

Structural transformation of cereal markets in Ethiopia

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Abstract

We study cereal markets in Ethiopia over the last decade, a period that has been characterized by important local changes, including strong economic growth, urbanization, improved road and communication infrastructure, and higher adoption of modern inputs in agriculture. These changes are associated with better spatial price integration as well as with significant declines in real price differences between supplying and receiving markets and in cereal milling and retail margins. In short, important improvements have occurred in Ethiopia's cereal marketing system. This is especially important because dysfunctional cereal markets were previously identified as an important cause of food insecurity in the country.

Keywords: Ethiopia, marketing system, price analysis, transformation

1. Introduction

Given the importance of food in expenditures of households in developing countries, the functioning of food markets and their impact on food prices are closely watched by policy makers and consumers alike. High food marketing costs can push consumer prices up to unaffordable levels for vulnerable groups and further hamper farmers' incentives to invest in new production technologies. The interest in food markets has become even more prevalent since the recent global food crisis when food prices reached very high levels (Headey et al., 2010).

Understanding food markets is especially relevant in Ethiopia given the disastrous implications that poorly functioning food markets had on food security in the past, when food stocks were available in some parts of the country while widespread famine occurred in other parts (Webb and von Braun, 1994; Gabre-Madhin, 2001a, 2012).¹ Major reasons for historically poorly functioning food markets have been a lack of market information, poor road infrastructure and high transaction costs, and distress sales and lack of storage by small farmers (e.g. von Braun and Olofinbiyi, 2007; von Braun et al., 1998). Important changes have occurred in these areas in the last decade in Ethiopia however. In this paper, we assess the extent to which these changes have affected cereal markets using primary data collected from wholesale markets and secondary data on cereal prices and margins. Further, we discuss 5 possible reasons for the market transformation and for the changes in cereal price margins over the period 2001–2011.²

We find that the period under study has been characterized by important changes in five possible factors affecting the functioning of cereal markets. First, fast economic and income growth is changing food demand. Second, urbanization is leading to larger rural–urban food and cereal marketing flows. Third, investments in road infrastructure and a better organized transport sector have led to significant declines in real transportation costs. Fourth, the widespread availability of mobile phones has improved access to price information for a

large number of players in the commercial circuit and has led, for some, to a different way of making commercial deals. Fifth, increased adoption of modern inputs and better access to extension agents have likely contributed to increased cereal supply.

Price data collected over the last 10 years at wholesale and retail level show that these changes are associated with significant declines in real margins of wholesale food prices between supplying and receiving markets over time, in real cereal milling margins, as well as in retail margins. We find that cereal prices increased over the decade but that price levels were affected differently in different markets. For example, cereal deficit and vulnerable regions experienced lower price rises than other regions. Price integration between wholesale markets has also improved significantly over the period studied. The cereal marketing system thus appears to have undergone important changes in Ethiopia to the benefit of producers and consumers alike.

The contribution of this paper to the literature is two-fold. First, we rely on unique primary data from major wholesale cereal markets in a poor agricultural economy and document the degree to which structural changes are taking place in the way that business is done in these markets. Second, we use price series to test for structural transformation in price relationships along different dimensions, such as space, form, quality, and marketing level. Such comprehensive assessments of changes in structural factors and food price relationships, based on unique qualitative and quantitative data, are rare in developing countries.

The structure of the paper is as follows. In section 2, we discuss the data and the methods used. In section 3, we empirically document the changes that likely contributed to structural transformation in the country and discuss economic and income growth, urbanization and commercial surplus, roads, access to and use of communication technology by brokers and traders, and adoption of improved agricultural technologies. In section 4, we look at spatial

price variation, price integration, quality price premia, processing margins, and retail margins. We finish with the conclusions in section 5.

2. Data and methodology

We rely on two main datasets—using primary as well as secondary data—for the analysis in the paper. The Ethiopian Grain Trading Enterprise (EGTE), a grain procurement arm of the government, gathers prices of cereals in 66 major wholesale markets in the country. Prices are collected during the early morning, late morning, and afternoon on major market days and simple averages of these prices over the course of a month are reported as monthly prices. The prices are collected, not by asking what price levels are, but by noting prices from observing actual transactions. Producer, wholesale, and retail prices³ are all collected but only wholesale and retail prices at 12 selected markets are made available publicly. These price data were obtained in electronic form and are thus used in the analysis. Because the weights of individual cereals in the national Consumer Price Index (CPI) are relatively low, and due to a lack of any reasonable alternative, we rely on this national CPI as constructed by the Central Statistical Agency (CSA) to deflate prices.⁴

To complement the price data, a survey was conducted in 31 major cereal wholesale markets of the country in the beginning of 2012. The objective of this survey was to gather information about changes that have taken place in these markets over the last ten years. Almost all major cities as well as the most important production areas are included in this survey.⁵ The survey was conducted with focus groups of transporters and key informants for specific crops in the selected wholesale markets. The focus groups were comprised of respondents with significant experience in cereal trade in each market (as there were many recall questions). Questions were asked about the extent of changes in transport costs and travel times between different wholesale markets, changes in access to and the spread of mobile phones and the use of mobile phones in agricultural trade, and changes in the size of the market. Given that we only interviewed focus groups in these markets where these crops

were deemed important (as indicated by the markets where EGTE collects prices for these crops), the total number of focus groups differs by crop. For example, there are 25 groups for teff, 16 for wheat, 5 for sorghum, 6 for barley, and 19 for maize, for a total of 71 focus groups. While the focus group interviews were carefully fielded and therefore give a good indication of changes over time, we acknowledge that focus group interview methods are prone to measurement error, and are especially so in the case of recall questions. Consequently we do not rely on statistical techniques that are based on sampling to test differences over time from the recall data.

We look at several aspects of cereal price behavior. First, we analyze quality premia and spatial margins. Using the EGTE wholesale price series, we estimate regression models that include temporal, spatial, and quality variables as explanatory variables. We use year-month fixed effects to control for all potential temporal variation.⁶ These controls allow us to better estimate the issues of interest, i.e. quality and location. In estimating the standard errors, we allowed for clustering by quarter, and therefore for dependence between months. The regression used is as follows:

$$\text{Log (real price of cereal grain } i) = f(\text{year*month, market location, quality}) \quad (1)$$

Second, we study the processing and retail margins. To do this, we combine the wholesale prices with two other datasets. For the analysis of processing margins, we merge cereal flour price data collected by the CSA in retail markets with the wholesale cereal grain market prices. We only retain the prices for these markets and for those periods that are common to both datasets. For the analysis of the retail margins, we merge the wholesale prices with the prices collected by EGTE at the retail level. Unfortunately, these retail price data are only available until the end of 2009 and we thus have to limit our analysis to the period from 2001 to 2009. We follow a similar method as explained above and the estimated regression is as follows:

$$\text{Log (real price of cereal } i) = f(\text{year*month, market location, quality, grain/flour, retail/wholesale}) \quad (2)$$

A major objective of the study is to evaluate the structural transformation of these markets. To understand if a structural break in these time series occurred in the last decade, we interact the different variables with a time dummy for the 2nd part of the period studied (2006–2011). We then assess the significance of these coefficients and compare them to the coefficients in the first part of the decade (2001–2005) through an F-test. In the case of a significant difference, we conclude that a structural break occurred over the last decade. We present the results of these tests for spatial variation, quality premia, retail margins, and processing margins.

Third, we test the extent to which markets in Ethiopia are integrated. Following Van Campenhout (2007), we estimate threshold autoregressive (TAR) models where we allow the thresholds and adjustment parameters to vary over time in the following way:

$$\Delta d_t = \begin{cases} \rho_{out} d_{t-1} + \rho'_{out} t d_{t-1} + \varepsilon_t & : d_{t-1} > \theta_t \\ \varepsilon_t & : -\theta_t \leq d_{t-1} \leq \theta_t \\ \rho_{out} d_{t-1} + \rho'_{out} t d_{t-1} + \varepsilon_t & : d_{t-1} < -\theta_t \end{cases} \quad (3)$$

where d_t is the difference between the price in Addis Ababa and the regional wholesale market of interest (i.e. $d_t = p_{t,A} - p_{t,r}$, where $p_{t,A}$ is the market price in Addis and $p_{t,r}$ is the market price in regional markets at time t), $\Delta d_t = d_t - d_{t-1}$, ε_t is the estimated residual, t denotes the time trend, θ is an approximation for transaction costs, and ρ_{out} is the adjustment factor for prices outside of the transaction cost band (i.e. $-\theta$ to θ).

As in Van Campenhout (2007), we allow the threshold θ_t to vary over time in the following manner:

$$\theta_t = \theta_0 + \frac{(\theta_T - \theta_0)}{T} \cdot t \quad (4)$$

The threshold can therefore vary from θ_0 at $t=0$ to θ_T at $t=T$. We also report the speed of price adjustments in the price integration results. Following Van Campenhout (2007), this is the *half-life*, which is defined as the time needed for prices to return to half of their initial value following a shock from a long-run equilibrium. In other words, the half-life measures how fast errors are corrected, and is calculated as the solution for T in $f(t+T)=f(t)/2$, which is just $T=\ln(1/2)/\ln(b)$ where in our case, $b=1+\rho$. If, for example, ρ is -0.5, then T is one, which means that it takes one week to correct half the shock. In the limit, when ρ approaches -1, any shock in $t-1$ is fully corrected in t .

3. Possible reasons for structural transformation in cereal markets

In the last decade, a number of structural changes have occurred in the overall economy as well as in the food economy of Ethiopia — on top of the changes in the international food markets (Headey et al., 2010) — that have affected cereal markets and price formation in the country. Given data constraints, it is impossible to estimate the exact effects of the changes of these different factors on food price formation and market transformation, but it seems clear that they have all had some impact.⁷ These changes include economic and income growth, urbanization and commercial surplus, transport and communication infrastructure, agricultural technologies and extension and we elaborate on them here.

(a) Economic and income growth

Since 2004, Ethiopia has been one of the fastest growing economies in the world, which is a remarkable feat for a non-oil exporting African country. While growth of the GDP measured in constant market prices was negative in the beginning of the decade, it shot up from 2004 onwards and has stayed in double digits since. While it remains unclear how the benefits of economic growth were distributed among Ethiopia's population, the upshot is that such growth rates lead to significantly different consumption patterns for those who benefited from this growth. This has important implications for food markets.

To understand how food markets have been affected, we distinguish two effects of GDP growth: (i) how incomes of consumers are affected, and (ii) how consumers change their consumption patterns because of increases in income. First, evidence from national household surveys suggests that consumption expenditures are increasing and that poverty levels are decreasing. Real per adult equivalent consumption in 2004/2005 (1,542 ETB at 1995/1996 constant prices) was 16 percent higher than five years prior, and 17 percent higher than ten years earlier (MoFED, 2008). Kuma (2010) finds similar results in urban areas, where consumption expenditures grew by almost 15 percent between 1994 and 2004. Analysis of the most recent national household data shows that poverty declined between 2004/2005 and 2010/2011 from 38.7 percent to 29.6 percent, indicating further welfare improvements over the period considered (MoFED, 2012).

Second, as incomes grow, consumption patterns are likely to change as households consume more high quality foods relative to lower quality foods. An indicator that this is taking place in Ethiopia in the presence of income growth is that income elasticities of demand for meat, fruits and vegetables are considerably higher than for most cereals. Even among cereals, however, some such as teff have high demand elasticities while others such as sorghum and maize have low elasticities (Tafere et al., 2010). As such, it is not surprising that urban consumption patterns over the past decade have increasingly included more teff, milk and milk products, meat, and fruit (Kuma, 2010).

(b) Urbanization and the increase in commercial surplus

Although it started from a low base, Ethiopia has experienced rapid urbanization over the past couple of decades (Schmidt and Kedir, 2009). This trend is important for cereal markets since urban populations typically do not grow their own food, and instead rely on markets for their food needs. A consequence of growing urban areas therefore is an increasing flow of agricultural commercial surplus within a country.⁸

Based on data from the national census in 2007, Schmidt and Kedir (2009) estimate that 14.2 percent of the Ethiopian population lived in urban areas, and that urban centers have grown by up to 3.7 percent per year on average. Using these growth rates, the urban population grew by 44 percent, or by 3.7 million people over the period 2001–2011. To put that number into perspective, consider the following: Assuming that the average urban consumption level of cereals was as high as was estimated in the national household survey (HICES) of 2004/2005, and that the urban population relied completely on production shipped in from rural areas, commercial flows of cereals increased by about 500,000 tons between 2001 and 2011. This is equivalent to an additional 65,000 truckloads (of 7.5 tons in a FSR truck) between rural and urban areas over the decade, or 650 additional trucks per year (assuming 100 cycles per truck). According to official statistics published by the CSA, there was indeed a large increase in the commercial quantities of cereals traded in the country over the last decade as the commercial surplus for the five cereals together increased by an estimated 117 percent over this ten-year period.⁹

Focus group participants in the wholesale market survey were asked about level and trends vis-à-vis numbers of traders and brokers in the markets, and of cereal trucks arriving in these markets. These numbers confirm that the commercial surplus has increased rapidly over the last decade. For example, significantly more trade is reported on average in these markets over time. The reported number of the trucks increased over the ten years by almost 70 percent and by almost 80 percent in the peak and lean periods, respectively. These growth rates are faster than the urban population growth rates in the country (Schmidt and Kedir, 2009), possibly indicating higher consumption levels in the cities over time, more trade between rural areas that might pass through these urban wholesale markets, and shifts from other means of transportation to trucks.

The focus groups' assessment of trends in the number of traders and brokers that operate on these markets also indicates considerable growth over time. With the number of traders perceived to be growing by almost 150 over the past decade, and the number of brokers

growing by more than 250 percent, competition appears to have become keener and turnover per trader and broker lower.

(c) Roads and transportation costs

Several factors have contributed to changes in transportation costs over the last ten years. In what follows, we review some of these factors, including changes in the road network and investments in road infrastructure improvements, increases in fuel costs, and changes in the types of trucks plying the roads.

First, since coming to power two decades ago, the Ethiopian government has embarked on a large road investment program and the current level of infrastructure development in the country is unprecedented. For example, all-weather surfaced roads are in the process of being built or have already been built between the capitals of all regions. Further, the length of all-weather surfaced roads more than doubled in 15 years, from an estimated 19,000 km in 1993 to 44,300 km in 2008. This type of road development has important effects on the connectivity of agricultural markets in the country. Based on interviews with transporters in the wholesale market survey who were asked about travel times between different wholesale markets in the country and the Addis wholesale market, transport times have fallen on average by 20 percent over the last ten years, from 10 hours to 8 hours.¹⁰

Second, fuel prices have risen substantially over time. Until October 2008, the Ethiopian government subsidized fuel prices.¹¹ But with the abolition of fuel subsidies combined with the increase in international fuel prices, real fuel prices increased significantly. CSA retail price data indicate that the real price of diesel in the beginning of the decade was 60 percent lower than at the end of the decade. Given that fuel is an important determinant of transport costs, this undoubtedly contributed to relatively higher transport costs over time.

Third, the increase in the number of larger capacity trucks plying the roads is putting downward pressure on transportation costs. This follows because the bigger the truck, the lower the per unit transport costs. As increasing quantities of food are being shipped

between markets, it is becoming easier to fill larger loads in bigger trucks, and consequently there are greater incentives to enter into food trade with larger trucks. The wholesale market survey data indicate that this is indeed taking place. Over time, the importance of larger trucks (FSR; able to carry about 7–8 tons) has grown compared to smaller ones (regular Isuzu; carrying about 5–6 tons) – the share of FSR trucks in the total number of trucks transporting cereals grew from about 15 percent in 2001 to 33 percent in 2011. The use of trailer trucks, able to transport 20 tons, is still limited and its share stayed constant over time. Overall they make up 13 percent of the trucks that transport cereals (they are more important for longer distance journeys).^{12,13}

Taken together, these three factors are likely to have affected transportation costs between wholesale markets in Ethiopia. To assess this, participants in the transporter focus groups were asked to estimate travel costs over the last ten years for those trips that were commonly taken from the market where they were interviewed. To allow for comparison over time, these prices were deflated by the CPI.¹⁴ The results from recall data from focus group interviews indicate that the mean and median of transport costs fell significantly throughout the decade (estimated by focus groups to be about 50 percent, although this is admittedly a very rough estimate given that recall error for cost estimates is likely large in the presence of high inflation). The improvements in roads and the shift to bigger and cheaper trucks appear to have far outweighed the rise of fuel prices and have resulted in significantly lower real transportation costs between markets in the country.

(d) Access to mobile phones

Mobile phones have become widely available in Ethiopia allowing traders and farmers to exchange information more easily. The widespread availability of the mobile phones in rural areas of developing countries has led to a number of beneficial effects on farmers and on the trade environment in general (e.g. Aker and Fafchamps, 2013; Jensen, 2007). These effects may also benefit Ethiopian farmers and traders given that at the time of the wholesale

survey in early 2012, almost all traders and brokers in the survey used mobile phones in their business. Figure 1 shows how cell phone coverage changed over time in the wholesale markets in the survey. In 2000, only the Addis Ababa market had cell phone coverage but that quickly changed and by the year 2005 there was almost universal coverage of these rural wholesale markets. Figure 1 further shows that cell phone usage rates increased to 100 percent for traders and brokers of all the cereal crops in the various markets within an average of only 4 to 5 years after the introduction of coverage.

To understand the impact of this rapid spread of cell phones on cereal trade, further follow-up questions were asked of the focus groups. First, in order to better understand their access to communication technology over time, focus groups were asked to assess the percentage of traders and brokers who had access to fixed phones before mobile phones became available. The results reported in Table 1 indicate that a large majority of these traders and brokers previously had some form of access to fixed phones (e.g. at home, on the market, or at another location). Nearly half of the traders reported having a fixed phone at home before gaining access to mobile phones, indicating that mobile phones did not fill a complete communications void as experienced in other countries.

Second, while telephone communications existed prior to the introduction of mobile phones, mobile phone technology has improved the ease of access to communications as evidenced by the frequency of phone use. According to the focus groups an average broker now makes 34 business calls per day during the peak trading period, while traders make 24. This is roughly three to six times more than the number of calls made using fixed lines prior to the introduction of mobile phones. It is also worth noting that the number of calls made with mobile phones drops off significantly in the lean period reflecting the important seasonality in traders' and brokers' business activities.

Figure 2 here: Mobile phone use by brokers and traders on wholesale markets

Third, questions regarding the purpose for using mobile and fixed-line phones indicate that almost all traders and brokers use mobile phones today to transmit prices compared to roughly half who did so previously with fixed lines (Table 1). 38 percent of the traders and 34 percent of the brokers use the mobile phones to request for a show-up with the product at the market. Fewer use phones to agree on prices with sellers and buyers. Given the lack of standards in Ethiopia, this is likely due to buyers wanting to inspect the produce personally before make a deal. A large majority of traders use phones to follow up on payments of traders and buyers. This number is much lower for brokers, possibly because their transactions are less likely to involve the extending of credit. Compared to the situation before mobile phones were introduced, it is clear that more information is obtained and more deals are struck by phone. Indeed, more than twice as many traders and brokers use their mobile phones today for conveying price information and for making deals with sellers, buyers, and transporters than did so with fixed-line phones when the latter was all that was available.

Finally, focus group participants were asked subjective questions about how the situation in trade has changed since mobile phones were introduced. While it is highly unlikely that mobile phones were the sole cause of the changes reported by the focus groups, they likely did contribute significantly in some way. Most of the traders and brokers report interacting with more sellers, buyers, and transport brokers before making deals. Since physical location of the market matters less with mobile phone technology, traders and brokers appear to be bypassing wholesale markets in rural areas and in Addis Ababa. While the wholesale markets are not completely bypassed, the focus groups report that in rural areas this is occurring to some extent in 94 (88) percent of the markets for traders (brokers). Further, 61 (66) percent of the trader (broker) focus groups report bypassing the Addis Ababa wholesale market. The traditional role that Addis Ababa has played as a clearinghouse in the cereal trade in Ethiopia, because of its central geographical location

and the lack of alternative roads (Gabre-Madhin, 2001a), may therefore slowly be changing because of easier access to information and because of the improved road network.

Table 1 here: Use of mobile phones by traders and brokers

(e) Agricultural technology and agricultural extension

A number of changes have taken place in the last decade which have led to increases in agricultural production. While much of the increased production appears to be driven by the expansion of cultivated land (Taffesse et al., 2013; Dercon and Hill, 2009), and while the adoption of improved agricultural technologies in the country is rather low, there are some indicators that bode well for increased productivity. Foremost among these are the increasing availability and adoption of improved modern technologies and the widespread placement of extension agents. Admittedly though, those in better connected areas appear to have greater access to these technologies and services (Minten et al., 2013).

First, although adoption rates for improved cereal seeds are low (as shown in official statistics), these rates are however an underestimate and adoption has seemingly improved over the last decade (Spielman et al., 2011). The use of improved seeds is primarily found in the case of maize and wheat (Spielman et al., 2011), though the adoption of an improved teff (*quncho*) seed variety accelerated in the latter part of the decade (Minten et al., 2013).

Second, fertilizer consumption in Ethiopia grew from 140 thousand tons in the early 1990s to about 650 thousand tons in 2012, and the area dedicated to cereal production that was fertilized more than doubled over the last decade (Rashid et al., 2013). Third, the Ethiopian government has invested heavily in the expansion of the agricultural extension system. At the end of decade, the government had placed 45,000 extension agents in villages. This compares to 2,500 and 15,000 extension agents in 1995 and 2002 respectively (Davis et al., 2010). With a target of three extension agents per *kebele*, Ethiopia has one of the largest extension agent–farmer ratios found in the world today (Davis et al., 2010).¹⁵

We summarize this section with an overview in Table 2 of the possible drivers of structural transformation in Ethiopia's cereal markets and how they have changed over the past decade. We see important changes in all cases.

Table 2 here: Changes in structural factors in the last decade

In short, the evolving drivers of structural change in cereal markets are likely to manifest themselves in a number of predicted outcomes. For example, increasing urbanization, increasing supply and income growth will likely lead to more quantities traded and greater economies of scale, and thus to lower margins overall. In addition, access to better price information should lead to a more efficient marketing system, and consequently lower overall margins. Finally, changes in food consumption patterns due to income growth may be reflected in higher quality premia if changes in the supply of high quality products do not keep pace with the growing demand for these products. In the next section, we empirically address these questions. In particular, we analyze spatial price variation, spatial market integration, quality premia, and margins (processing and retail).

4. Cereal price behavior

(a) Spatial price variation

Ethiopia is characterized by a very diverse agro-ecology which results in spatial specialization and in different agricultural production and consumption patterns across the country (Chamberlin and Schmidt, 2011; CSA, EDRI, and IFPRI, 2006). To better understand the spatial flows of cereals in the country, the focus groups in the wholesale markets were asked questions about trucks arriving in and departing from their markets, and about the types of loads they carry. Using this information, it is possible to identify areas in Ethiopia that supply and receive cereals. These data on cereal market flows indicate that areas in the west (maize) and south (barley, wheat) are the major suppliers of cereals. Addis Ababa and areas in the east (Dire Dawa) and the north (Mekelle) on the other hand are

cereal deficit areas (Gelan and Dinka, 2006; Gabre-Madhin, 2001a) and consequently receive grain shipments from the suppliers in the west and south of the country. The supply base for teff is more diversified than for other cereals, but major demand comes from Addis Ababa, Dire Dawa and Mekelle, three of the most important cities in the country. On the other hand, sorghum production and trade is most concentrated in the north and east of the country.

To test the degree to which these flows are reflected in wholesale market price differences, we compare the prices of different markets to the Addis Ababa market (the default market) using the model described in equation (1). Since the dependent variable (real price of cereal i in market j) is expressed in logs, the reported coefficients for the market dummies in Table 3 show the relative difference in real prices compared to the Addis Ababa market (the left out category). In a second specification, we test for structural changes by effectively splitting the analysis period in two parts (2001-2005 and 2006-2011). This is done by including a dummy for the latter period separately and interacting it with all of the other coefficients in the model. The Addis Ababa market in the first and second period are therefore the default markets. Our test for structural change follows from comparing price differences in the first period to those in the second period (significant changes are highlighted in grey in Table 3). In particular, we are interested in price changes from the major supplying areas to the other markets.¹⁶ Significant changes at the 5% level over the period are shaded in the Table.¹⁷

Three salient points follow from the results that appear in Table 3. First, while Addis Ababa is the biggest city in the country, cereal prices are not always the highest there. For example, prices tend to be higher in cereal deficit areas such as the eastern city of Dire Dawa, where the prices of all cereals are between 12 percent (teff) and 27 percent (maize) higher than in Addis Ababa (see top panel of Table 3). In the northern cities of Mekelle and Dessie, three out of four cereals are significantly more expensive than in Addis Ababa.¹⁸ The only exception is the case of barley, where the difference is not significant at the 5% level. On the other hand, cereal prices in major supply areas tend to be lower than in Addis Ababa. This is

the case, for example, in the markets of Shashemene and Nekemt, which are both located in major cereal production zones. In short, price differences in the country generally reflect quite well the perceived flow of products throughout the country.

Second, we see that there are substantial changes in the relative ratios between the first and second halves of the decade (see the bottom two panels of Table 3), possibly reflecting the effective changes in transport costs between wholesale markets. For example, differences in teff and wheat prices relative to major supply area declined significantly for 5 and 11 of the 11 markets respectively. For maize and barley, significant reductions were observed in 4 out of 9 and in 5 out of 11 markets, respectively. For two major demand “sinks”, Mekelle and Dire Dawa (After Addis Ababa, the two biggest cities in the country), price differences relative to Addis Ababa fell for all of the cereals (significantly for 7 of the 8). For example, while the price of maize was 39 percent and 26 percent higher in Dire Dawa and Mekelle in the period 2001–2005, these differences declined to 17 percent and 12 percent respectively for the period 2006–2011. Similar changes took place with respect to differences between supply areas and Addis Ababa (see the supply markets with negative coefficients in Table 3) but to a lesser extent (the decreases were significant for 2 out of 4 cereals). Note that this is occurring despite a lack of infrastructure improvements for some of the supplying areas, such as Nekemt where price differences have nonetheless fallen significantly for teff and maize. On the other hand, for some cereal supply regions, major infrastructure improvements have taken place and have translated into large declines in relative prices. For example, the price difference for wheat between Bale Robe and Addis Ababa fell from 32 percent in the 2001–2005 period to 18 percent in the 2006–2011 period. Similar declines are noted for Assela, a major producing area for wheat and barley.

Third, the variation in price differences among the wholesale markets with respect to the Addis Ababa markets declined over time. The difference between the highest and the lowest price differences in the first half of the decade compared to the second half, declined by 11, 28, 30, and 19 percentage points for teff, wheat, maize, and barley, respectively.

Table 3 here: Regional wholesale price differences compared to Addis Ababa

(b) Spatial price integration

The degree to which cereal prices move together across markets throughout Ethiopia (i.e. how well they are integrated) provides a measure of how well these markets function. Thus we analyze the integration of wholesale markets by studying various market pairs for each of the major cereals using the TAR model described in equation (3). In particular, we pair Addis Ababa with the four to six most important regional wholesale markets for each of the cereals, thus reflecting major cereal flows in the country.¹⁹

Three important results stem from this market integration analysis (Table 4). First, there has been an improvement in market integration over the past decade. In the aggregate, 33 percent more markets were integrated in 2011 than in 2001.²⁰ Further, all of the most important markets for mixed teff, red teff, and maize were well integrated at the end of 2011, while only half were in 2001. 83 percent of the regional white teff and white wheat markets were integrated with respect to the Addis Ababa market in 2011, compared to 50 percent and 67 percent respectively in 2001. While the improvement is not as dramatic for mixed barley, nonetheless 75 percent of markets for this cereal were integrated in 2011 compared to 50 percent in 2001.

Second, the speed of price adjustments has also improved considerably. This is illustrated in the average half-life of adjustment to price changes that declined from an average of 17 weeks in 2001, to 8 weeks in 2011. In other words, it now takes less than half of the time for prices between wholesale markets to adjust halfway from deviations in long-run equilibrium prices than it did in 2001.

Third, the transaction costs between markets estimated in the TAR model (i.e. the thresholds) fell for all cereals, with the exception of white sorghum. Indeed, the declines have been substantial, averaging nearly 50% for all cereals (except sorghum) between 2001 and 2011.²¹ We note that sorghum is not widely consumed in major markets such as in

Addis Ababa. As such, the thin sorghum markets with limited flows among them appear to be reflected in the estimation results.

Table 4 here: Degree of market integration of Addis Ababa with other cereal wholesale markets between 2001 and 2011

(c) Quality premia

When consumers get richer, they demand more high quality food products. This often implies an increase in quality premia for such products (e.g. Vandeplas and Minten, 2011). To assess if this is occurring in Ethiopia, we use the EGTE wholesale market price data to examine the levels of and trends in quality premia at the national level and in Addis Ababa. Our measure of quality is the color of the grain, which is the only quality information available in the data. Although color is often only one characteristic of quality for cereals, Bekele and Ayele (2006) and Minten et al. (2013) find that it is an especially important determinant of quality premia paid in the Ethiopian market place.

The results of the regression analysis on price premia (from equation (1)) and their evolution over time in Table 5 illustrate two points. First, quality premia do exist in the Ethiopian markets in that *white* cereals all command a premium over *mixed* cereals (or red in the case of teff). These premia range from 9 percent for white wheat over mixed wheat, to 14 percent for white barley over mixed barley, and to 27 percent for white teff over red teff in the national market. The price premia paid in Addis Ababa are general higher than in other markets, but not uniformly. Second, the quality premia change surprisingly little over time. In none of the cases are the changes between the first and second halves of the decade significant. Moreover, with the exception of sorghum in national markets, the quality premia paid by consumers are stable or declining. This may indicate that suppliers are responding to price signals and that supplies of higher quality cereals are keeping up with the increases in demand.

Table 5 here: Quality premia of cereals

(d) Processing margins

Part of the supply chain that affects the transmission of prices from producers to consumers is the processing sector. To analyze how processing and milling margins have changed as part of the structural transformation of cereal markets in Ethiopia, we compare the prices of milled products such as flour to the wholesale grain prices as described in section 2. By testing the extent to which prices of processed products changed over time relative to raw materials, we effectively test the changes in processing margins. We conduct these tests using the model described in equation (2) for the Addis Ababa market as well as for all wholesale markets for which retail price data are available. In general, we find that flour margins are declining over time for all four cereal products in the analysis (Table 6), though the change in wheat (at the national level) and maize margins are not statistically significant. This result might reflect an improvement in the milling sector.

Table 6 here: Premium of flour over grain

Changes in the milling sector are confirmed by secondary data from the Addis Ababa Trade and Industry Office Database. For example, the number of mills in the capital city has increased substantially over the last decade. While there was less than one mill per ward (*kebele*) on average in the middle of the decade, by 2011 there were five. Although part of this increase is likely due to increased formalization of the milling sector and consequently more previously informal mills now being recorded in the data, this is unlikely to explain the entire increase. A consequence of this growing number of mills may be an increase in competition and a relative reduction in milling costs. Retail data collected by CSA indicate that this may indeed be the case since the real price charged for milling cereals at the end of 2010 was 50 percent lower than it was a decade earlier.

(e) Retail margins

The final link in the supply chain affecting the transmission of prices from producers to consumers is at the retail level. To estimate the changes that have taken place at the retail

level, we analyze retail margins by using data that EGTE collects on retail pricing and merging them with their wholesale price series. These retail price data are collected from traders who operate in or close to the wholesale market and who sell directly to consumers. In many cases, however, these retail traders are also involved in wholesale activities.

Before we discuss the results of the analysis, we highlight two caveats with respect to the EGTE retail price data. First, these retail data are only available up through the end of 2009. We therefore limit the retail margin analysis to comparisons between the 2001–2005 and 2006–2009 periods. Second, the retail data collected are not representative of the entire retail sector in the cities because the data are only collected for those particular retail agents near to or in the wholesale markets. As such they do not include retailers elsewhere in the cities, nor do they include the amalgam of retailers who supply cereals through their shops or supermarkets, or especially through small mills. Nonetheless, despite these drawbacks, the data provide indications about the sizes of retail margins and how they evolve over time.

Three relevant findings emerge from the retail margin regressions in Table 7 for Addis Ababa and for all the markets for which the data were available. First, retail margins in Addis Ababa are significantly higher than in the rest of the country. This is not surprising, however, given the higher retail costs associated with a large city the size of Addis Ababa (e.g. real estate costs and higher labor costs).²² Second, margins differ by crop. Teff, for example, is characterized by the lowest margin, while maize has the highest. This might partly reflect the higher value of teff compared to other crops, while the difference in absolute retail margins between the other cereals is significantly smaller, possibly reflecting the fixed costs of retailing of cereals (Gardner, 1975). Third, retail margins have generally fallen over time. In eight out of the ten changes tested, the decline is significant. Further, cereal margins declined significantly for all five cereals in Addis Ababa. Indeed, the average retail margin for cereals fell by half in the capital city.

Table 7 here: Retail margins for cereals

5. Conclusions

This study of Ethiopian cereal wholesale markets in the last decade (2001–2011) is important for three reasons. First, cereals make up almost half of the expenditures of consumers in Ethiopia and about three-quarters of the land area under cultivation in the country. Any price and market changes thus have important welfare and food security implications. Second, poorly functioning cereal markets have in the past been identified a major cause of food insecurity. Third, because the explicit purpose of several government plans over the last decade²³ has been to stimulate agricultural market transformation, an evaluation of market changes is an important first step in understanding impact of such government programs. To better understand the structural transformation taking place in Ethiopian cereal markets, we examine possible reasons for changes as well as changes themselves in terms of cereal price behavior. This is accomplished by using a unique wholesale market survey that was fielded in the beginning of 2012 and by using monthly price data in major wholesale markets throughout the country.

The five identified reasons of change over the past decade are economic growth, urbanization, improved roads, greater access to information technologies, and better agricultural technology adoption. First, economic growth has been substantial over this period, and has likely resulted in household income growth and changes in food demand patterns. Second, urbanization has increased rapidly as 3.7 million more people are estimated to be living in urban settings than a decade ago. Given that urban dwellers are much less likely to grow their own food, this implies that commercial surplus has increased significantly over the last ten years. Third, the government has invested heavily in improved road infrastructure in the last decade. We find that travel costs and travel times have decreased substantially over the last decade, possibly also driven by more competition and a shift to better and bigger trucks. Fourth, cell phones are now universally being used by brokers and traders alike. Access to mobile phones changes price transmission between

traders, farmers, and brokers in important ways. More deals are struck by phone and traders have begun to bypass wholesale markets entirely. It is also possible that the spread of mobile phones has led to more entry into trade as the information-based barriers to entry are removed. Fifth, increasing adoption of modern inputs and more widespread presence of extension agents may have also led to increased agricultural supply.

The evolving drivers of structural change in cereal markets are likely to manifest themselves in a number of predicted outcomes. For example, increasing urbanization, increased supply and income growth will likely lead to more quantities traded and greater economies of scale, and thus to lower margins overall. In addition, access to better price information should lead to a more efficient marketing system, and consequently lower overall margins. Finally, changes in food consumption patterns due to income growth may be reflected in higher quality premia if changes in the supply of high quality products do not keep pace with the growing demand for these products. These predictions were tested through various analyses of price behavior over the last decade.

First, we find that there do exist quality premia among cereals, but that these premia changed little over time. Second, the spatial variation in cereal prices among wholesale markets and the margins between supplying and receiving markets have decreased significantly over time. Third, markets are becoming more spatially integrated as prices co-vary among more markets and as price adjustments take less time. Fourth, retail and milling margins declined by half.

While better road conditions, declining transportation costs, and smaller marketing margins generally result in a better functioning agricultural economy, change inevitably results in both winners and losers. The winners are the suppliers in major production zones as they receive higher prices on average, while urban consumers in the big cities also benefit from the lower prices that result from lower margins. The losers are likely net consumers residing near to or in the supplying areas as they might now confront higher prices. Further,

producers who reside close to the consuming areas may be worse off as they now face lower prices. Nonetheless, the net gain for the economy as a whole from such market improvements is likely to be substantial (e.g. Gardner, 1975).

While these findings are encouraging for Ethiopia, there is still significant room for market improvement. First, despite the large sums of money invested in road improvements, Ethiopia started from a low base and still has one of the lowest road densities in the world (von Braun and Olofinbiyi, 2007). Second, even when roads are available, transport costs are still relatively high compared to international standards. Further measures are needed to reduce transportation costs (Teravaninthon and Raballand, 2009). Third, while access to information is now widely available for traders and brokers, penetration and use of mobile phones by farmers is still one of the lowest in Africa (Nakasone et al., 2014). Fourth, while modern input adoption has improved considerably, adoption levels, especially of improved seeds, are still low often because of lack of supply. Finally, food prices in Ethiopia remain highly volatile. This type of price volatility is often linked to the uncertainty associated with ad hoc policy decisions (such as price controls, export bans, and other market interventions) which hamper sustainable private market development.

References

- Aker, J.C. and Fafchamps, M. (2014) Mobile phone coverage and producer markets: Evidence from West Africa. *World Bank Economic Review*, forthcoming.
- Bekele, A. and Ayele, G. (2006) Market price index for quality characteristics of teff: A hedonic price analysis of six markets in the Eastern Shewa. Photocopy Ethiopian Development Research Institute, Addis Ababa, Ethiopia.
- Chamberlin, J. and Schmidt, E. (2011) Ethiopian agriculture: A dynamic geographic perspective. ESSP II Working Paper 17, International Food Policy Research Institute / Ethiopia Strategy Support Program II, Addis Ababa, Ethiopia.
- CSA, EDRI, and IFPRI. (2006) Atlas of the Ethiopian rural economy. Central Statistical Agency (CSA); Ethiopian Development Research Institute (EDRI); International Food Policy Research Institute (IFPRI), Addis Ababa, Ethiopia.
- Davis, K., Swanson, B., Amudavi, D., Mekonnen, D., Flohrs, A., Riese, J., Lamb, C. and Zerfu, E. (2010) In-depth assessment of the public agricultural extension system of Ethiopia and recommendations for impact. IFPRI discussion paper 1041, International Food Policy Research Institute, Washington, DC.
- Dercon, S. (1995) On market integration and liberalization: Method and application to Ethiopia. *Journal of Development Studies*, 32, pp. 112–143.
- Dercon, S. and Vargas Hill, R. (2009) Growth from agriculture in Ethiopia: Identifying key constraints. Paper prepared as background for a study on agriculture and growth in Ethiopia. Accessed at http://users.ox.ac.uk/~econstd/Ethiopia%20paper%203_v5.pdf. July 21th, 2013.
- Dercon, S., Gilligan, D.O., Hoddinott, J. and Woldehanna, T. (2009) The Impact of agricultural extension and roads on poverty and consumption growth in fifteen

- Ethiopian villages. *American Journal of Agricultural Economics*, 91(4), pp. 1007-1021.
- Drèze, J. and Sen, A. (1989) *Hunger and Public Action* (Oxford: Clarendon Press).
- Gabre-Madhin, E.Z. (2001a) Market institutions, transaction costs, and social capital in the Ethiopian grain market. IFPRI Research Report 124, International Food Policy Research Institute, Washington, DC.
- Gabre-Madhin, E.Z. (2001b) The role of intermediaries in enhancing market efficiency in the Ethiopian grain market. *Agricultural Economics*, 25 (2-3), pp. 311–320.
- Gabre-Madhin, E.Z. (2012) A market for Abdu: Creating a commodity exchange in Ethiopia. Occasional Essays Series, International Food Policy Research Institute, Washington, DC.
- Gardner, B.L. (1975) The farm-retail spread in a competitive food industry. *American Journal of Agricultural Economics*, 57(3), pp. 399–409.
- Gelan, A. and Dinka, H. (2006) Investigating underlying relationships among population density, food insecurity and road density in Ethiopia. *Regional Development Studies*, 10, pp. 81–98.
- Getnet, K., Verbeke, W. and Viaene, J. (2005) Modeling price transmission in the grain market of Ethiopia with an application of the ARDL approach to white teff. *Agricultural Economics*, 33 (3), pp. 493–501.
- Graham, J., Rashid, S. and Malek, M. (2012) Disaster response and emergency risk management in Ethiopia, in: P. Dorosh and S. Rashid (eds.) *Food and Agriculture in Ethiopia: Progress and Policy Challenges* (Philadelphia: IFPRI/Pennsylvania University Press).
- Headey, D., Malaiyandi, S. and Fan, S. (2010) Navigating the perfect storm: Reflections on the food, energy, and financial crises. *Agricultural Economics*, 41(s1), pp. 217–228.

- Jensen, R. (2007) The digital divide: Information (technology), market performance, and welfare in the South Indian fisheries sector. *Quarterly Journal of Economics*, 127 (3), pp. 879–924.
- Kojima, M. (2009) Government response to oil supply volatility. Extractive Industries for Development Series 10, World Bank, Washington, DC
- Krishnan, P. and Patnam, M. (2012) Neighbours and extension agents in Ethiopia: Who matters more for technology diffusion? IGC Working Paper 12/0159, International Growth Centre, London, U.K.
- Kuma, T. (2010) Analyzing changes in food consumption patterns in urban Ethiopia. EDRI Working Paper 2, Ethiopian Development Research Institute, Addis Ababa, Ethiopia.
- Minot, N. and Roy, D. (2007) Impact of high-value agriculture and modern marketing channels on poverty: An analytical framework. Photocopy International Food Policy Research Institute, Washington, DC.
- Minten, B., Tamiru, S., Engeda, E. and Kuma, T. (2013) Ethiopia's value chains on the move: The case of teff. ESSP II Working Paper 52, International Food Policy Research Institute / Ethiopia Strategy Support Program II, Addis Ababa, Ethiopia.
- MoFED (2008) Dynamics of growth and poverty in Ethiopia (1995/96–2004/05). Photocopy Ministry of Finance and Economic Development, Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia.
- MoFED (2012) Ethiopia's progress towards eradicating poverty: An interim report on poverty analysis study (2010/2011). Photocopy Ministry of Finance and Economic Development, Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia.
- Nakasone, E., Torero, M. and Minten, B. (2014) The power of information: The ICT revolution in agricultural development. *Annual Review of Resource Economics*, forthcoming.

- Negassa, A. and Myers, R. (2007) Estimating policy effects on spatial market efficiency: An extension to the parity bound model. *American Journal of Agricultural Economics*, 89 (2), pp. 338-352.
- Rashid, S. (2011) Intercommodity price transmission and food price policies: An analysis of Ethiopian cereal markets. ESSP II Working Paper 22, International Food Policy Research Institute / Ethiopia Strategy Support Program II, Addis Ababa, Ethiopia.
- Rashid, S., Tefera, N., Minot, N. and Ayele, G. (2013) Can modern input use be promoted without subsidies? An analysis of fertilizers in Ethiopia, *Agricultural Economics*, 44(6), pp. 595-611.
- Ravallion, M. (1987) *Markets and Famines* (Oxford: Clarendon Press).
- Reardon, T., and Timmer, C.P. (2007) Transformation of markets for agricultural output in developing countries since 1950: How has thinking changed?, in: R. E. Evenson and P. Pingali (eds.) *Handbook of Agricultural Economics, Volume 3* (Amsterdam: Elsevier Press).
- Rivers, J., Holt, J., Seaman, J. and Bowden, M. (1976) Lessons from epidemiology from the Ethiopian famines. *Ann. Soc. Belge Méd. Trop.*, 56(4-5), pp. 345-357
- Schmidt, E. and Kedir, M. (2009) Urbanization and spatial connectivity in Ethiopia: Urban growth analysis using GIS. ESSP II Working Paper 3, International Food Policy Research Institute / Ethiopia Strategy Support Program II, Addis Ababa, Ethiopia.
- Shin, M. (2010) A geospatial analysis of market integration: The case of the 2004/05 food crisis in Niger. *Food Security*, 2, pp. 261-269.
- Spielman, D. J., Kelemwork, D. and Alemu, D. (2011) Seed, fertilizer, and agricultural extension in Ethiopia. ESSP II Working Paper 20, International Food Policy Research Institute / Ethiopia Strategy Support Program II, Addis Ababa, Ethiopia.

- Tadesse, G. and Guttormsen, A.G. (2011) The behavior of commodity prices in Ethiopia. *Agricultural Economics*, 42, pp. 87–97.
- Tadesse, G., and Shively, G. (2009) Food aid, food prices and producer disincentives in Ethiopia. *American Journal of Agricultural Economics*, 91(4), pp. 942–955.
- Tafere, K., Taffesse, A.S. and Tamiru, S. (2010) Food demand elasticities in Ethiopia: Estimates using Household Income Consumption Expenditure (HICE) survey data. ESSP II Working Paper 11, International Food Policy Research Institute / Ethiopia Strategy Support Program II, Addis Ababa, Ethiopia.
- Taffesse, A.S., Dorosh, P. and Gemessa, S.A. (2013) Crop production in Ethiopia: Regional patterns and trends, in: P. Dorosh and S. Rashid (eds.) *Food and Agriculture in Ethiopia: Progress and Policy Challenges* (Philadelphia: IFPRI/Pennsylvania University Press).
- Teravaninthon, S. and Raballand, G. (2009) *Transport Prices and Costs in Africa: A Review of the International Corridors* (Washington, DC: World Bank).
- Ticci, E. (2011) Can inflation be a good thing for the poor? Evidence from Ethiopia. *Development in Practice*, 21(4–5), pp. 629–641.
- Van Campenhout, B. (2007) Modeling trends in food market integration: Methods and an application to Tanzanian maize markets. *Food Policy*, 32, pp. 112-127
- Vandeplas, A. and Minten, B. (2011) Food quality in domestic markets of developing economies: A comparative study of two countries. LICOS Discussion Papers 28911, LICOS - Centre for Institutions and Economic Performance, K.U.Leuven, Leuven, Belgium.
- von Braun, J. and Olofinbiyi, T. (2007) Famine and food security in Ethiopia, in: P. Pinstrip-Andersen and F. Cheng (eds) *Food Policy for Developing Countries: The Role of Government in the Global Food System* (Ithaca: Cornell University).

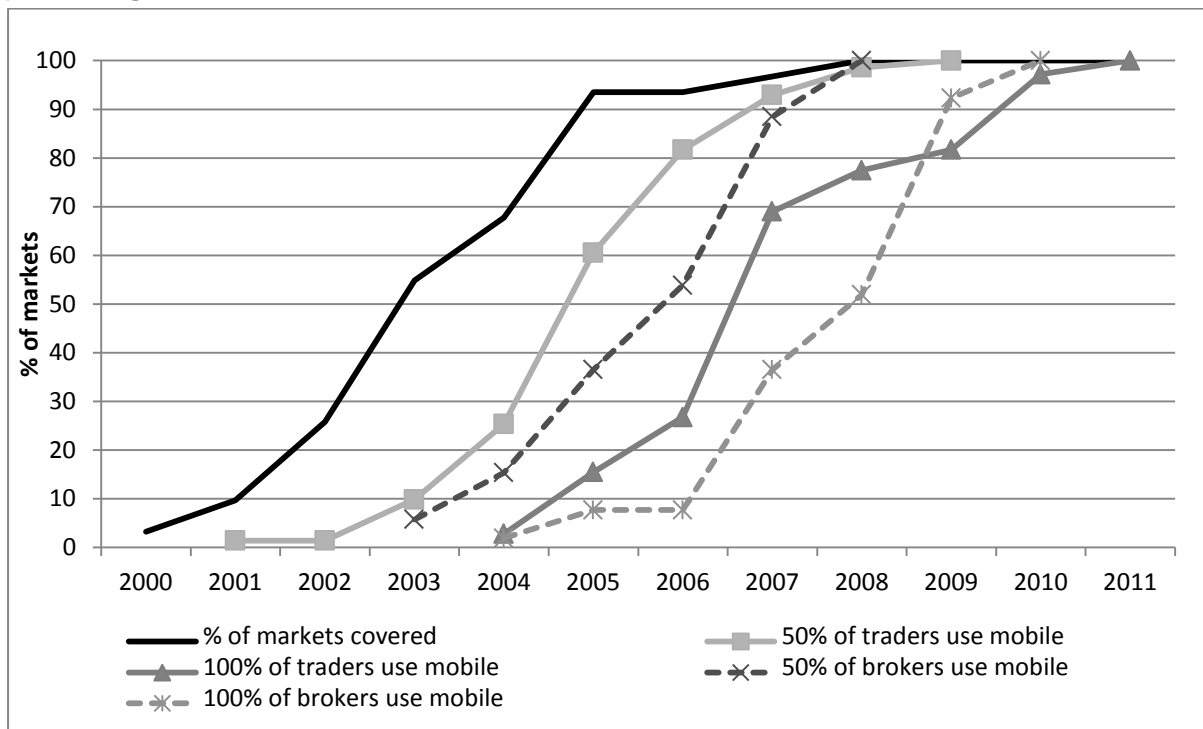
von Braun, J., Teklu, T. and Webb, P. (1998) *Famine in Africa. Causes, Responses and Prevention* (Washington DC: International Food Policy Research Institute).

Webb, P. and von Braun, J. (1994) *Famine and Food Security in Ethiopia: Lessons for Africa* (London: John Wiley).

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Figure 1—Mobile phone use by brokers and traders on wholesale markets, cumulative percentage over markets, 2000–2011



Source: Authors' compilation from focus group interviews

Table 1. Use of mobile phones by traders and brokers

	Percentage of traders/brokers			
	Mean	Median	Mean	Median
<i>Percentage of traders/brokers that had access to a fixed phone</i>	<u>now</u>		<u>before</u>	
a. Traders				
... at home			46	50
... on the market			22	15
... at another location			62	75
b. Brokers				
... at home			11	5
... on the market			3	0
... at another location			56	65
<i>Estimated number of phone calls per trader per day related to his trade business</i>	<u>by mobile phone</u>		<u>by fixed phone</u>	
a. Traders				
... In the peak period	24	25	8	5
... In the lean period	8	8	2	2
b. Brokers				
... In the peak period	34	30	6	5
... In the lean period	11	10	2	2
<i>Use of phone</i>	<u>"Are mobile phones used to..."?</u>		<u>"Were fixed phones used to..."?</u>	
a. Traders				
"... inform/transmit prices"	86	99	47	50
"... agree on prices (plus quantity/quality) with sellers"	36	25	14	5
"... request a show-up (quantity requested but without price agreements) with sellers"	38	25	16	0
"... agree deals (prices and quantity) with transporters"	40	35	6	0
"... agree on prices (plus quantity/quality) with buyers"	46	45	19	10
"... request a show-up (quantity requested but without price agreements) with buyers"	38	25	19	10
"... follow-up payments with buyers/sellers"	81	100	31	25
b. Brokers				
"... inform/transmit prices"	59	75	20	15
"... agree on prices (plus quantity/quality) with sellers"	20	0	2	0
"... request a show-up (quantity requested but without price agreements) with sellers"	34	0	11	0
"... agree deals (prices and quantity) with transporters"	39	45	7	0
"... agree on prices (plus quantity/quality) with buyers"	20	0	6	0
"... request a show-up (quantity requested but without price agreements) with buyers"	36	0	12	0
"... follow-up payments with buyers/sellers"	45	30	13	0
Number of observations	71		71	

Source: Authors' compilation from focus group interviews

Table 2. Changes in structural factors in the last decade

Driver - Measure	Number of obs.	Average 2001-2005	Average 2006-2011
1. Economic growth			
- GDP per capita (constant 2005 USD, PPP)	10	6.7	10.6
2. Urbanization/commercial surplus*			
Cereal trucks per week arriving....			
- ... in peak period	31	37	50
- ... in lean period	31	15	21
3. Roads and transportation costs **			
- time taken to travel between markets (hours)	205	9.6	8.4
- real transportation costs between cereal wholesale markets (constant 2010 costs; ETB/quintal per trip)	205	128	79
4. Mobile phones***			
Share of markets (%) where at the end of the period			
- ... 100% of traders are using mobile phone	71	15	100
- ... 50% of traders are using mobile phones	71	61	100
- ... 100% of brokers are using mobile phone	71	8	100
- ... 50% of brokers are using mobile phones	71	37	100
5. Agricultural technology			
- Share of cereal land with improved seeds	10	5	5
- Share of fertilized cereal land	10	47	51

Source: Authors' compilation from 1/ World Bank macro-economic data; 2/, 3/ and 4/ focus group discussions; 5/ CSA agricultural sample surveys; *: 31 observations reflecting the 31 markets visited; **: the 205 observations reflect the major effective product flows of the 31 surveyed wholesale markets with the other major wholesale markets (time and costs were only asked for those markets where there was an effective flow); ***: 71 crop focus groups (25 teff; 16 wheat; 5 sorghum; 6 barley; 19 maize)

Table 3. Regional wholesale price differences compared to Addis Ababa (Results of coefficients of regression)

†	Market	Dummy time interaction	Teff		Wheat		Maize		Barley	
			Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
1	Ambo	none	-0.05	-5.61	-0.14	-10.19	-0.08	-5.87	-0.06	-3.42
	Assela	none	0.02	3.17	-0.09	-7.26	0.14	12.92	-0.10	-6.76
	Bale Robe	none	0.08	4.77	-0.24	-11.36			-0.49	-12.09
	Dessie	none	0.04	3.13	0.06	2.51	0.06	4.79	0.01	0.68
	Dire Dawa	none	0.12	7.49	0.19	6.74	0.27	3.89	0.15	7.52
	Gondar	none	0.00	0.29	0.11	4.89	0.06	3.36	0.23	10.43
	Jimma	none	-0.04	-3.35	0.06	3.23	-0.15	-2.76	0.04	2.10
	Mekelle	none	0.08	7.58	0.18	6.16	0.18	8.77	0.12	1.55
	Nazreth	none	0.00	0.28	0.00	0.01	-0.01	-0.48	-0.06	-4.39
	Nekemt	none	-0.14	-16.96	-0.01	-1.08	-0.19	-9.36		
	Shashemene	none	-0.01	-0.48	-0.06	-5.90	-0.04	-3.60	-0.09	-4.89
2	Ambo	2001–2005	-0.06	<u>-5.27</u>	-0.16	-8.24	-0.10	-4.44	-0.03	-1.29
	Assela	2001–2005	0.03	2.51	-0.12	-7.56			-0.14	-7.61
	Bale Robe	2001–2005	0.03	1.18	-0.32	<u>-10.02</u>			-0.49	-7.26
	Dessie	2001–2005	0.09	3.97	0.09	2.60	0.09	3.82	0.06	2.43
	Dire Dawa	2001–2005	0.18	7.13	0.26	6.26	0.39	2.69	0.22	7.49
	Gondar	2001–2005	0.08	7.91	0.21	7.77	0.10	4.14	0.33	13.05
	Jimma	2001–2005	-0.04	-3.74	0.05	2.44	-0.20	-1.04	0.04	1.84
	Mekelle	2001–2005	0.13	13.38	0.24	6.54	0.26	9.13	0.32	5.90
	Nazreth	2001–2005	0.02	2.05	-0.00	-0.17	0.02	0.30	-0.04	-2.08
	Nekemt	2001–2005	-0.17	-13.01	0.02	0.87	-0.23	<u>-7.53</u>		
	Shashemene	2001–2005	-0.03	-1.60	-0.07	-7.52	-0.06	-3.11	-0.09	<u>-3.80</u>
3	Ambo	2006–2011	-0.04	<u>-3.16</u>	-0.11	-7.55	-0.06	-4.17	-0.10	-3.45
	Assela	2006–2011	0.02	2.01	-0.07	-4.28	0.13	14.44	-0.07	-3.70
	Bale Robe	2006–2011	0.12	6.03	-0.18	<u>-9.72</u>			-0.47	-25.43
	Dessie	2006–2011	0.00	0.34	0.02	0.78	-0.04	3.62	-0.03	-0.87
	Dire Dawa	2006–2011	0.07	6.30	0.10	6.34	0.17	10.21	0.08	5.59
	Gondar	2006–2011	-0.05	-4.08	0.03	1.28	0.03	1.32	0.16	6.18
	Jimma	2006–2011	-0.04	-1.92	0.06	2.09	-0.14	-3.93	0.04	1.29
	Mekelle	2006–2011	0.04	3.52	0.12	3.16	0.12	5.99	-0.15	-3.26
	Nazreth	2006–2011	-0.01	-1.47	-0.00	-0.38	-0.03	-1.69	-0.08	-4.56
	Nekemt	2006–2011	-0.12	-13.54	-0.04	-2.54	-0.15	<u>-6.45</u>		
	Shashemene	2006–2011	0.01	0.92	-0.06	-3.65	-0.03	-2.01	-0.07	<u>-2.73</u>

Source: Authors' calculations

Notes: † = Model Specification; Addis is the default market in all specifications; Shaded values represent statistically significant differences at the 5 percent level between the 2001-2005 and 2005-2011 periods from that market to major supplying areas, which coefficients are underlined (teff; Ambo; wheat: Bale Robe; maize: Nekemt; barley: Shashemene); Shaded values indicate statistically significant differences at the 5 percent level between the 2001-2005 and 2005-2011 periods for the price differences between the supplying regions and the Addis Ababa (default) market; Coefficients in bold are significant at the 5% level; robust White standard errors to within cluster (by quarter) correlation

Table 4. Degree of market integration of Addis Ababa with other cereal wholesale markets between 2001 and 2011

	Year	White teff	Mixed teff	Red Teff	White wheat	Maize	White sorghum	Mixed Barley
Total market pairs		6	6	6	6	6	4	4
Percent integrated markets	2001	50	50	50	67	50	50	50
	2011	83	100	100	83	100	50	75
Number of pairs where coeff. time trend sign. at 5% level		2	3	3	3	3	2	2
Half-life of adjustment to price changes (in weeks)	2001	4	12	9	11	6	28	49
	2011	3	6	7	6	4	25	8
Transaction cost (percent of average price)	2001	9	8	15	33	45	19	33
	2011	8	7	8	16	17	27	31

Source: Authors' calculations

Table 5. Quality premia of cereals

		Overall		Period 2001–2005		Period 2006–2010		F-test structural change	
Compared to		Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	F-value	Prob>F
All markets									
<i>Teff</i>									
Mixed teff	White teff	-0.12	-18.57	-0.12	-11.20	-0.12	-15.20	0.00	0.99
Red teff	White teff	-0.27	-24.52	-0.28	-14.27	-0.26	-22.42	1.14	0.29
<i>Barley</i>									
Mixed barley	White barley	-0.14	-18.93	-0.15	-10.62	-0.13	-13.63	1.34	0.25
<i>Wheat</i>									
Mixed wheat	White wheat	-0.09	-11.34	-0.09	-10.01	-0.09	-7.87	0.05	0.82
<i>Sorghum</i>									
Mixed sorghum	White sorghum	-0.15	-14.05	-0.12	-6.39	-0.16	-10.94	2.63	0.11
Addis Ababa									
<i>Teff</i>									
Mixed teff	White teff	-0.11	-9.43	-0.12	-6.58	-0.11	-6.80	0.36	0.55
Red teff	White teff	-0.32	-17.54	-0.33	-10.13	-0.32	-15.15	0.16	0.69
<i>Barley</i>									
Mixed barley	White barley	-0.19	-9.56	-0.22	-7.18	-0.16	-7.24	2.46	0.12
<i>Wheat</i>									
Mixed wheat	White wheat	-0.11	-7.43	-0.12	-7.31	-0.09	-4.00	0.87	0.36
<i>Sorghum</i>									
Mixed sorghum	White sorghum	-0.11	-8.14	-0.13	-6.24	-0.09	-6.20	2.29	0.13

Source: Authors' calculations

Notes: Coefficients in bold are significant at the 5% level; robust White standard errors to within cluster (by quarter) correlation

Table 6. Premium of flour over grain (measured as prices of flour retail to grain wholesale)

	Overall		Period 2001–2005		Period 2006–2010		F-test structural change	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	F-value	Prob>F
All markets								
Teff	0.22	13.62	0.29	19.76	0.15	7.90	44.43	0.00
Barley	0.45	5.18	0.67	10.73	0.38	4.28	10.62	0.00
Wheat	0.48	20.41	0.49	16.68	0.47	15.70	0.21	0.65
Maize	0.59	15.69	0.59	12.54	0.59	13.85	0.00	0.99
Addis Ababa								
Teff	0.31	13.15	0.37	12.61	0.24	7.46	10.89	0.00
Barley	0.08	1.45	0.27	2.70	0.03	0.99	5.09	0.03
Wheat	0.46	11.58	0.49	10.81	0.33	6.66	5.33	0.03
Maize	0.70	10.43	0.75	8.83	0.58	8.15	2.37	0.13

Source: Authors' calculations

Notes: Coefficients in bold are significant at the 5% level; robust White standard errors to within cluster (by quarter) correlation

Table 7. Retail margins for cereals

	Overall		Period 2001–2005		Period 2006–2009		F-test structural change	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	F-value	Prob>F
All markets								
Teff	0.016	14.71	0.018	12.69	0.014	9.41	4.12	0.05
Barley	0.048	19.20	0.055	18.13	0.039	20.69	22.22	0.00
Wheat	0.044	19.52	0.050	17.21	0.036	16.64	15.11	0.00
Sorghum	0.026	5.54	0.034	7.27	0.016	1.98	3.60	0.07
Maize	0.049	11.05	0.040	6.10	0.060	9.00	3.86	0.06
Addis Ababa								
Teff	0.043	10.62	0.056	10.64	0.028	13.11	24.52	0.00
Barley	0.098	7.89	0.135	8.47	0.054	7.62	21.75	0.00
Wheat	0.090	9.07	0.122	11.04	0.050	8.43	32.67	0.00
Sorghum	0.076	4.00	0.120	10.49	0.023	0.70	7.71	0.01
Maize	0.105	8.48	0.128	7.44	0.078	6.83	5.99	0.02

Source: Authors' calculations

Notes: Coefficients in bold are significant at the 5% level; robust White standard errors to within cluster (by quarter) correlation

Notes

¹ The interest in agricultural markets in Ethiopia is reflected in the literature as a significant body of research exists that has looked at food price related issues in Ethiopia (e.g. Dercon, 1995; Gabre-Madhin, 2001b; Getnet et al., 2005; Negassa and Myers, 2007; Rashid, 2011; Tadesse and Guttormsen, 2011; Tadesse and Shively, 2009; Ticci, 2011).

² One important caveat of our analysis is that the markets that we analyze and for which we have consistent price series mostly serve regional centers. It is well possible that rural markets are more dysfunctional and responsible for famines in rural areas (for papers on famines and market behavior, see e.g. Rivers et al., 1976; Shin, 2010; Ravallion, 1987; Drèze and Sen, 1989).

³ Producer prices are defined as those prices that are received by producers at the wholesale market; wholesale prices are the prices that wholesalers obtain when they sell in large bulks; retail prices are prices on the wholesale market or in nearby markets obtained by traders that sell in small quantities to consumers.

⁴ We use a de-seasonalized index. To construct such a de-seasonalized index, we calculated a twelve-month moving average and use the constructed series as the deflator.

⁵ Of the 13 cities with a population over 100,000, two of these cities were not part of the EGTE price series, i.e. Harar and Awassa.

⁶ Most of the agricultural seasons in the highlands of Ethiopia (where the majority of the analyzed markets are located) are similar, with harvests occurring at the same time. Taffesse et al. (2013), for example, show that 97% of all agricultural production in the country occurs during the Meher season and that the Belg season is of minor importance. We therefore do not include additional market-month interactions in the regression as this would also limit the scope of the spatial price analysis.

⁷ For a discussion of market transformation and its drivers, see e.g. Reardon and Timmer (2005) and Minot and Roy (2007).

⁸ While urbanization has led to increased rural-market flows, higher population growth in rural areas has also led to increased demand for marketed food in rural areas. Using the census data of 1994 and 2007, Schmidt and Kedir (2009) estimate that the absolute growth of the rural population (13.7 million) was twice as high as the urban population (6.7 million). However, given that most household food consumption in rural areas derives from own produced food, it is unlikely that rural population growth has had as much of an impact on food marketing flows than has increasing urbanization, as city dwellers typically depend completely on purchased food.

⁹ Changes in commercial surplus for cereals appear to be driven mostly by increasing production. CSA's agricultural data indicate that changes in commercialization rates per farmer have played a small role. Further, because urban populations rely heavily on purchased food, and because rural populations rely mostly on their own production for their food consumption needs, most of the increase in commercial surplus can therefore reasonably be linked to the increasing rural-urban market flows that follow from growing urban demand, despite rapid rural population growth. Unfortunately, no good updated and nationally consistent food consumption data for the major cereals were available at the time of writing of this paper and no good inference on the influence of income growth can be made.

¹⁰ This trend is consistent with estimates taken from the 1983 and 2007 population censuses. Because of improved infrastructure and because of urbanization, the population census data show the percentage of people who were connected with cities increased dramatically over the twenty-three year period between 1983 and 2007. According to Schmidt and Kedir (2009), the percentage of the population that lives further than 10 hours away from a city (more than 50,000 people) decreased from 40 percent in 1984 to 12 percent in 2007. Given that a number of large construction projects have continued since the 2007 census, it is safe to assume that this trend has only continued.

¹¹ Ethiopia froze fuel prices between August 2006 and January 2008; it had decreased the price of gasoline in February 2007. In October 2008, it eliminated fuel price subsidies altogether (Kojima, 2009).

¹² However, given that they are able to transport between twice or four times the load of the smaller trucks, their share of the total quantity of cereal transported is significantly higher than 13 percent.

¹³ While increasing competition in the transport sector is hard to measure, one rough indicator is the increasing number of trucks imported into the country each year. *Comtrade* data (Data on international trade are collected by the UN and can be downloaded from <http://comtrade.un.org/>), for instance, show that the number of trucks imported in the country doubled between 2001 and 2011. This increase is greater than observed in the wholesale markets. These imports thus illustrate not only the important increases in commercialization in the country, but likely also reflect important other changes, such as in the construction sector.

¹⁴ For those trips where no complete time series could be collected from the group over the whole ten years, the rest of the series was deleted. Thus, we ended up with 204 consistent price series of transport costs between wholesale markets.

¹⁵ While there are questions on the efficacy of this system (Davis et al., 2010), evaluations have shown that access to extension did positively affect agricultural yields (Dercon et al., 2009) and adoption of improved technologies (Krishnan and Patnam, 2012).

¹⁶ From our data, the following markets can then be considered to be situated in major supply zones: Jimma and Nekemt for maize; Assela and Bale Robe for wheat; and Assela for barley.

¹⁷ Tests for structural change in the sorghum trade are hampered by missing price information in the first part of the decade. It has therefore been excluded from the analysis.

¹⁸ Mekelle is the capital of Tigray region. Tigray is among the poorest and most vulnerable regions in the country, together with the pastoralist regions (MoFED 2012). Dessie is the capital of the South Wollo zone. The population in this zone has been hit hard by several famines in the past (Graham et al., 2012).

¹⁹ In the TAR model, unit root behavior in the transaction cost band is imposed by setting $\rho_{\pi}=0$. This reduces the estimated model inside the band (if $-\theta_1 \leq d_{t-1} \leq \theta_1$) from $\Delta d_t = \rho_{\pi} d_{t-1} + \varepsilon_t$ to $\Delta d_t = \varepsilon_t$. Consistent with the TAR model's requirement, all the markets considered for all categories of cereals are tested for a unit root and only those that are non-stationary in level terms and stationary in the price differences for any market pair were considered for the analysis.

²⁰ A market pair is considered integrated when the price adjustment in one market in response to a shock in the other is statistically significant in the TAR model. It is considered well integrated when the estimated adjustment parameter is not statistically different from -1 (i.e. prices in the two markets move in step with each other).

²¹ Unfortunately, we have no data on observed transaction costs between these markets. In the focus group interviews, respondents were asked about average transportation costs over the last year. From this, we find that transportation costs (an important part of the transaction costs) as a share of average annual prices in Addis at the time of the survey were as high as 7% for white teff, 8% for mixed teff, 9% for red teff, 8% for white wheat, 16% for maize, 12% for white sorghum, and 12% for barley. These numbers are close to the transaction costs estimates from the price integration model (based on weekly data) and suggest that the results of the model are mostly consistent with these data (except for sorghum and barley).

²² For example, MoFED (2012) shows that nonfarm prices in Addis (mostly rent) are significantly higher than the rest of the country.

²³ Such as the ALDI (Agricultural-Led Development Industrialization) and PASDEP (A Plan for Accelerated and Sustained Development to End Poverty).