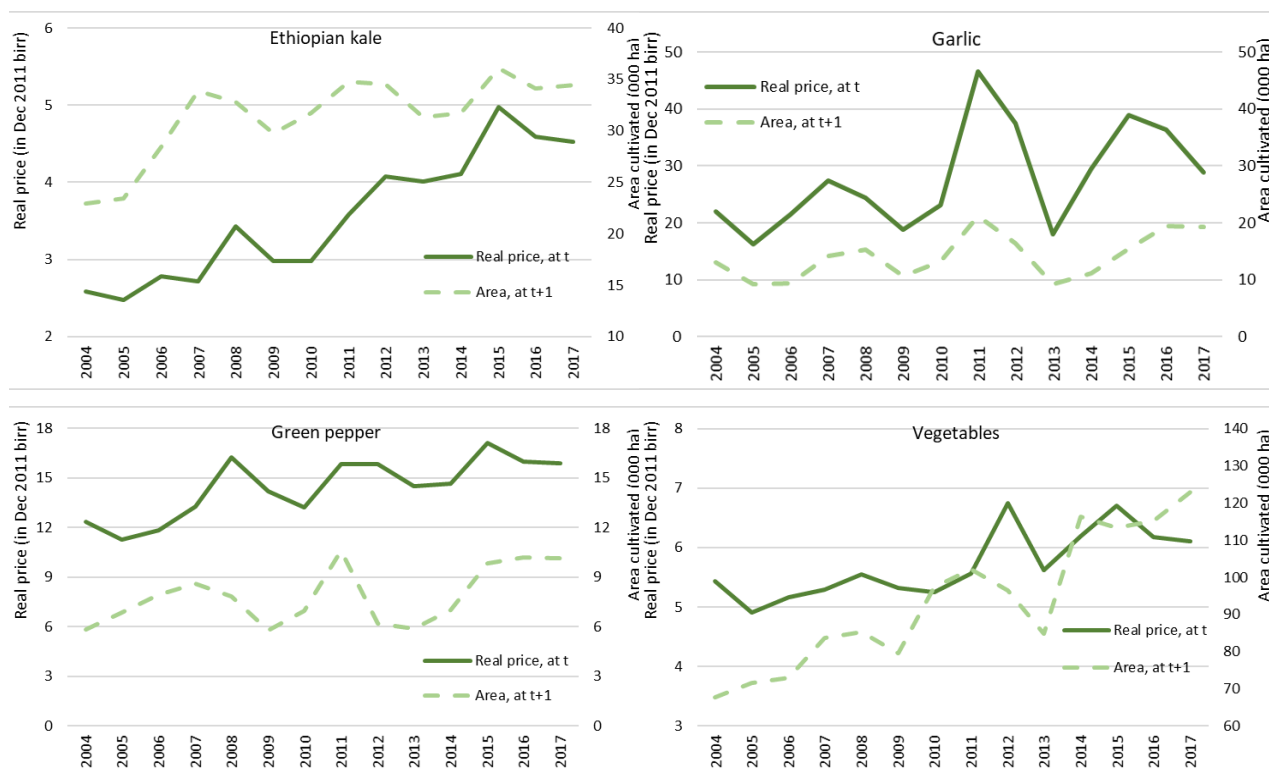
Table 4.2: Monthly seasonal price indices of fruit in Ethiopia, 2005 to 2019

	Banana	Orange	Lemon	Papaya	Avocado	Mango
January	1.00	0.99	1.13	0.98	1.03	1.00
February	0.97	1.04	1.21	0.96	1.00	1.03
March	0.97	1.07	1.23	0.97	1.02	1.06
April	0.97	1.06	1.17	0.99	1.00	1.02
May	0.96	1.03	1.05	0.99	0.95	0.96
June	0.97	1.01	0.94	0.99	0.94	0.94
July	0.99	1.01	0.87	0.98	0.95	0.94
August	1.03	0.99	0.82	1.00	0.96	0.98
September	1.04	0.97	0.83	1.05	0.99	1.00
October	1.03	0.94	0.84	1.06	1.03	1.04
November	1.02	0.93	0.89	1.03	1.05	1.04
December	1.01	0.94	0.99	1.00	1.04	1.03
Amplitude	0.08	0.14	0.40	0.10	0.11	0.13

Source: Authors' computations using CSA price data.

The area cultivated to vegetables in the current year appears to be influenced by farmers' expectations of vegetable prices. Bachewe and Taffesse (2018) study farmers' acreage responses to changes in prices of annual crops in Ethiopia. They show that the area cultivated to grain crops in the current year (or outputs produced next year) responds positively to prices expected next year. Moreover, expectations about next year prices are a function of current prices. Does such inter-period relationship between prices and the area cultivated to vegetables exist? While we defer conducting an inter-period vegetable acreage response econometric analyses similar to Bachewe and Taffesse (2018) for another paper, here we investigate the issue descriptively.

Figure 4.2: Correlation between real price in current year (t) and area cultivated to crops in next year (t+1) for Ethiopian kale, garlic, green pepper, and vegetables overall, 2004 to 2017



Source: Authors' computations using CSA price and area data.

In Figure 4.2 we summarize data on median real prices for different types of vegetables and fruits in the current year (t), beginning with 2004, and the areas cultivated to the crops in the next year ($t+1$), beginning with 2005. The figures suggest that the area cultivated to Ethiopian kale, garlic, green pepper, and vegetables overall in the next year ($t+1$) follows the pattern of prices of the items this year (t). A similar relationship is observed for the other eight types of vegetables except onion, tomato, and spinach.

In Annex Figure 2 we provide a similar figure for fruit. However, this analysis shows that prices and areas cultivated to fruit lack the unique features observed for vegetables in Figure 4.2. This is likely because the relationship between fruit prices and area cannot be captured by this model given the longer period required from planting the trees until they bear fruit. However, banana prices and banana cultivated area the following year appear to follow the same pattern as for vegetables.

Consequently, we further investigate the strength of relationships between prices of all types of vegetables and fruits considered in year t and their cultivated areas in year $t+1$ and whether the correlations are spurious or resulted simply because both prices and cultivated areas are growing. We provide our results of stationarity tests and correlation coefficients in the first five columns of Annex Table 4. The results indicate that any positive correlations of prices in year t and areas under fruit types in year $t+1$ are mainly spurious. In contrast, stationarity of either or both planted area and prices is rejected for all vegetables with positive correlations. These results suggest that the positive correlations between vegetable prices in year t and area cultivated in year $t+1$ are not spurious.

4.2. Spatial patterns

Regional and national prices

In Table 4.3, we summarize regional median vegetables prices and the percentage difference of this median price from the national median price for the entire 2005 to 2019 period. We complement these numbers with the results of similar analyses conducted for each year of the period (Annex Table 5). The results of similar analyses for fruit types are presented in Table 4.4 and in Annex Table 6, respectively. We draw four observations from these analyses.

First, average vegetable prices are higher in predominantly pastoralist Somali and Afar regions and lower in SNNP and Amhara regions. Vegetable prices in Addis Ababa are moderate (fifth highest), and, surprisingly, Addis Ababa has the lowest median price for onion, an item used in almost all Ethiopian dishes. Table 4.3 indicates that prices of five vegetable types are highest in Gambella region, while Somali, Addis Ababa, and Afar regions have the highest prices for three, two, and one type of vegetable, respectively. Per capita consumption weighted overall vegetable prices was highest in Somali region, followed by Afar, Dire Dawa, and Harari regions. Although Gambella has the highest price for many types of vegetables and the highest unweighted vegetable prices, it ranked seventh in vegetable prices when the consumption share of the items is considered. Per capita consumption weighted overall vegetable prices was lowest in SNNP, which had the lowest prices for six types of vegetable, followed by Amhara and Tigray.

Table 4.3: Real prices of vegetables by region, 2005 to 2019

	Tigray	Afar	Am-hara	Oro-miya	Somali	BG	SNNP	Gam-bella	Harari	Addis Ababa	Dire Dawa	Natio-nal
Median real price per kg												
Ethiopian kale	2.9	7.8	3.4	3.4	6.6	3.6	2.8	5.3	4.0	6.2	4.1	3.7
Cabbage	3.9	5.7	3.5	4.0	6.4	5.5	3.4	5.4	4.5	4.2	4.8	4.0
Lettuce	6.8	13.0	5.5	8.2	9.0	6.3	7.7	14.9	13.9	14.9	6.5	7.8
Spinach	3.7	7.7	3.4	4.0	8.3	5.1	4.1	9.2	4.1	4.8	4.0	4.1
Carrot	5.8	8.2	6.5	6.0	9.1	6.5	5.3	10.7	6.7	7.2	6.8	6.3
Tomato	7.7	9.1	7.0	8.3	9.6	7.7	8.5	12.1	8.4	7.8	9.2	8.2
Onion	8.8	9.0	8.2	8.3	9.3	9.9	9.1	10.6	8.7	7.3	8.3	8.6
Garlic	23.9	29.2	21.5	26.0	29.8	28.4	28.0	33.3	25.9	27.0	26.9	26.3
Green pepper	16.5	18.9	13.8	14.0	18.4	13.6	12.6	15.7	19.1	19.4	15.5	14.8
Pumpkin	2.0	3.6	1.6	1.8	4.3	1.6	1.5	3.1	2.2	4.0	2.3	1.8
Beet root	6.9	6.7	5.4	4.4	8.0	6.8	4.2	6.6	6.7	5.4	6.2	5.2
Overall vegetables	5.7	9.5	5.1	5.7	9.5	7.4	4.0	6.6	8.3	7.6	8.7	5.8
Comparison with national median (%)												
Ethiopian kale	78	210	92	91	177	96	76	143	107	168	110	100
Cabbage	98	142	89	101	160	137	86	135	112	104	119	100
Lettuce	87	167	71	106	115	81	99	192	178	192	83	100
Spinach	89	186	82	98	201	123	99	224	101	118	98	100
Carrot	92	131	103	95	145	103	85	170	106	115	108	100
Tomato	95	111	86	102	117	94	104	148	102	95	112	100
Onion	102	104	95	96	108	115	105	123	101	85	96	100
Garlic	91	111	82	99	114	108	106	127	99	103	102	100
Green pepper	111	127	93	94	124	92	85	106	129	131	105	100
Pumpkin	113	206	90	105	245	93	84	178	127	229	133	100
Beet root	131	129	103	85	153	129	80	127	128	103	118	100
Overall vegetables	98	164	88	98	164	127	69	113	143	131	150	100

Source: Authors' computations using CSA price data. Real prices are expressed in December 2011 birr.

Note: BG = Benishangul-Gumuz region; SNNP = Southern Nations, Nationalities, and Peoples' region.

Table 4.4: Prices of fruit by region, 2005 to 2019

	Tigray	Afar	Am-hara	Oro-miya	Somali	BG	SNNP	Gam-bella	Harari	Addis Ababa	Dire Dawa	Natio-nal
Median real price per kg												
Banana	8.9	12.4	9.9	8.8	10.2	5.3	4.8	12.5	9.9	9.1	11.4	8.5
Orange	13.1	13.8	11.4	13.0	14.9	4.9	6.0	14.0	14.0	15.2	13.5	11.8
Lemon	8.6	16.4	7.8	9.8	16.5	4.6	7.0	8.5	15.3	14.2	16.0	9.3
Papaya	8.5	9.9	6.7	7.0	9.1	3.7	2.8	3.7	11.5	12.5	12.4	6.7
Avocado	10.0	10.7	9.6	9.5	12.4	6.3	6.2	10.6	10.5	9.7	12.0	8.7
Mango	11.1	14.4	10.1	9.1	11.8	4.5	5.4	5.5	9.2	10.1	13.9	9.2
Overall fruits	10.0	13.5	8.9	8.3	11.1	3.4	4.8	9.0	9.4	10.8	11.9	8.2
Comparison with national median (%)												
Banana	104	145	116	104	120	62	56	146	117	107	133	100
Orange	112	117	97	110	126	41	51	119	119	129	115	100
Lemon	93	176	84	105	178	50	75	91	165	153	172	100
Papaya	127	149	101	106	136	55	43	55	173	188	187	100
Avocado	115	122	110	108	142	73	71	121	121	111	137	100
Mango	120	156	110	98	128	49	59	60	100	110	151	100
Overall fruits	122	164	109	101	136	42	58	109	115	132	145	100

Source: Authors' computations using CSA price data. Real prices are expressed in December 2011 birr.

Note: BG = Benishangul-Gumuz region; SNNP = Southern Nations, Nationalities, and Peoples' region.

Second, overall fruit prices are highest in Afar followed by Dire Dawa, Somali, and Addis Ababa regions, while Benishangul-Gumuz has the lowest fruit prices. Lemon and avocado were most expensive in Somali; orange and papaya were most expensive in Addis Ababa; and mango and banana were most expensive in Afar and Gambella, respectively. Although Afar has the highest median price for only one type of fruit, its overall median fruit price was the highest because the prices of most fruit types in Afar were among the highest across all regions.

Third, regional differences in prices are higher for fruit than for vegetables. Table 4.3 indicates that the differences of maximum and minimum vegetable prices range between 44 percent for onion to 191 percent for pumpkins. Differences between maximum and minimum vegetable prices are less than a 100 percent for seven of the 11 types of vegetable. Three of the four types of vegetable with differences exceeding a 100 percent involve green-leafy vegetables – lettuce, spinach, and Ethiopian kale – that are difficult to transport longer distances without specialized equipment. In contrast, Table 4.4 for fruit shows that the difference between maximum and minimum prices is the lowest at 99 percent for avocado, followed by 160 percent for banana, and at a maximum of 340 percent for papaya.

Finally, spatial patterns in average vegetable and fruit prices for the overall study period also hold when considering each year separately. The top panels of Annex Tables 5 and 6 provide averages of percentage differences between regional and national median prices computed for each year and vegetable and fruit type. The bottom panel lists the number of years that the median price in the region was higher than national median price during the period from 2005 to 2019, i.e., out of 15 years. Annex Tables 5 and 6 not only provide a more nuanced picture of spatial variation in vegetable and fruit prices but also are consistent with Tables 4.3 and 4.4, respectively. For instance, considering Annex Table 5, median prices of the seven types of vegetable exceeded the national median in all 15 years for Afar region while the same held for five types of vegetable for Somali, Gambella, and Addis Ababa. The per capita consumption weighted overall vegetable median prices for these four regions was higher than the national median in all 15 years. Overall vegetable prices were lower than national median prices in all 15 years for SNNP and Amhara.

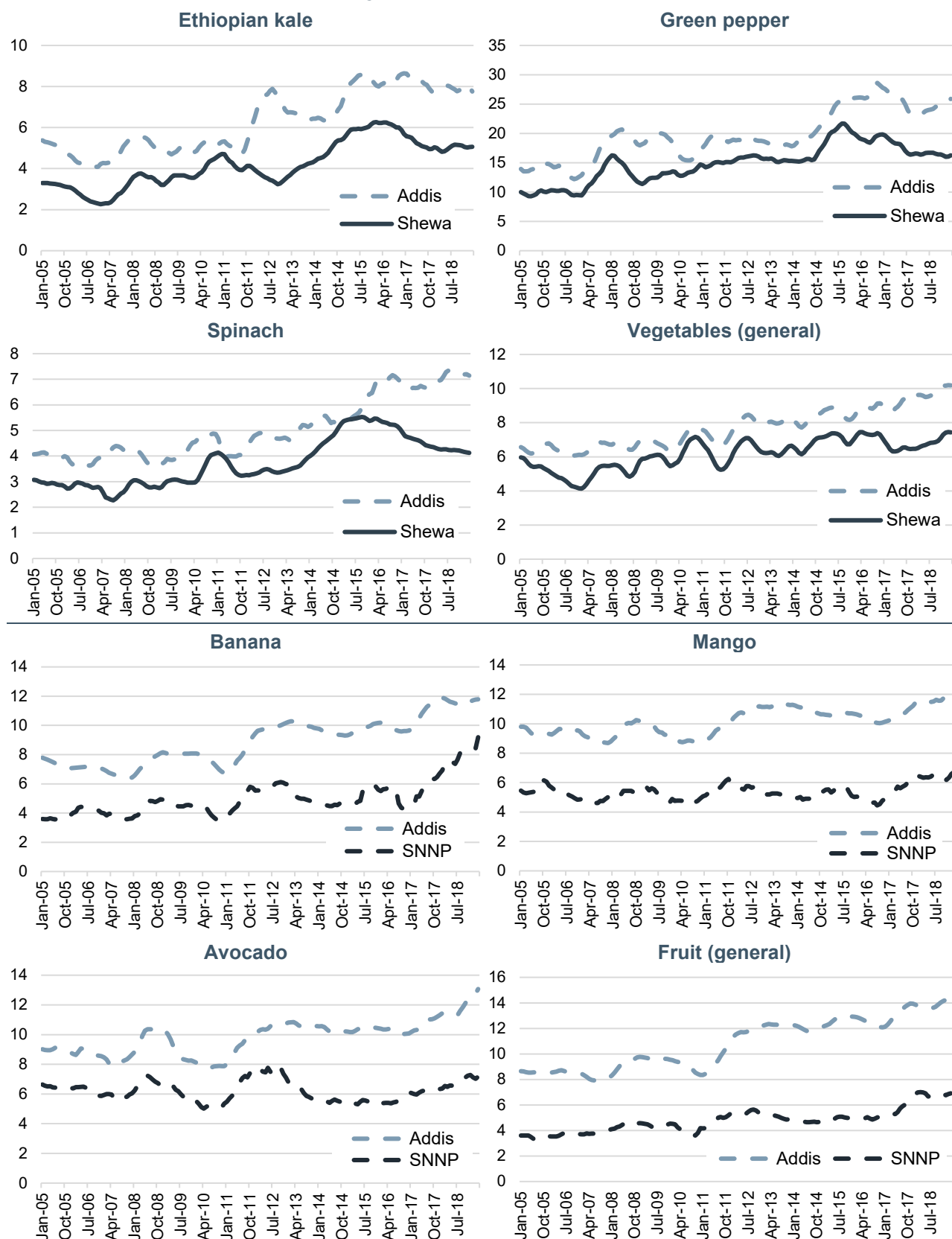
Co-movements of Addis Ababa and Shewa vegetable prices and Addis Ababa and SNNP fruit prices

Urban areas are likely to be supplied with vegetables and fruits by areas around the cities (Minten et al. 2014) or by surplus producing rural areas, even when the latter are distant. If there exist such a supply-demand relationship, the markets in the two areas are usually well integrated, with price differences reflecting marketing costs. We investigate if there exist such a relationship in vegetable prices between Addis Ababa, the capital and by far the largest urban center of demand for vegetables and the North Shewa zone in Amhara region and East Shewa zone in Oromiya, important adjoining vegetable producing zones near Addis Ababa (Annex Table 3). We also investigate the relationship for fruit supply and demand between SNNP, an important fruit producing region (Annex Table 3), and Addis Ababa. The results are shown in Figure 4.3.

Three observations can be made from Figure 4.3. First, vegetable prices in Addis Ababa and the Shewa zones and fruit prices in Addis Ababa and SNNP are well integrated during the study period. Prices in Addis Ababa are higher than those in Shewa for Ethiopian kale, green pepper, spinach, and overall vegetables. Similar patterns are observed for the prices of the other vegetables considered, excluding onion and garlic, for which the patterns are not clear. Similarly, Addis and SNNP fruit prices are shown to be well integrated for the fruit types in Figure 4.3 as well as for orange and lemon, which are not shown in the figure. Correlation coefficients for Addis Ababa and Shewa vegetable prices and Addis Ababa and SNNP fruit prices are presented in

Annex Table 4 (sixth column). The prices in the respective supply areas are statistically significantly positively correlated with those for Addis Ababa for all vegetable or fruit types.

Figure 4.3: Real prices for selected types of vegetables in Addis Ababa and surrounding Shewa zones and for selected types of fruit in Addis Ababa and SNNP, 2005 to 2019



Source: Authors' computations using CSA price data.

Second, both the Addis Ababa and Shewa zone vegetable price-gap and the Addis Ababa and SNNP fruit price-gap increased during the study period. The real prices of vegetables in Addis Ababa and Shewa zones overall averaged 6.4 and 5.3 birr/kg in 2005, respectively, but increased to 10.2 and 6.4 birr/kg in 2019, respectively. That is, the overall vegetable price-gap increased from 1.1 birr/kg in 2005 to 3.8 birr/kg in 2019. Furthermore, the Addis Ababa and Shewa price-gap increased for all 11 vegetable types examined.

Similarly, per capita consumption weighted overall fruit prices in Addis Ababa and SNNP averaged 8.6 and 3.5 birr/kg in 2005 and 14.3 and 6.8 birr/kg in 2019, respectively. The Addis Ababa and SNNP overall fruit price gap increased during the period, from 5.1 birr/kg in 2005 to 7.5 birr/kg in 2019. Furthermore, the price-gap increased for all six fruit types examined.

Thirdly, the Addis Ababa and Shewa price-gap expressed as a ratio of both Addis Ababa and Shewa prices increased for vegetables, while it generally declined for fruit. The Addis Ababa and Shewa overall vegetable price-gap expressed as a ratio of Addis Ababa (Shewa) prices more than doubled, from 17 (21) percent in 2005 to 37 (59) percent in 2019. Similarly, the Addis Ababa and Shewa price gap expressed as a ratio of Addis Ababa or Shewa prices was at least twice as high in 2019 than in 2005 for almost all vegetable types, except tomato and Ethiopian kale.

The Addis Ababa and SNNP overall fruit price-gap, expressed as a ratio of Addis Ababa (SNNP) prices, declined during 2005 the 2019 period for fruit overall and for three of the fruit types considered, while it increased for lemon, avocado, and mango.

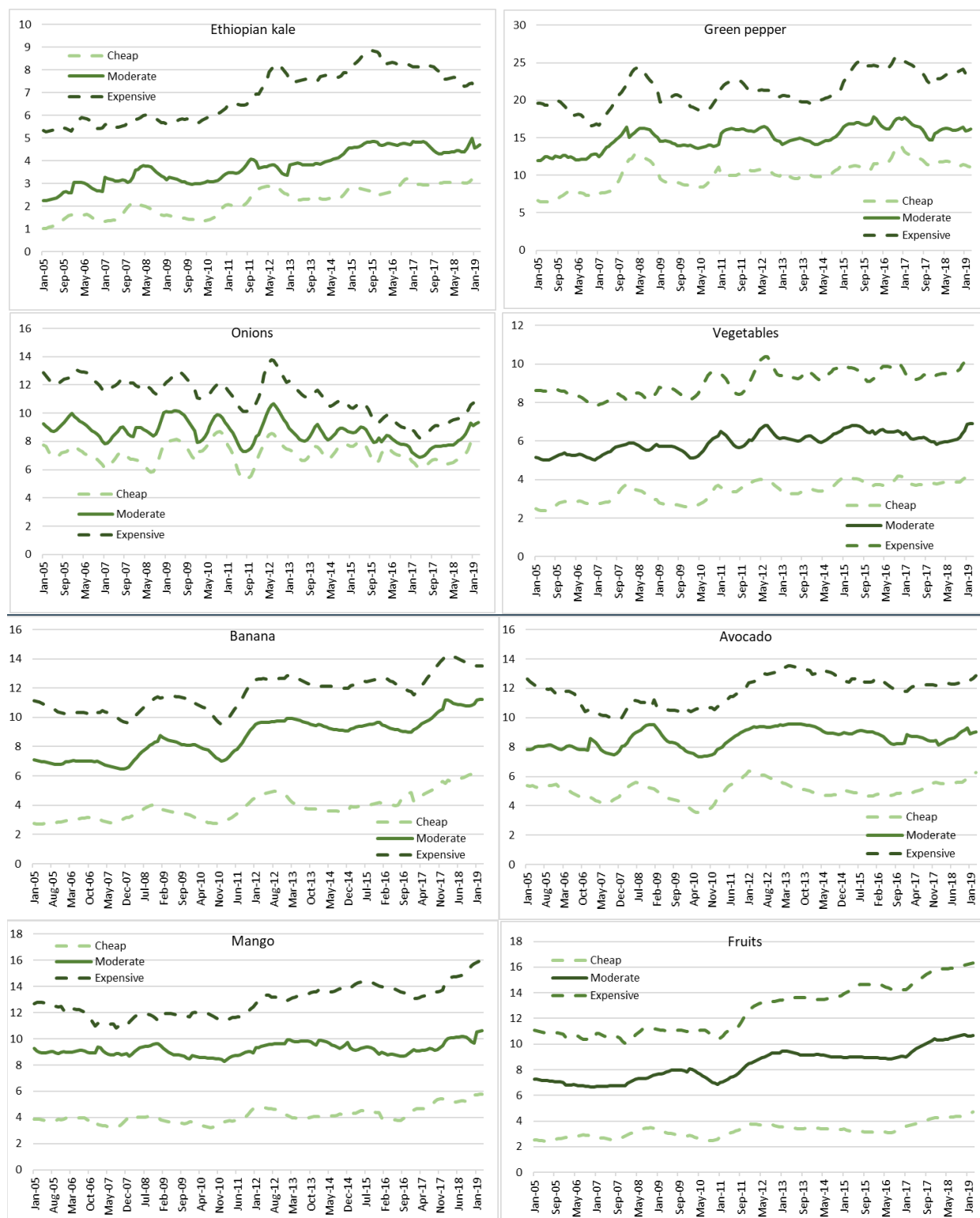
Co-movements of lower, moderate, and high price area prices

The foregoing discussion of Addis Ababa and Shewa vegetable and Addis Ababa and SNNP fruit price trends assume that Addis Ababa is likely to be supplied with the respective items. However, the assumption may not necessarily hold, at least not all the time, and may not capture what is happening in all urban centers and supplying areas. Consequently, we also investigate whether there exist price co-movements in markets with relatively lower vegetable and fruit prices, which likely are surplus producing areas, and those with higher prices that are likely to be supplied with the items. To conduct this analysis, we divide the markets for each item and year into five equal groups based on prices of the items. Then we take three of the five groups to form a group of markets with low prices (first group), moderate prices (third group), and high prices (fifth group), excluding from the analysis markets in the second and fourth groups. We provide trends in prices of these areas in Figure 4.4, where we label markets in the first, third, and fifth groups respectively as lower, moderate, and high. Three observations, similar to those made by comparing Addis Ababa and Shewa vegetable and Addis Ababa and SNNP fruit price trends, can be made from the results in Figure 4.4.

First, lower, moderate, and high price area markets display a strong co-movement in both vegetable and fruit prices. Prices increased in all of these areas over the study period, but prices in lower price areas grew faster. The strong co-movement holds not only for the vegetable and fruit types displayed in Figure 4.4 but also for other types not shown in the figure.¹² Overall vegetable prices averaged 2.5 and 8.6 birr/kg in lower and high price areas in 2005, respectively, while prices in the respective areas increased to 4.2 and 10.1 birr/kg in 2019, a total growth of 69 and 17 percent, respectively. Prices of all vegetable types increased in lower price areas. The same held for high price areas, except for cabbage, onion, and tomato prices. However, vegetable price increases in lower price areas were relatively higher even in absolute (birr/kg) terms for vegetables overall and for seven types of vegetable.

¹² We also provide correlation coefficients of prices in the three areas in the last three columns of Annex Table 5. The results indicate that prices in these areas are statistically significantly positively correlated for all items and market pairs.

Figure 4.4: Vegetable and fruit prices in lower, moderate, and high price areas, 2005 to 2019, 2011 birr/kg



Source: Authors' computations using CSA price data.

Note: To compute prices in lower, moderate, and high price areas, we first divide the markets for each item and year into five groups in increasing order of their prices. Prices in lower, moderate, and high price areas are monthly average prices of the items in first/lowest, third/moderate, and fifth/highest quintiles of markets.

Overall fruit prices in lower price areas in 2019 (4.6 birr/kg) were 85 percent higher than that in 2005 (2.5 birr/kg) while price increases in high price areas were lower at 49.5 percent (from 11 birr/kg in 2005 to 16.3 birr/kg in 2019). Common across all fruit and vegetable types, excluding pumpkins, is that growth in lower price area prices were rather faster relative to high price area

prices. The relatively faster growth in lower price area fruit prices is mainly due to the lower fruit prices in those areas to begin with. That is, the absolute (birr/kg) increase in fruit prices were relatively higher in high price areas.

Second, the high price area to lower price area price-gap slightly declined for vegetables and increased for fruits. Furthermore, the price gap between the two areas has generally been higher for fruits than for vegetables. Figure 4.4 shows that the overall vegetables price gap declined from 6.2 birr/kg in 2005 to 5.9 birr/kg in 2019. Furthermore, the price gap declined for seven vegetable types, stagnated for spinach, and increased for the remaining three vegetables. In contrast, the overall fruit gap increased by 3.3 birr/kg, from 8.4 birr/kg in 2005 to 11.6 birr/kg in 2019.

Third, the high price area to lower price area price gap, expressed as a ratio of vegetable and fruit prices in both high price and lower price areas, declined during the period. The decline was higher when expressed as a ratio of lower price area prices. This is implied by the previous two observations. In particular, the overall vegetable price-gap expressed as a ratio of lower price area prices declined from about 245 percent in 2005 to 142 percent in 2019 while expressed as a ratio of high price area prices it declined from 72 percent to 59 percent. The decline was also observed for all vegetables except pumpkins. The same pattern held in overall fruit prices and all six fruits types. Particularly, the overall fruit price-gap expressed as a ratio of lower price and high price area prices declined from 334 and 77 percent, respectively, in 2005 to 251 and 72 percent in 2019.

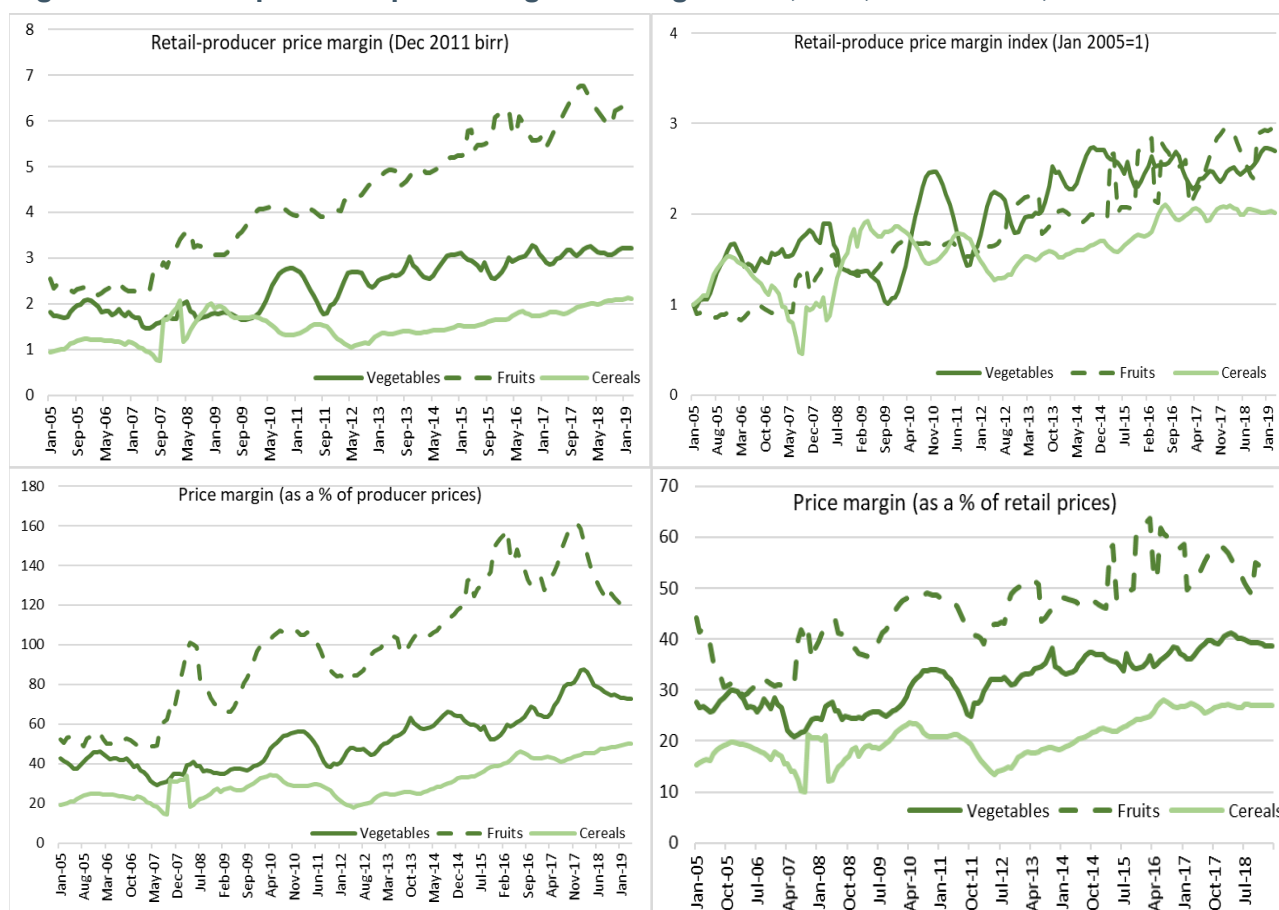
Despite this decline in the vegetable and fruit price gap relative to prices in high price areas, the price gaps in 2019 were higher than prices in lower price areas for seven vegetable types and for vegetables overall as well as for all fruits. Indeed, the high price area to lower price area price gaps were more than double the prices in lower price areas for two vegetable and four fruit types.

While we defer to a future paper a proper econometric analysis of the integration of markets in the high price and lower price areas, trends in these prices, more specifically, the decline in the price gap expressed as a ratio of prices in both areas, imply increased integration of markets in these two areas. However, the increase in price gap in real birr during the period from 2005 to 2019 observed for fruit, together with price gaps in 2019 that exceed prices in lower price areas for almost all vegetables and fruits, may indicate that there still remains a large price gap that needs to be bridged.

Trends in retail-producer price margins

Finally, we investigate whether there have been changes in the producer-retail price margins of vegetables, fruits, and cereals over the period studied. This is important both to determine whether there exist co-movements of rural and urban or semi-urban area prices and to gauge whether the relative cost of purchasing vegetables and fruits has changed in these areas. Bachewe et al. (2020) in a study that covers almost the same period found that the urban-rural wage gap has been low during most of the period, but that the wage gap has been widening in recent years. This finding, coupled with trends in food prices of urban areas and urban-rural food price-gaps, would provide insights on whether vegetables and fruits are becoming more or less accessible over time to residents of urban areas. Three observations can be made from the trends in vegetable, fruit, and cereal price margins graphed in Figure 4.5.

Figure 4.5: Retail-producer price margins for vegetables, fruit, and cereals, 2005 to 2019



Source: Authors' computations using CSA price data.
 Note: Graphs use 12-month rotating smoothed prices

First, the retail-producer price margin of fruit is highest in all years and months followed by vegetables. The price margins are lowest for cereals. The data indicate that the retail-producer price margin of vegetables averaged 2.4 birr/kg during the 2005 to 2019 period, while it was about two times higher for fruit at 4.8 birr/kg. The retail-producer price margin for cereals was the lowest of the three food groups at 1.6 birr/kg. The data further indicate that the pattern in retail-producer price margins for an average year also holds for all months during the period (Figure 4.5, top left panel). This excludes most of the months in 2008 and 2009, a period marked by the international food price crisis when there were spikes in cereal prices and when the cereals retail-producer price margins were higher than that for vegetables. The magnitudes of retail-producer price margins observed for vegetables and fruits on the one hand and cereals on the other may have to do with the extent of perishability of the food items during transportation. However, further investigation is needed to determine whether these differences are commensurate with the extent of wastage during transportation.

Second, there has been rapid growth in the retail-producer price margins of vegetables, fruits, and cereals. The top left and top right panels of Figure 4.5 indicate that the vegetable retail-producer price margin grew by 80 percent over the study period, from less than 2 birr/kg in 2005 to over 3.5 birr/kg in 2019, at 5.3 percent per year. Growth was faster at 8.0 percent per year for cereals, from a retail-producer price margin of 1.1 birr/kg in 2005 to 2.1 birr/kg in 2019. The retail-producer price margin more than doubled for fruit, from less than 3 birr/kg in 2005 to over 6 birr/kg in 2019, an increase of 6.8 percent per year.

Third, despite the rapid growth in both retail and producer prices, there has been rapid growth in the retail-producer margins expressed both as a ratio of producer prices (lower left panel of Figure

4.5) and retail prices (lower right panel of Figure 4.5). Growth in the second half of the period from 2012 to 2019 was relatively faster for vegetables and cereals, while it was relatively slower for fruit. The data indicate that the retail-producer margin of vegetables, expressed as a ratio of vegetables' producer price, was 44 percent in 2005 and nearly 79 percent in 2019. That is, the retail-producer margin to producer price ratio of vegetables grew by 81 percent. The retail-producer margin of vegetables, expressed as ratio of retail prices, increased by 58 percent from 27 percent in 2005 to 43 percent in 2019. Similarly, the retail-producer margin to producer price ratio of fruit increased by nearly 92 percent, from 68 percent in 2005 to 129 percent in 2019. That is, in 2019 the retail-producer price margin was 29 percent higher than producer prices of fruit. The retail-producer margin to producer price ratio of cereals showed the highest total growth of 111 percent, from 23 percent in 2005 to 49 percent in 2019, mainly because it started from a lower base.

That the retail-producer price margin, expressed as a ratio of both producer and retail prices, has been increasing during the period, implies that price margins have been growing faster than both producer and retail prices. This, in turn, implies that there is a large price gap in producer and retail prices, particularly for vegetables and fruits, that needs to be bridged to better integrate markets in the value chains for these nutritious foods. This finding reinforces the similar point made earlier regarding the price gap between high price and lower price areas.

5. EVOLUTION OF VEGETABLE AND FRUIT PRICES FROM JANUARY 2005 TO JUNE 2019

In this section we first study trends in prices of vegetables and fruits in Ethiopia for the 15 year period from January 2005 to June 2019. Then we study the extent to which vegetable and fruit prices have changed relative to other food items – specifically, we compare changes in vegetable and fruit prices to changes in the prices of the five staple cereals.

5.1. Vegetables and fruits

We summarize real urban retail prices in December 2011 birr of vegetables for the years 2005, 2009, 2012, 2016, and 2019 in the top panel Table 5.1 (columns 2-6). The bottom panel of Table 5.1 (columns 3-6) provides comparison of prices in 2009, 2012, 2016, and 2019 relative to 2005, expressed as a percentage of prices in 2005. Columns 7 through 11 of the table provide a similar summary for rural producer prices using CSA's Producer Survey Data (CSA 2019b). Table 5.2 provides a similar summary for fruit prices over this period. Furthermore, we provide trends in smoothed prices of all vegetable and fruit items in Annex Figure 3. The following two observations can be made about the results in Tables 5.1 and 5.2.

First, overall vegetable and fruit retail prices as well as retail prices of all vegetable and fruit items were higher in real terms in 2019 than in 2005. Table 5.1 indicates that the overall vegetable price in 2019 was 39 percent higher than 2005 and was the highest in 2019 among all the years, including those not presented in Table 5.1. Most vegetable items saw their highest real prices in 2019. By type of vegetable, price growth between 2015 and 2019 was relatively lower for tomato, onion, and cabbages and relatively higher for garlic, Ethiopian kale, and lettuce.

Similarly, the overall fruit price in 2019 was nearly 60 percent higher in real terms than the 2005 price, the highest among all years examined. Prices were the highest in 2019 for all fruit types, except avocados. Price growth between 2005 and 2019 was lowest among fruit types for avocado, while it was highest for lemon.

Table 5.1: Price evolution for vegetables in Ethiopia, 2005, 2009, 2012, 2016, and 2019

Vegetable type	Urban retail prices					Rural producer prices				
	2005	2009	2012	2016	2019	2005	2009	2012	2016	2019
Median real prices, Birr/kg										
Ethiopian kale	2.5	2.9	4.1	4.6	4.8	1.7	2.3	2.6	3.0	3.0
Cabbage	3.9	3.8	4.7	4.4	4.5	2.6	2.4	2.7	2.4	3.1
Lettuce	5.0	6.2	9.5	9.5	10.0	4.2	3.8	6.8	6.4	5.1
Spinach	3.0	3.1	4.3	5.3	5.2	3.0	3.1	3.4	3.8	3.4
Carrot	5.3	5.9	6.9	6.7	8.3	3.7	3.7	3.5	3.2	3.3
Tomato	7.6	7.2	9.2	9.8	8.0	3.6	3.5	4.2	4.3	3.9
Onion	8.9	10.1	10.8	7.6	9.6	6.2	6.9	8.1	5.6	6.4
Garlic	15.9	18.8	37.4	36.2	28.6	12.5	16.9	23.2	20.8	20.5
Green pepper	11.4	14.6	15.9	16.0	16.1	6.6	6.5	8.0	7.8	8.0
Pumpkin	1.6	1.6	1.9	1.6	2.3	1.1	1.3	1.5	1.5	1.4
Beet root	4.2	4.7	5.8	5.9	5.8	3.1	2.8	3.6	3.0	3.2
Overall vegetables	5.0	5.4	6.6	6.3	6.9	3.3	3.6	4.6	4.2	4.3
Comparison with national median in 2005 (%)										
Ethiopian kale	-	115	162	185	193	-	139	158	182	182
Cabbage	-	99	121	114	116	-	94	106	95	119
Lettuce	-	124	188	188	199	-	91	161	152	120
Spinach	-	104	142	174	171	-	104	115	129	114
Carrot	-	112	131	127	158	-	100	93	84	88
Tomato	-	95	121	129	106	-	97	116	119	109
Onion	-	113	122	85	108	-	111	132	90	103
Garlic	-	118	236	228	180	-	135	186	167	165
Green pepper	-	128	140	140	141	-	99	122	120	122
Pumpkin	-	102	116	103	145	-	112	137	137	122
Beet root	-	111	137	140	137	-	91	115	97	101
Overall vegetables	-	109	133	126	139	-	107	136	125	128

Source: Authors' computations using CSA price data.

Table 5.2: Price evolution for fruit in Ethiopia, 2005, 2009, 2012, 2016, and 2019

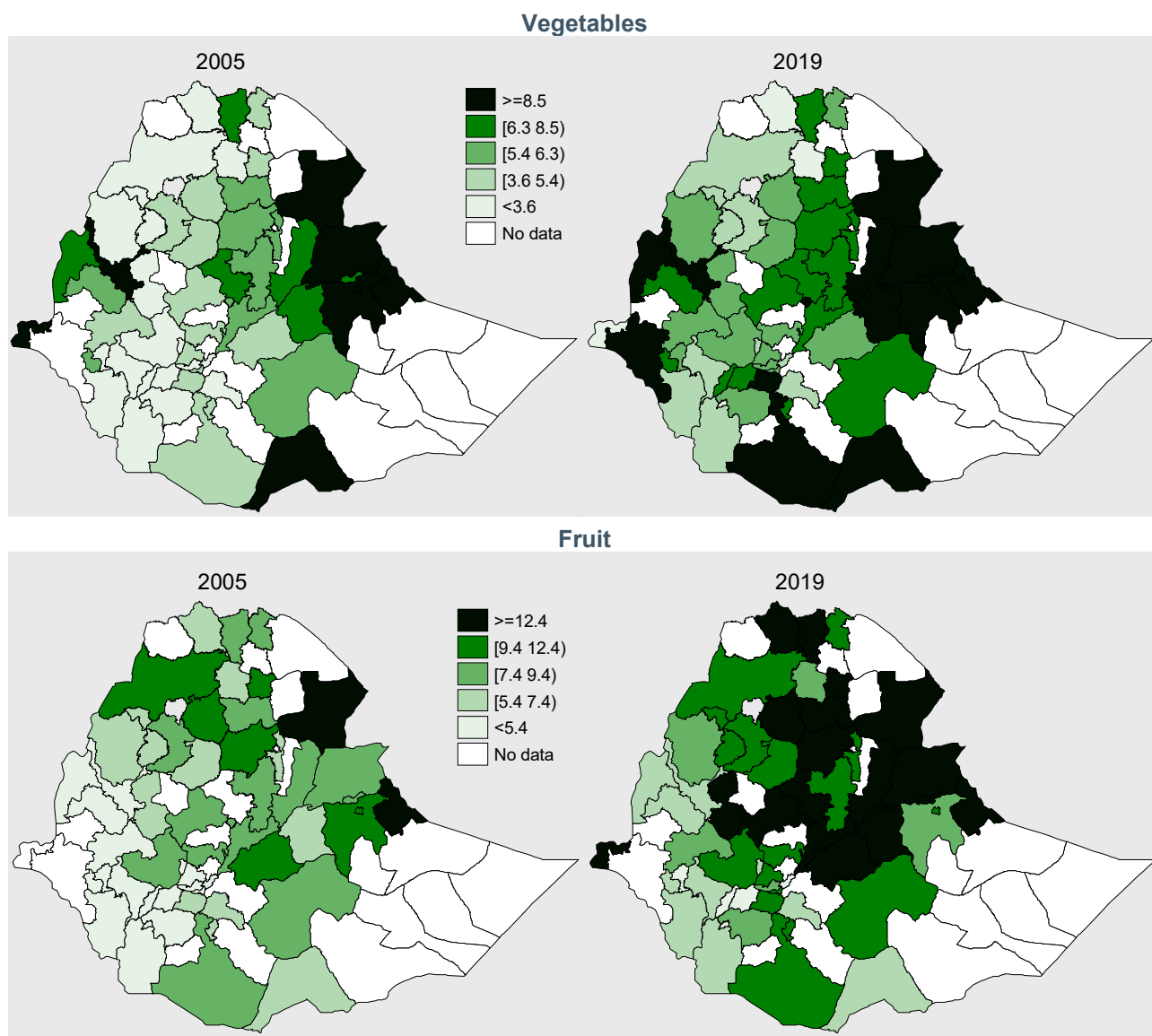
Fruit type	Urban retail prices					Rural producer prices				
	2005	2009	2012	2016	2019	2005	2009	2012	2016	2019
Median real prices, Birr/kg										
Banana	6.9	8.3	9.5	9.2	11.3	3.2	3.6	4.1	3.6	3.9
Orange	9.4	10.9	12.8	15.0	18.2	2.5	2.9	3.5	3.9	6.3
Lemon	7.0	8.3	10.1	10.5	15.1	2.7	2.5	4.1	3.7	7.1
Papaya	5.3	6.3	7.9	7.7	9.1	2.8	2.8	3.4	3.1	3.4
Avocado	8.8	8.3	9.5	8.7	9.6	3.1	2.9	4.2	2.8	2.8
Mango	9.2	9.0	9.6	9.2	10.6	2.4	2.5	3.8	2.4	5.8
Overall fruits	6.9	8.1	9.0	9.2	11.0	3.5	3.6	4.3	3.5	4.9
Comparison with national median in 2005 (%)										
Banana	-	121	139	133	164	-	114	127	112	122
Orange	-	116	137	159	194	-	116	141	157	251
Lemon	-	118	144	150	215	-	92	148	136	258
Papaya	-	119	149	146	171	-	103	124	113	122
Avocado	-	94	108	99	109	-	95	134	90	91
Mango	-	97	104	99	115	-	102	156	100	237
Overall fruits	-	118	131	133	159	-	104	124	100	142

Source: Authors' computations using CSA price data.

Taking the entire period into consideration, growth in overall vegetable retail prices averaged 3.6 percent per year. Average annual growth was the lowest for cabbage, tomato, and onion, while price growth was fastest for spinach, lettuce, and Ethiopian kale. The high variation in garlic prices (Annex Figure 3) implies that the price of this item has been marked by both rather high growth and decline in prices. Overall, garlic retail prices increased by 12.3 percent in an average year during the period. Annual growth in overall fruit price averaged 3.5 percent per year. Growth in avocado and mango prices was slow, while it was faster for other fruit types.

Secondly, comparing the producer prices in last five columns of Tables 5.1 and 5.2 with the retail prices in the preceding five columns indicates that producer prices were lower than retail prices for all years and all items, as expected. Furthermore, the bottom panels of these columns reveal that growth in producer prices were generally lower than retail price growth between 2005 and 2019. This held for the overall price of vegetables and the overall price of fruit as well as for most individual types of vegetables and fruit.

Figure 5.1: Real overall prices of vegetables and fruits (December 2011 birr/kg) in 2005 and 2019, by zone



Source: Authors' calculations based on CSA price data

We depict the evolution of retail prices of vegetables and fruits across space in Figure 5.1, where we provide zonal maps for overall vegetable and overall fruit retail prices for the first two

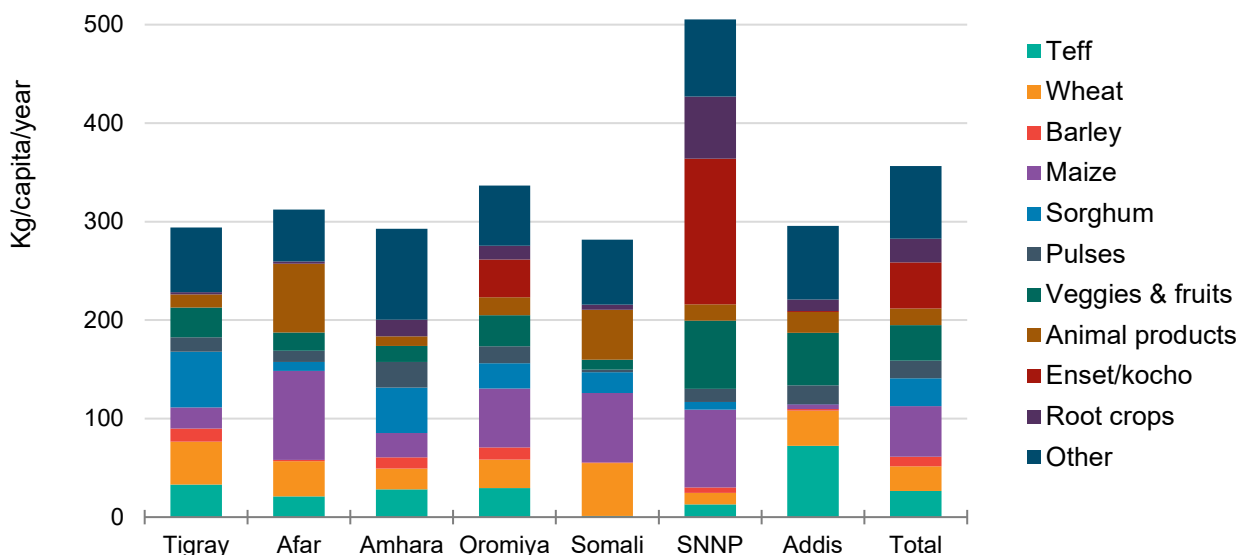
quarters of 2005 and first two quarters of 2019. In this figure, increases in the prices are indicated by a change of colors from light to darker green. Overall vegetable prices in 2019 were higher than those in 2005 for almost all (93 percent) of the 56 administrative zones with retail price data for vegetables. Spatial patterns for price changes for the 11 specific vegetable types are similar to the map in Figure 5.1 for the overall vegetable price, with colors changing from light green in 2005 to dark green in 2019, in most administrative zones and for most vegetable types.

The lower panel of Figure 5.1 shows that the overall fruit price in 2019 was higher relative to prices in 2005 in all administrative zones except one. For banana, 2019 prices were higher than 2005 prices in 89 percent of the zones. Similarly, 2019 prices of lemon, papaya, and orange were relatively higher for between 91 and 98 percent of the administrative zones, while 2019 prices of avocado and mango were higher than 2005 prices in 60 and 70 percent, respectively, of the zones.

5.2. Vegetable and fruit versus other food prices

Worku et al. (2017) show that there has been a considerable increase in the consumption of vegetables and fruit in quantity, in value, and in their share of consumption spending over the past 20 years in Ethiopia. This increase implies at least a partial trade-off in the consumption of other major products in the consumption basket, particularly cereals. All cereals, except teff, have seen a decline in consumption levels over the same period. In this section, we compare to what extent the real prices of vegetables and fruits have changed relative to real prices of cereals during the period from 2005 to 2019.¹³ To do so, we first examine the per capita consumption of different crops and products, including fruits and vegetables, in the four major crop producing regions (Tigray, Amhara, Oromiya, and SNNP), as well as for the Afar, Somali, and Addis Ababa regions.¹⁴ For this purpose, we use data on the average consumption basket from the Household Consumption Expenditures Survey (HCES) in 2011, which we summarize in Figure 5.2.

Figure 5.2: Annual per capita food consumption in 2011 in Ethiopia, by food type and region, kg/capita/year



Source: Authors' calculations from CSA, HICES 2011.

¹³ WDI (2019) data indicate that nearly 80 percent of the population in 2018 lived in rural areas while CSA (2020d) data indicates 86 percent of crop farmers produced one or more type of cereals; and consumed 68 percent of the cereals output in 2017 (CSA 2018c). In the same year, 72 percent of the total crop area was used to produce cereals (CSA 2020d).

¹⁴ CSA (2013) data indicate that the seven regions accounted for 97.5 percent of Ethiopia's population (94.4 million) in 2017.

Figure 5.2 indicates that, in quantity terms, cereals are very important for household consumption in these regions, accounting for at least half of the average consumption basket in most regions. The one exception is SNNP region, where cereals comprise only 25 percent of the consumption basket, as enset and root crops account for 30 percent. Vegetables and fruit accounted for 18 percent of the consumption basket in Gambella and 17 percent in Addis Ababa. Other regions with relatively high vegetable and fruit consumption as a share of total consumption are SNNP and Dire Dawa. Lowest share of the consumption basket made up by vegetables and fruit are seen in Somali, Amhara, and Afar. While the relatively lower consumption of vegetables and fruits in Afar and Somali and higher consumption in SNNP is consistent with the prices of vegetables and fruit prevailing in those regions, the relatively higher consumption in Gambella, Addis Ababa, and Dire Dawa as well as the lower consumption in Amhara is not consistent with price levels in those regions.

We use the consumption data discussed above, together with CSA's retail price series, to compute the terms of trade of each vegetable and fruit type as a ratio of real cereal prices. The results of these computations are provided in Table 5.3 for vegetables and Table 5.4 for fruits.

One could buy one kg of spinach and one kg of Ethiopian kale with half a kg of cereals in 2005 while one needed 0.7 kg of cereals to buy one kg of spinach and 0.8 kg of cereals to buy one kg of Ethiopian kale in 2019 (Table 5.3). That is, the value of spinach and Ethiopian kale in terms of cereals increased by 40 and 60 percent, respectively, between the two years. Similarly, the price of garlic and lettuce in terms of cereals increased by 164 and 187 percent, respectively during the period. Relative to cereals the price of cabbage, tomato, and onion remained stable.

Table 5.3: Terms of trade of vegetables relative to cereals in Ethiopia, 2005, 2009, 2012, 2016, and 2019

Vegetable type	2005	2009	2012	2016	2019
Terms of trade for one kg of vegetables in terms of one kg of cereal					
Ethiopian kale	0.5	0.4	0.6	0.8	0.8
Cabbage	0.7	0.5	0.7	0.8	0.7
Lettuce	0.8	0.7	1.4	1.6	1.5
Spinach	0.5	0.4	0.5	0.8	0.7
Carrot	0.9	0.7	1.0	1.2	1.3
Tomato	1.3	0.9	1.3	1.8	1.3
Onion	1.6	1.3	1.6	1.5	1.5
Garlic	2.9	2.5	5.4	6.6	4.7
Green pepper	2.0	1.9	2.2	2.9	2.5
Pumpkin	0.3	0.2	0.3	0.3	0.4
Beet root	0.7	0.6	0.9	1.0	0.9
Overall vegetables	0.9	0.7	0.9	1.1	1.1
Comparison with national median terms of trade in 2005 (%)					
Ethiopian kale	-	81	129	182	167
Cabbage	-	73	97	110	97
Lettuce	-	84	166	202	186
Spinach	-	74	110	160	141
Carrot	-	82	112	133	141
Tomato	-	70	99	132	98
Onion	-	83	101	91	96
Garlic	-	89	191	230	164
Green pepper	-	95	113	145	125
Pumpkin	-	76	99	113	134
Beet root	-	84	118	135	121
Overall vegetables	-	78	110	128	124

Source: Authors' computations using CSA price data.

In addition to increases in terms of trade of almost all vegetables during the period from 2005 to 2019, two important observations can be made from Table 5.3. First, terms of trade were lower in 2009 for all vegetable types. That is because real prices of all cereal types were the second highest of all years in the period in 2009, following 2008, as a consequence of the international food price crisis in those years. As a result, cereals were relatively more expensive and vegetables relatively lower in value in 2009. Second, relative to 2005, the terms of trade for all types of vegetables were higher or about the same in all remaining years; including 2012, a period of another international food price crisis, during which cereal prices were at third highest level. However, this pattern does not include onion, cabbage, and tomato, which had lower terms of trade in most years.

Table 5.4: Terms of trade of fruit relative to cereals in Ethiopia, 2005, 2009, 2012, 2015, and 2019

Fruit type	2005	2009	2012	2016	2019
Terms of trade for one kg of fruit in terms of one kg of cereal					
Banana	1.1	1.0	1.4	1.6	1.7
Orange	1.5	1.2	1.6	2.5	2.5
Lemon	1.3	1.0	1.4	1.9	2.3
Papaya	0.9	0.7	1.1	1.2	1.2
Avocado	1.5	1.0	1.3	1.4	1.4
Mango	1.5	1.0	1.3	1.5	1.5
Overall fruits	1.1	0.9	1.2	1.5	1.7
Comparison with national median terms of trade in 2005 (%)					
Banana	-	94	126	145	158
Orange	-	81	109	168	171
Lemon	-	82	114	150	183
Papaya	-	83	129	136	140
Avocado	-	69	91	93	97
Mango	-	72	87	102	106
Overall fruits	-	80	110	134	151

Source: Authors' computations using CSA price data.

Table 5.4 reveals a similar pattern to vegetables in the cereal terms of trade for fruit. One would need 1.1 kg of cereals to buy a kg of banana in 2005, while the cereals needed to buy a kg of banana increased by nearly 60 percent, to 1.7 kg of cereals in 2019. Similarly, the terms of trade of other fruits increased between 2005 and 2019 – 6 percent for mango and by over 70 percent for orange and lemon. Avocado had the lowest terms of trade across the entire period. The two observations made regarding relative prices of vegetables and cereals also hold for all fruit types, the exception here being avocado. Relative to 2005, all fruit types had lower terms of trade in 2009. Moreover, relative to 2005, terms of trade of all fruit types were higher in all remaining years, excluding mango in 2012.

6. CONCLUSIONS AND POLICY IMPLICATIONS

Policymakers have long focused on sustainably reducing malnutrition given associated high human and economic costs and its strong link with poverty. Despite rapid improvements in poverty and malnutrition in the last two decades there still remains significant malnutrition in most of Africa. Complete nutrition requires regular consumption of diverse diets. The push towards consumption of more diversified diets has far reaching implications on nutrition, agricultural, food system, and health policies. Vegetables and fruits contain important quantities of micronutrients and are among the most nutritious foods found in the diets of Ethiopians. This paper studies vegetable and fruit

prices, production, and marketed output in Ethiopia during the period from 2005 to 2019, when the country achieved rapid declines in malnutrition and poverty. Despite these improvements, the country is among the poorest performing in Africa in terms of nutritional outcomes. The rising costs of nutritious foods is considered one of the factors contributing to this poor performance. This study examines changes in the production, marketing, and prices of vegetables and fruits in Ethiopia during the period from 2005 to 2019. The analyses reveal several findings.

The cropped area and output of vegetables and fruit nearly doubled during the period studied. However, vegetable yields grew only slightly, while fruit yields declined. Although vegetables and fruit accounted for a small share of the area under major crops, these shares are increasing rapidly. Relative to the meher (major) cropping season, vegetables and fruits production is more important and is expanding more quickly in the belg (minor) season. Irrigation is significantly more important in the production of vegetables and fruit than it is for other crops. Less than 50 percent of fruit and a considerably lower proportion of vegetable outputs are marketed. Smallholder farmers consume most of their vegetable and fruit horticultural output, but there have been slow increases in the proportion of the output that is marketed. Relative to fruit, a higher proportion of vegetables are home-consumed. The quantity of vegetables and fruit output marketed grew more rapidly than the quantity produced.

Overall, in real terms vegetable and fruit prices as well as prices of all vegetable and fruit items were higher in 2019 than in 2005. Overall vegetable and fruit prices in 2019 were at least 40 percent higher than 2005. Furthermore, 2019 prices were higher than 2005 prices for almost all administrative zones across Ethiopia. Growth in producer prices were generally lower than retail price growth. Relative prices of vegetables and fruit also increased during the period. Terms of trade for vegetables and fruit relative to cereals were higher in 2019 than in 2005. Price seasonality is generally higher for vegetables than for other items, including animal-source foods, and this is likely due to the relatively higher paucity of vegetable production at certain times of the year. However, there is less seasonality in the prices of fruit, likely because the longer period required from planting the trees until they bear fruit.

Average vegetable prices are higher in the predominantly pastoralist Somali and Afar regions and lower in SNNP and Amhara. Vegetable prices in Addis Ababa are moderate and, surprisingly, Addis Ababa has the lowest median price for onion, an item used in almost all Ethiopian dishes. Fruit prices are high in Afar, Dire Dawa, and Somali, while Benishangul-Gumuz, SNNP, and Oromiya have relatively low fruit prices. Regional differences in prices are higher for fruit than for vegetables.

Prices in markets located in vegetable and fruit producing areas co-move strongly with prices in urban area markets. High price, moderate price, and lower price area markets display strong co-movement in both vegetable and fruit prices. Retail-producer price margins for fruit are the highest in all months of the year, followed by vegetables, while cereals have the lowest retail-producer price margin in almost all months. The marketing margins observed for vegetables and fruit, on the one hand, and cereals, on the other, may have to do with the degree of perishability of the food items in marketing. There has been a rapid growth in retail-producer price margins expressed in absolute terms (birr/kg) as well as relative to both producer and retail prices. This implies that retail-producer margins have been growing faster than either producer or retail prices. This implies that there is a large gap in producer and retail prices that needs to be bridged for the markets for these foods to be well integrated. These findings have several important policy implications.

First, policymakers need to reimagine current agricultural policies to place the agriculture sector at the center of the transformation of food systems in Ethiopia. Growth in agriculture, particularly in the cereals subsector, fueled most of the economic growth and poverty reduction in Ethiopia since

2004. However, the productivity of noncereal crops, particularly vegetables and fruit, stagnated during this period. Any increase in production resulted from expansion of area cultivated and not improved productivity. Similarly, the share of livestock in agricultural output declined and livestock productivity stagnated (Bachewe and Tadesse 2019). This is a result of agricultural policies during this period that focused primarily on addressing food security challenges (Worku et al. 2017). Therefore, increasing productivity in noncereal and livestock subsectors will not only reinvigorate agriculture's importance in income growth and poverty reduction, but also will contribute towards increased availability of nutrition-dense vegetables, fruit, and animal-sourced foods.

Second, nutrition sensitive small and medium agro-processing is an area that needs intervention. Ethiopia's manufacturing sector is dominated by agro-processing firms and the country has recently invested tremendously in large scale agro-processing-dominated industrial parks (Gebru et al. 2017; Priewe 2016). However, further research is required to ascertain whether the establishment of these firms is consistent with and supportive of current efforts to transform the food system in Ethiopia, given that these firms are established to achieve different goals (Gebru et al. 2018). In addition to efforts to expand such large-scale industrial parks, we are suggesting that government support the establishment of nutrition-sensitive small and medium scale agro-processing enterprises in small towns and rural areas of Ethiopia. Such enterprises, in addition to helping the transformation out of an agrarian society, catering for the demands of urban areas, and stabilizing prices, can also contribute to achieving other targets. These smaller enterprises use local inputs, including agricultural outputs and labor, and help reduce food waste through simple processing and packaging. Policymakers can learn from experiences gained in expanding small and medium scale enterprises in urban areas in order to tailor the technical, logistical, and financial support for small and medium scale agro-processing enterprises in rural areas.

Third, Ethiopia needs to further invest in physical infrastructure and to introduce and invest in newer technologies, such as cold chains (Gebru et al. 2018). The incentive structure to stimulate investment in agricultural marketing and processing also needs to be strengthened. Expansion of infrastructure is shown to improve agricultural productivity (Bachewe et al. 2018) and the rural nonfarm economy (Haggblade et al. 2007). Ethiopia invested massively in the past two decades in physical infrastructure, including roads, communication networks, electrification, and marketing and transportation. Although it is difficult to assess what prices for vegetables and fruit would have been without these investments, our results show increases in vegetable and fruit price-gaps over the past 15 to 20 years, implying the need for further improvements to marketing infrastructure and technologies.

Fourth, policymakers need to take advantage of the low urbanization level in Ethiopia. While low urbanization may have slowed the pace of nonfarm sector growth, it may also have positively contributed to slowing down the spread of nutrition-insensitive food production and consumption. Deliberate agricultural, health, and nutrition education policies (Popkin 1999) and efforts to stem current trends in the production and consumption of foods associated with overweight and obesity will help curtail the looming double-burden of malnutrition in Ethiopia of rising levels of both undernutrition and obesity. Furthermore, policymakers can capitalize on some of the positive habits in Ethiopia that, for one reason or another, discipline most Ethiopians to consume vegetables, fruit, and other components of diverse diets.

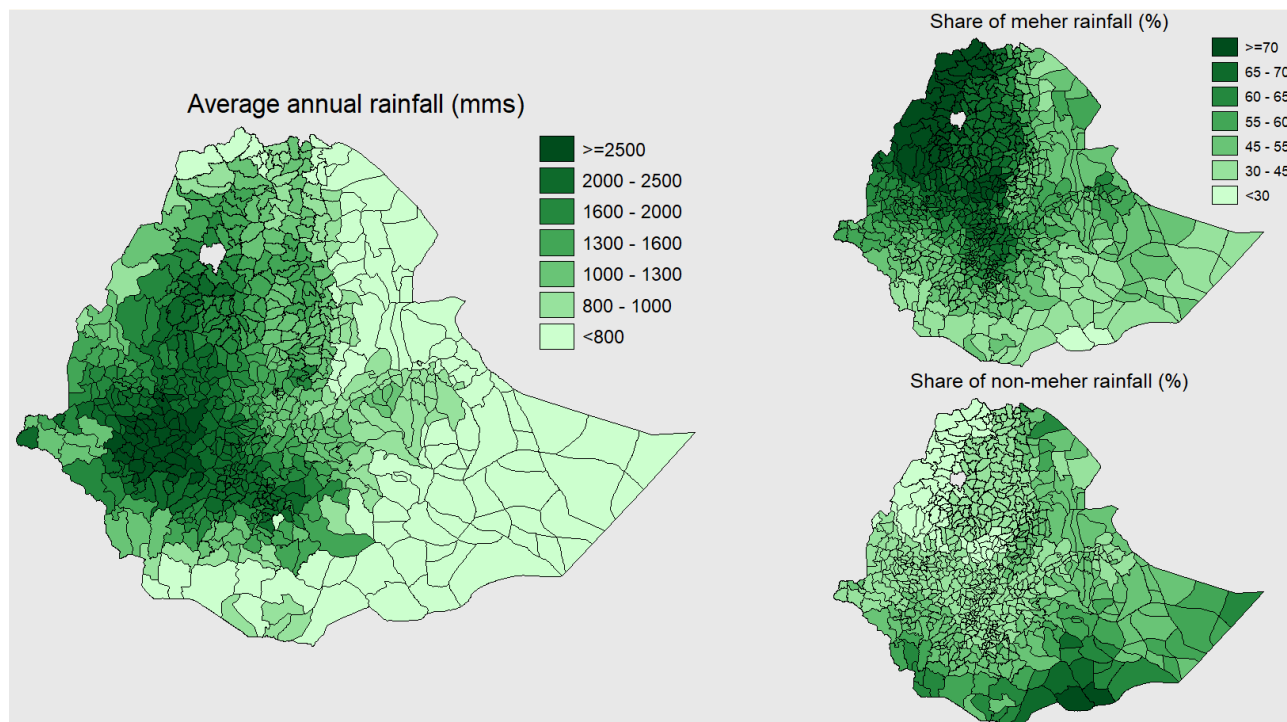
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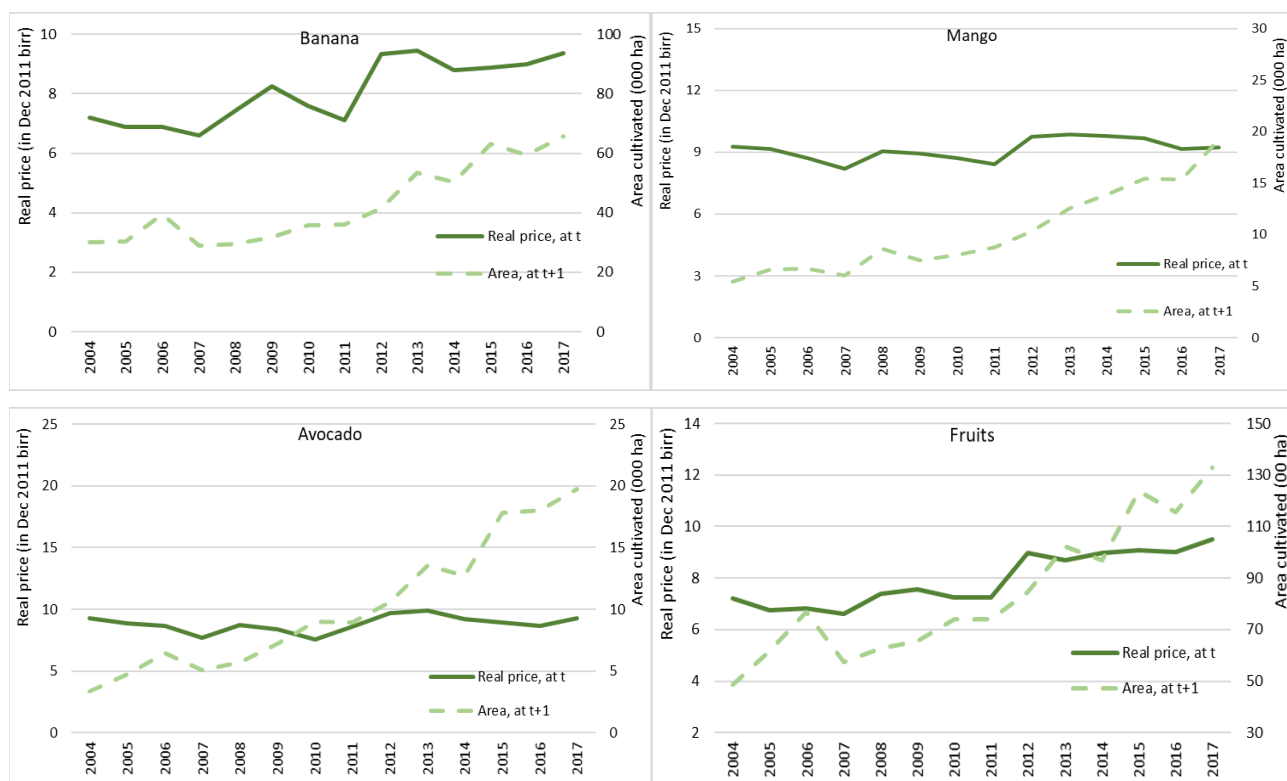
ANNEXES

Annex Figure 1. Spatial and seasonal distribution of rainfall in Ethiopia



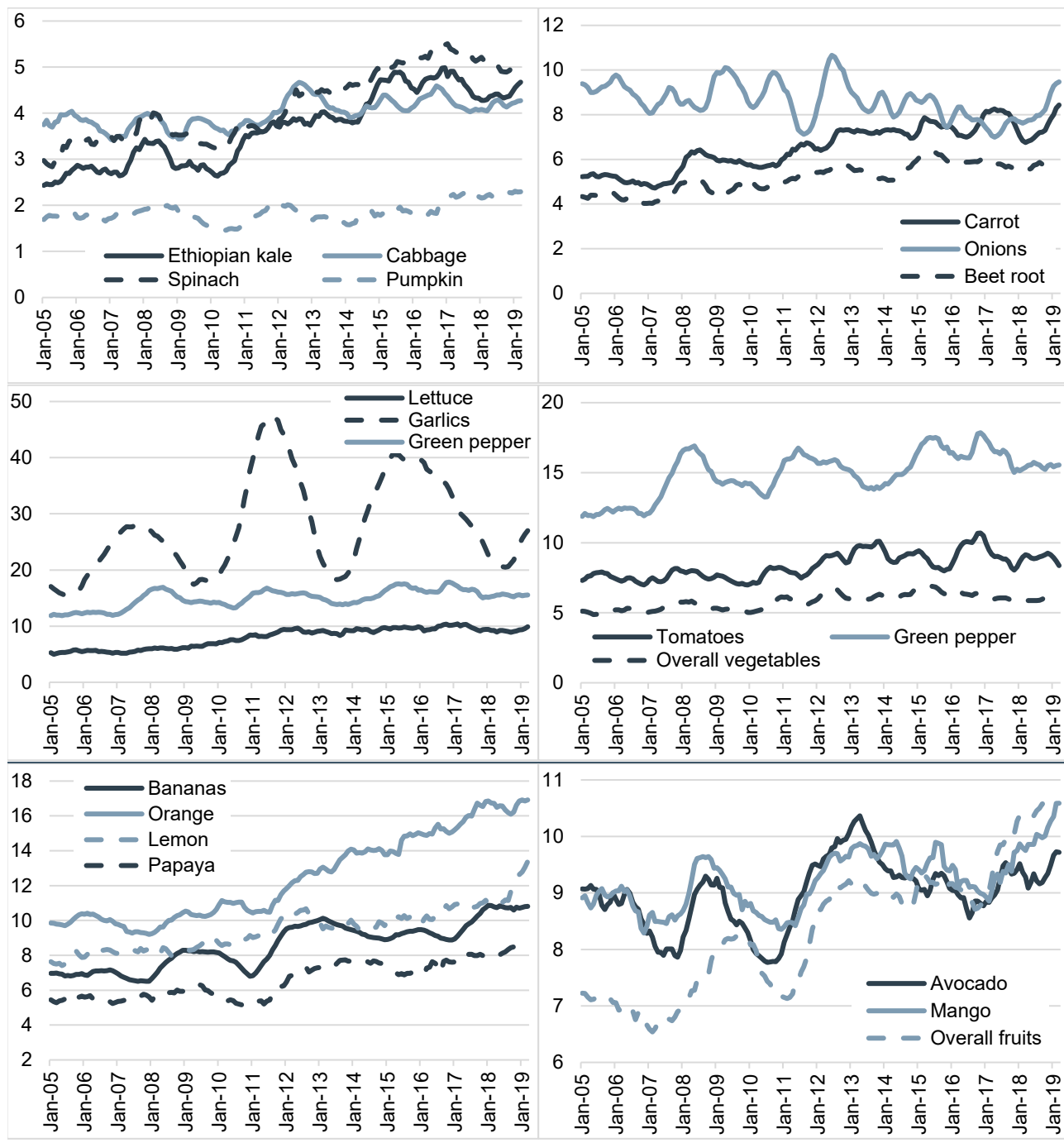
Source: Authors' drawing using daily rainfall data for January 1981- November 2019 period from NASA (2019).
 Note: The share of meher season rainfall is computed by taking the total rainfall during June to October as a percent of total annual rainfall.

Annex Figure 2: Correlation between current year price and next year area for types of fruit



Source: Authors' computations using CSA price and area data.

Annex Figure 3: Trends in real prices of vegetables and fruit, 2005 to 2019, December 2011 birr/kg



Source: Authors' computations using CSA price data.

Annex Table 1: Share of vegetables and fruit area and output and share of irrigated land, meher season 2005/06-2018/19

Crop type	Share out of crop group (%)		Share out of major crops (%) ^a		Share of irrigated area (%)
	Area	Output	Area	Output	
Vegetables					
Ethiopian kale	29.1	38.00	0.25	2.79	1.5
Cabbage	3.5	1.75	0.03	0.07	5.2
Lettuce	0.2	0.10	0.00	0.01	33.1
Spinach	0.2	0.11	0.00	0.01	15.6
Carrot	2.4	1.64	0.02	0.13	16.0
Tomato	5.3	4.83	0.05	0.38	48.5
Onion	21.1	27.78	0.18	1.91	33.7
Garlic	12.4	16.61	0.11	1.23	9.7
Green pepper	7.0	6.74	0.06	0.52	14.6
Pumpkin	16.9	-	0.15	-	0.9
Beet root	1.9	2.44	0.02	0.18	11.4
Overall vegetables	100.0	100.0	0.88	7.23	13.7
Fruit					
Banana	60.4	62.0	0.33	2.64	19.4
Orange	4.9	7.1	0.03	0.30	20.5
Lemon	1.4	1.2	0.01	0.05	33.3
Papaya	4.5	9.2	0.02	0.41	21.0
Avocado	14.3	6.2	0.08	0.15	3.3
Mango	14.6	14.2	0.08	0.58	12.8
Overall fruit	100.0	100.0	0.55	4.12	16.6
Cereals					
Teff	30.6	20.8	21.31	13.75	0.4
Barely	10.9	9.4	7.58	6.26	0.5
Wheat	17.5	18.5	12.20	12.42	0.4
Maize	21.8	31.3	15.17	21.31	1.7
Sorghum	19.2	20.0	13.33	13.63	1.1
Overall cereals	100.0	100.0	69.59	67.36	0.8

Source: Authors' computations using CSA AgSS data (CSA 2006a-2019a)

Note: a) "Major crops" includes cereals, pulses, oilseeds, vegetables, fruits, root crops, and other crops, which include enset, chat, coffee, hops, and sugar cane.

Annex Table 2: Share of vegetables and cereals out of annual crops area in meher and belg, 2011-2016

Meher	Area shares (%)				
	Cereals	Pulses	Oilseeds	Vegetables	Root Crops
2011	77.0	13.0	7.1	1.7	1.2
2012	75.7	14.7	6.5	1.9	1.2
2013	77.1	13.6	6.4	1.6	1.3
2014	78.5	12.1	6.6	1.4	1.4
2015	77.3	12.8	6.7	2.0	1.2
Average	77.1	13.2	6.6	1.7	1.3
Belg					
2011	68.0	20.0	1.4	3.3	7.4
2012	68.6	18.4	1.1	3.4	8.5
2013	68.7	17.3	1.9	3.2	8.9
2014	61.3	18.1	2.0	4.9	13.7
2015	61.5	20.7	1.7	4.3	11.8
Average	65.6	18.9	1.6	3.8	10.0

Source: Authors' computations using CSA AgSS data (CSA 2012b-2017b)

Note: CSA reports on belg production and area included only grain crops (cereals, pulses, and oilseeds) prior to 2011, while we could not obtain official belg reports for the period after 2015.

Annex Table 3: Average percentage share of area and output for the ten zones most important for vegetable and fruit production, meher seasons 2005/06 to 2018/19

	Importance in vegetable area and output			Importance in fruit area and output			
	Administrative Zone	Area	Output	Region	Administrative Zone	Area	Output
Amhara	North Shewa	6.0	8.9	Oromiya	Jimma	7.8	8.4
Oromia	Arsi	8.6	7.2		West Wellega	6.2	5.5
	East Shewa	4.5	5.1		Ilubabor	3.0	2.6
	West Arsi	4.4	4.7	SNNP	Gamo Gofa	14.4	17.9
	Jimma	3.6	3.5		Sidama	9.0	9.8
	West Shewa	3.1	2.9		Wolayita	7.7	8.4
SNNP	Sidama	5.6	7.6		Bench Maji	3.5	4.4
	Hadiya	3.8	4.4		Hadiya	3.5	4.0
	Selti	2.9	4.4		Kembata Timbaro	3.2	3.2
	Gurage	2.8	3.0		South Omo	1.8	2.7
All others		54.8	48.4	All others		39.8	33.3

Source: Authors' computations using CSA AgSS farmer level data (CSA 2019d)

Annex Table 4: Stationarity tests and correlation coefficients of prices and cultivated area for vegetables and fruit, correlation coefficients of prices in different areas, 2004 to 2019

	Results of unit root tests				Price _t & area _{t+1}	Correlation coefficients between:			
	Prices		Area			Addis Ababa & Shewa for vegetable prices; Addis Ababa & SNNP for fruit prices	Lower & high price areas	Moderate & high price areas	Lower & moderate price areas
	test statistic	p-value [†]	test statistic	p-value [†]					
Vegetables									
Ethiopian kale	-0.99	0.76	-2.84	0.05	0.75*	0.86*	0.87*	0.89*	0.90*
Cabbage	-2.19	0.41	-2.69	0.24	0.23	0.63*	0.35*	0.58*	0.75*
Lettuce	-3.45	0.04	-3.93	0.01	-0.53*	0.70*	0.95*	0.93*	0.94*
Spinach	-4.19	0.00	-4.47	0.00	0.60*	0.78*	0.68*	0.77*	0.84*
Carrot	-4.08	0.01	-3.29	0.07	0.15	0.91*	0.93*	0.94*	0.93*
Tomato	-5.52	0.00	-2.83	0.19	0.12	0.94*	0.67*	0.80*	0.9*
Onion	-2.90	0.16	-2.33	0.42	0.12	0.29*	0.46*	0.83*	0.79*
Garlic	-3.77	0.02	-2.76	0.21	0.81*	0.96*	0.95*	0.97*	0.98*
Green pepper	-1.76	0.40	-2.59	0.09	0.55*	0.79*	0.87*	0.90*	0.90*
Pumpkin	-3.94	0.01	-1.60	0.79	0.01	0.21*	0.59*	0.45*	0.61*
Beet root	-3.65	0.03	-3.32	0.06	0.60*	0.75*	0.66*	0.79*	0.90*
Overall vegetables	-3.75	0.02	-3.05	0.12	0.72*	0.73*	0.79*	0.88*	0.89*
Fruit									
Banana	-3.10	0.11	-2.02	0.59	0.78*	0.85*	0.89*	0.97*	0.90*
Orange	-2.43	0.36	-2.81	0.19	0.58*	0.83*	0.89*	0.99*	0.91*
Lemon	-3.29	0.07	-3.37	0.06	0.87*	0.83*	0.86*	0.77*	0.84*
Papaya	-3.52	0.04	-2.86	0.18	0.07	0.28*	0.57*	0.78*	0.83*
Avocado	-3.10	0.11	-2.13	0.53	0.04	0.42*	0.56*	0.68*	0.58*
Mango	-2.98	0.14	-1.15	0.92	0.39	0.58*	0.79*	0.67*	0.70*
Overall fruits	-2.88	0.17	-2.35	0.41	0.81*	0.88*	0.82*	0.96*	0.88*

Source: Authors' computations using CSA price data.

Note: †) MacKinnon approximate p-value.

Correlation coefficients with * are statistically significantly different from zero at 10 percent level

Annex Table 5: Average annual differences between regional and national median real prices of vegetables, 2005 to 2019

	Tigray	Afar	Am-hara	Oro-miya	Somali	BG	SNNP	Gam-bella	Harari	Addis Ababa	Dire Dawa
Average differences between regional and national median prices (%)											
Ethiopian kale	-12.0	103.6	-6.4	-10.0	87.6	-4.7	-22.6	44.8	12.8	70.6	13.5
Cabbage	-1.7	45.8	-11.2	0.6	58.2	35.9	-14.2	40.5	13.6	3.7	20.2
Lettuce	-20.0	59.0	-31.7	1.3	18.6	-17.1	-8.0	68.3	78.7	72.5	-15.3
Spinach	-8.6	81.4	-17.7	-4.0	89.1	29.5	-3.6	150.6	5.8	20.2	1.0
Carrot	-7.7	29.3	1.1	-5.2	45.6	4.4	-16.7	64.7	4.9	16.8	8.5
Tomato	-7.3	12.6	-13.4	2.5	16.8	-2.8	3.8	48.4	2.7	-4.8	12.8
Onion	-0.5	2.5	-4.8	-3.8	7.8	15.8	5.2	24.5	0.4	-13.1	-5.0
Garlic	-5.6	17.7	-18.4	0.1	15.5	7.2	6.4	29.3	0.0	0.1	-1.8
Green pepper	10.2	26.7	-5.8	-5.8	28.4	-5.9	-15.5	3.5	40.7	31.8	7.4
Pumpkin	33.6	93.2	-11.5	6.4	135.1	-5.2	-13.5	84.7	43.4	134.1	49.7
Beet root	35.0	30.3	3.1	-14.9	55.2	29.2	-18.4	25.9	24.0	3.7	24.1
Overall vegetables	-1.7	63.9	-11.5	-2.0	63.8	26.6	-30.7	17.0	43.2	32.4	49.6
Number of years regional prices were higher than national median (out of 15)											
Ethiopian kale	4	15	2	1	13	5	0	14	9	15	12
Cabbage	6	15	0	9	15	15	0	15	14	9	13
Lettuce	0	15	0	8	11	2	5	11	15	15	2
Spinach	1	15	0	4	14	13	6	11	9	15	7
Carrot	2	15	10	2	15	12	0	15	9	12	9
Tomato	2	14	0	8	13	6	13	15	8	3	12
Onion	7	8	0	1	14	15	13	15	8	3	5
Garlic	1	14	0	5	14	13	15	15	7	7	6
Green pepper	14	13	2	2	15	4	0	10	15	15	12
Pumpkin	10	15	2	13	15	3	1	12	9	15	9
Beet root	15	15	11	0	15	15	0	13	15	9	12
Overall vegetables	6	15	0	3	15	15	0	13	15	15	15

Source: Authors' computations using CSA price data.

Note: Numbers in the top panel are averages of differences between the median price of each vegetable type in each region and year and the nationwide median price of the corresponding item in the same year. The bottom panel is the number of years during 2005-2019 the median price in the region was higher than the nationwide median price.

BG = Benishangul-Gumuz region; SNNP = Southern Nations, Nationalities, and Peoples' region.

Annex Table 6: Average annual differences between regional and national median real prices of fruit, 2005 to 2019

	Tigray	Afar	Am-hara	Oro-miya	Somali	BG	SNNP	Gam-bella	Harari	Addis Ababa	Dire Dawa
Average differences between regional and national median prices (%)											
Banana	4.9	39.4	15.7	2.0	17.4	-29.3	-38.8	47.3	18.3	4.3	28.7
Orange	7.7	9.7	-6.2	9.6	21.5	-58.3	-47.5	17.8	13.8	23.9	14.3
Lemon	-8.3	80.9	-16.3	7.5	75.3	-51.2	-26.1	-5.9	64.9	62.1	65.9
Papaya	28.3	44.8	0.7	4.4	29.3	-45.5	-58.7	-45.9	57.0	83.6	71.9
Avocado	14.6	25.8	9.8	6.9	38.3	-27.7	-29.2	16.6	22.1	10.6	32.4
Mango	17.9	53.6	9.2	-2.0	29.7	-53.4	-41.8	-35.8	3.4	9.2	43.4
Overall fruits	18.6	55.8	7.2	0.3	26.2	-56.9	-42.2	-2.8	11.7	29.0	43.5
Number of years regional prices were higher than national median (out of 15)											
Banana	9	15	15	9	14	1	0	15	9	12	15
Orange	12	11	3	13	14	0	0	10	14	15	13
Lemon	2	15	1	13	15	0	0	5	15	15	15
Papaya	15	11	8	12	13	0	0	0	15	15	15
Avocado	14	7	15	14	14	0	0	8	13	14	12
Mango	15	15	14	5	13	0	0	1	7	15	11
Overall fruits	15	15	14	7	14	0	0	5	10	15	14

Source: Authors' computations using CSA price data.

Note: Numbers in the top panel are averages of differences between the median price of each fruit type in each region and year and the nationwide median price of the corresponding item in the same year. The bottom panel is the number of years during 2005-2019 the median price in the region was higher than the nationwide median price.

BG = Benishangul-Gumuz region; SNNP = Southern Nations, Nationalities, and Peoples' region.

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The Ethiopia Strategy Support Program (ESSP) is managed by the International Food Policy Research Institute (IFPRI); is jointly implemented with the Policy Studies Institute (PSI); and is financially supported by the United States Agency for International Development (USAID), the Foreign, Commonwealth & Development Office (FCDO) of the government of the United Kingdom, and the European Union (EU). Additional financial support for the research presented here was provided by the Bill and Melinda Gates Foundation (BMGF). This research was conducted as part of the CGIAR Research Program on Policies, Institutions, and Markets (PIM), which is led by IFPRI.

This publication has been prepared as an output of ESSP and has not been independently peer reviewed. Any opinions expressed belong to the author(s) and are not necessarily representative of or endorsed by IFPRI, PSI, USAID, FCDO, EU, BMGF, PIM, or CGIAR.

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