Cities and Agricultural Transformation in Africa:

Evidence from Ethiopia

Joachim Vandercasteelen, Seneshaw Tamru, Bart Minten
and Johan Swinnen

Invited paper presented at the 5th International Conference of the African Association of Agricultural Economists, September 23-26, 2016, Addis Ababa, Ethiopia

Copyright 2016 by [authors]. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Cities and Agricultural Transformation in Africa:

Evidence from Ethiopia

Joachim Vandercasteelen*, Seneshaw Tamru*, Bart Minten**, and Johan Swinnen*

* LICOS – Center for Institutions and Economic Performance,
University of Leuven
Belgium.

** Ethiopia Strategy Support Program, Ethiopian Development Research Institute,
Addis Ababa, Ethiopia.

Version: February 2016

Abstract

Due to the rapid growth of cities in Africa, a larger number of farmers is living in the rural hinterland providing food to urban residents. However, empirical evidence on how urbanization affects these farmers is scarce. To fill this gap, this paper explores the relationship between proximity to a city and the production behavior of rural staple crop producers. More in particular, we analyze unique data from teff producing farmers in major producing areas around Addis Ababa, the Ethiopian capital. We find that farmers more closely located to Addis Ababa face higher wages and land rental prices, but because they receive higher teff prices they have better incentives to intensify production. Moreover, we observe that modern input use, land and labor productivity, and profitability in teff production improve with urban proximity. There is a strong and significant direct effect of urban proximity, which is suggested to be related with more use of formal factor markets, less transaction costs, and better access to information. In contrast, we do not find strong and positive relationships of rural population density increases - as an alternative source of agricultural transformation - as they seem to lead to immiserizing effects in these settings. Our results show that urban proximity should be considered as an important determinant of the process of agricultural intensification and transformation in developing countries.

Keywords: Agricultural Transformation, Crop Intensification, Urbanization, Cities, Ethiopia, Sub Saharan Africa

Corresponding author. Joachim.Vandercasteelen@kuleuven.be. Waaistraat 6, box 3511, B-3000 Leuven – Belgium. Tel: +3216326571.

Introduction

Agricultural transformation is crucial for poverty reduction and improved food security in Sub-Saharan African (SSA) countries as their agricultural sector is characterized by mainly small-scale, low productivity, low external input usage, and family labor oriented enterprises (World Bank 2008, FAO 2015). Inducing a transformation towards higher agricultural productivity levels is therefore often the aim of public investments and policies in many of these SSA countries (Wiggins 2014). This is deemed especially important given that 70% of the SSA population, and the majority of the poor, are living in rural areas where farming remains the most important economic activity (Wiggins 2000, World Bank 2008, Christiaensen et al. 2011). Moreover, even though there have been recent improvements in absolute numbers, SSA still remains highly food insecure (von Grebmer et al. 2015).

Several drivers of agricultural transformation have been identified in the literature. Boserup (1956) saw growing population densities, and the associated increased land pressure, as the prime cause of technological change in agriculture. Available evidence shows indeed that population growth leads to a reduction in fallow periods and an increase in input use intensification, mechanization or other (labor) intensive practices, and land saving farming systems (Fresco 1986, Binswanger and Pingali 1988, Tsakok 2011). The argument of a positive relationship between population density and intensification of agricultural land is especially relevant in settings of semi-subsistence farming, prevalent in large areas of SSA (Jayne et al. 2014) and the Boserup hypothesis has indeed been confirmed in recent empirical work on land constraints and farming systems in Africa (Headey and Jayne 2014, Ricker-Gilbert et al. 2014, Muyanga and Jayne 2014, Headey et al. 2014, Josephson et al. 2014).

Building upon the Boserup-idea of transformation, other authors have focused on relative and absolute changes in factor and output prices, driven by a number of additional determinants, and looked at how these changes reshape agricultural systems. The induced innovation theory in agriculture (Hayami and Ruttan 1985) postulates that farmers intensify agricultural production in such a way to save on the most costly input factor. Given that farmers are responsive to differences in relative factor price ratios, Pingali and Binswanger (1986) and Pingali et al. (1987) further argue market access to be an additional source of technological change. Finally, agricultural intensification can result from growth in demand for agricultural products in international and domestic food markets (Reardon and Timmer 2005, Keys and McConell 2005, Pingali 2007, Djurfeldt 2015).

Especially urbanization is seen as an important new factor for transformation in Africa (Tschirley et al. 2013, Reardon et al. 2013). The UN estimates that the number of people living in cities in SSA has grown by 160% between 1990 and 2014 and that this number is further expected to triple to 1.3 billion people in 2050 (UN 2014). These changes have important economic impacts. Urbanization is considered an important driver of economic development and long-term structural transformation and has therefore the potential to significantly contribute to poverty alleviation in these countries (Ravallion et al. 2007, Dorosh and Thurlow 2014). In particular, urbanization fosters the shift from agricultural activities to more remunerative non-farm activities and agglomeration effects might generate economies of scale and additional employment (Fafchamps and Shilpi 2003, 2005, Deichmann 2009, Christiaensen and Todo 2014). Urbanization also indirectly affects rural poverty through urban-rural spillovers and economic linkages such as remittances and rural non-farm income opportunities.

Moreover, there are important effects through food and agricultural markets. For example, increased urban consumption and changing preferences for high-value and higher quality agricultural products increase the urban demand and willingness-to-pay for agricultural products (Tschirley et al. 2013, Reardon and Timmer 2014, Djurfeldt 2015). As urban residents most often do not produce their own food, this will have important implications on rural agricultural production systems (von Thünen 1826, Wiggens 2000, Cali and Menon 2012).[1] There is however relatively limited evidence on how increased urbanization and urban demand affects agriculture in the surrounding areas supplying these cities.[2]

In this paper we contribute to this literature by analyzing how proximity to a large urban city affects farmers' agricultural production practices in Ethiopia. More in particular, we look at the case of staple crops which are the overwhelming source of income for these farmers. In Ethiopia, important changes are happening in the urban-rural settlement patterns. It has been estimated that the rural population living less than 3 hours away from a city increased from 15% to 47% over a 13-year period (between 1998 and 2011) (Schmidt et al. 2015). Moreover, while the share in the urban population in Ethiopia is still relatively low (at 17%), the urban population is rapidly increasing and it is expected to triple from 15.2 million in 2012 to 42.3 million by 2034 (World Bank 2015). Although Ethiopia is urbanizing fast, it remains however one of the poorest and most food insecure countries in SSA and the majority of its people are still highly dependent on the agricultural sector for their livelihoods (von Grebmer et al. 2015). Agricultural transformation is therefore high on everybody's agenda.

To study the relationship of agriculture with cities, we first develop a conceptual framework and then use unique data from Ethiopian farmers in major producing areas surrounding the capital, Addis Ababa, to test different hypotheses. We focus on the transformation in the production of one specific staple crop (teff). This crop is especially relevant because it is at the same time an important staple food for urban consumers and a major source of income for poor farmers in rural areas. We find that farmers located close to Addis Ababa receive higher output prices but also face increased wages and land rental rates. At the same time, urban proximity is positively related with chemical fertilizer use and the adoption of improved seeds. The direct effect of urban proximity combined with the indirect (output) price effect result in intensification as measured by higher land and labor productivity, and profits. Our findings therefore suggest that increasing urbanization in Africa will likely lead to increased agricultural transformation that is beneficial for staple crop producers. In contrast, we do not find such significant and positive effects for intensification driven by increasing rural population densities. This confirms findings of Headey et al. (2014) and Josephson et al. (2014) who show immiserizing intensification driven by land pressure increases in rural Ethiopia.

The paper is structured as follows. The second section gives background information on Ethiopia. To understand through which channels urban proximity influences intensification we develop a conceptual framework in the third section. The next section discusses the empirical strategy used, while the fifth section presents the results. We finish in the last section with the conclusions.

Background on cities and teff in Ethiopia

Urbanization in Ethiopia is one of the lowest in the world, with only 17 percent of its population estimated to live in cities in 2012 (World Bank 2015). However, rapid growth of cities has occurred in the past and even faster changes are expected. Schmidt and Kedir (2009) estimate that, based on an agglomeration index approach and using the last three national censuses (1984, 1994, 2007), urbanization rates increased from 3.7 to 14 percent over the period studied, almost quadrupling the national urban share (CSA 2007). Using the latest census, Addis Ababa is evaluated to be by far the largest city in Ethiopia and about a quarter of the urban population (10.5 million) in Ethiopia lived in Addis in 2007 (Schmidt and Kedir 2009). Driven by complementary rapid road infrastructure development, Kedir et al. (2015) further estimate that only 15 percent of the population was located within 3 hours of a city with a population of at least 50,000 in 1997/1998 but in 2010/11, this number had changed to 47 percent of the population (Figure 1). The World Bank (2015) expects that urban populations will continue to grow rapidly in Ethiopia and they project an annual growth rate of 5.4 percent over the next decades, leading to a tripling of the urban population from 15.2 million in 2012 to 42.3 million in 2034. By 2028, 30 percent of the country's people would live in urban areas.

Teff is an important staple crop in Ethiopia. In 2011, teff constituted 23 % of the total grain crop area and 17% of the total grain production in Ethiopia (CSA 2012). Moreover, production has doubled in the last decade, from over 1.5 to 3.5 million metric tons. 29% of teff production is sold, relatively high compared to other cereals such as wheat and maize (20 and 11% respectively). Hence, teff has a higher commercial surplus, and is often considered a cash crop for its producing farmers (Minten et al. 2015, 2016). Teff is further more readily eaten in urban than rural areas. In urban areas, teff has a high share (23%) of per capita consumption in total food consumption (Berhane et al. 2011). In the case of Addis Ababa, teff accounts for almost half of total cereal expenditure, while in other regions this is much less. Moreover, teff is relatively more consumed by richer and urban households and the income elasticity of demand for teff is high in urban areas, estimated to be 1.1 by Berhane et al. (2011). Because Addis Ababa is growing in size, the demand for teff is increasing. Moreover, household incomes (proxied by per adult equivalent consumption) in urban areas of Ethiopia are increasing, by 38% between 2005 and 2011. Given that teff is an economically superior good in urban areas with high income elasticities, this has led to large increases in demand and expected growth in the size and in the average incomes of urban areas will increase the urban demand for teff even further in the future.

Methodology

(a) Sampling and Data

For the empirical analysis, we use data from a large-scale survey of teff producers in Ethiopia. Teff producers in five production areas with the largest teff commercial surplus around Addis Ababa were surveyed in 2012. An innovative sampling design was implemented to randomly select farmers from both the smallest and largest teff producing woredas in these zones. To do so, all woredas were ranked in terms of cultivated area per zone, and two woredas were randomly selected from both the group of upper and lower producing woredas. Within each of the 20 woredas, all kebeles (villages) were ranked in terms of teff production, and two kebeles were randomly selected from the top 50% producing kebeles and one from the bottom 50% producing kebeles. Hence, a total of 60 villages was randomly selected, and within each village a census listed all farmers based on area cultivated. From this list, 20 farmers were randomly selected to be interviewed: 10 farmers were selected from the list of large production farmers (cultivating all together 50% of the area) and 10 farmers from small production farmers (the other 50% of the area). Hence, a total of 1,200 farmers was surveyed and the third column of table 1 provides the descriptive statistics on the household head and farm characteristics of these teff producing households. The majority of farmers are males, with at least some form of education and over 45 years old.[3]

Urban remoteness (i.e. the inverse of urban proximity) is defined as the transportation costs that farmers face when selling teff in the urban center of Addis Ababa. Such indicator is assumed to be a better measurement of proximity than physical distance or travel times (Chamberlin and Jayne 2013). In practice, we measure urban proximity as the cost of transporting 1 quintal (0.1 ton) from the farm to the urban wholesale market of Addis Ababa (ETB/quintal).[4] This transportation cost is calculated as the combination of two costs, i.e. the cost of transporting teff (i) from the farm to the market center in the village and (ii) from the market center in the village to the major wholesale market in Addis Ababa, using common modes of transport.

Agricultural input prices were collected in a community questionnaire. Using monthly observations, village data were aggregated to yearly averages for DAP prices (ETB/quintal), urea prices (ETB/quintal) and agricultural wages (ETB/day). Land rental rates (ETB/ha) were calculated from the land tenure section in the household survey.[5] For each of the parcels rented-in or share-cropped, farmers reported the price paid to or the value of output shared with the land owners, together with the parcel size, soil quality, walking distance, etc. To obtain rental prices, we pooled fixed land rental rates and sharecropping payments at the plot level for those households involved in these arrangements. Data on teff prices (ETB/quintal) were further collected from the teff transaction section in the household survey which contains information on quantities sold, prices received, main place of sales, and the buyer in each teff sales transaction during the last production season. There might however be endogeneity issues when the reported land and output prices are related with household (farming) characteristics (e.g. welfare status). Therefore we estimate a land rental and output price formation model using the parcels and transaction panel data for each household as unit of observation. The reported land rental rates and teff output prices are regressed on respectively the parcel-level and transaction-level determinants of prices using a fixed effect model. From these panel estimations, the predicted values of the land rental and input price are calculated for each farmer and used as an independent variable later on.[6]

Data on inputs applied and teff output achieved was collected at the teff plot level and averaged over all plots cultivated by the household. The considered inputs are use of DAP (kg/ha), urea (kg/ha), improved teff seeds (kg/ha), agrochemicals (ETB/ha), and labor (person-days per hectare). We use these household level data in levels but also report on input ratios and the use of formal factor markets. The input ratios are the use of agrochemicals over labor, the plough equipment index over labor and the use of fertilizer and improved seeds over land.[7] We also look at the share of rented land, hired labor and purchased seeds in the total usage of each input by the household. The intensification outcomes are teff land productivity (kg/ha), labor productivity (kg/person-days), input expenditure (ETB/ha) and profits (ETB/ha). Profits or net income are calculating as the difference between the monetary value of teff output and monetary value of all input expenditures in teff production. The latter is the cost of fertilizer, agrochemicals and seed usage; and also includes the cost of labor, where we assume the local wage rate as the opportunity cost of (family) labor.

(b) Empirical strategy

Following the conceptual framework, we estimate empirically the effect of urban proximity on prices (b_i), agricultural inputs and indices (q_i) and intensification outcomes (y_i). First, we estimate a reduced form of the equations (6) – (8) where the outcome variables are regressed only on transportation cost d_i. Then, we estimate a less parsimonious model where we allow for indirect effects through teff output and input prices b_i (except in the price model) and control for different possible confounding variables. These regressions are estimated using a seemingly unrelated regression (SUR) framework. To overcome the problematic assumption of homoscedastic errors of the SUR estimator, we bootstrap the standard errors to allow for the heteroskedastic structure on the error terms (Cameron and Trivedi 2008).

$$\ln(\mathrm{b}_i) = \alpha_\mathrm{w} + \beta_\mathrm{w} * \mathrm{d}_i + \theta_\mathrm{w} * \mathrm{Controls} + \varepsilon_\mathrm{w} \tag{6}$$

$$\mathrm{q}_i = \alpha_\mathrm{q} + \beta_\mathrm{q} * \mathrm{d}_i + \gamma_\mathrm{q} * \ln(\mathrm{b}_q) + \theta_\mathrm{q} * \mathrm{Controls} + \varepsilon_\mathrm{q} \tag{7}$$

$$\mathrm{y}_i = \alpha_\mathrm{y} + \beta_\mathrm{y} * \mathrm{d}_i + \gamma_\mathrm{y} * \ln(\mathrm{b}_q) + \theta_\mathrm{y} * \mathrm{Controls} + \varepsilon_\mathrm{y} \tag{8}$$

In each of these models, we are primarily interested in the direct and indirect effect of urban proximity. The direct effect of urban proximity through the production function corresponds with the β coefficients in the above equations. This direct effect captures changes due to improved information flow, transaction costs, and institutions that may result from closer urban proximity (Stifel and Minten 2008, Josephson et al. 2014). The indirect effect of urban proximity on intensification outcomes is captured by the changing output prices (p_i) and input prices – i.e. wages (w_i), land rental rate (r_i) – over distance. To determine the total effect of urban proximity on the different outcome variables, the direct and indirect effects need to be combined. For example, the total effect of transportation cost on the demand for agricultural inputs (q_i) becomes

$$\frac{\partial \mathrm{q}_i}{\partial \mathrm{d}_i} = \beta_2 + \frac{\partial q_i}{\partial \mathrm{p}_i} * \frac{\partial \mathrm{p}_i}{\partial d_i} + \frac{\partial q_i}{\partial \mathrm{w}_i} * \frac{\partial \mathrm{w}_i}{\partial d_i} + \frac{\partial \mathrm{q}}{\partial \mathrm{r}_i} * \frac{\partial \mathrm{r}_i}{\partial d_i} \tag{9}$$

To minimize the extent of omitted variable bias in the estimated coefficient of urban proximity in equations (6) – (8), we further control for additional determinants of agricultural intensification. First, we include several farm characteristics: (i) age, gender, ethnicity, and education of the household head; (ii) households' assets and household size; and (iii) agro-ecological conditions (altitude, the share of brown or black soils, and the share of flat - versus sloped - land). Second, farmers' market access is generally considered an important determinant of agricultural outcomes in developing countries (Stifel and Minten 2008, Dorosh et al. 2010). Therefore, we control for household's membership in an agricultural cooperative, and the distance to the nearest asphalted road. Finally, we include a measure of population pressure as an independent determinant of intensification (Ricker-Gilbert et al. 2014, Muyanga and Jayne 2014, Headey et al. 2014, Josephson et al. 2014). The majority of the literature in this area has used GIS based estimates of rural population density as a measure for population pressure. These data are however not available at the village level in Ethiopia and Headey et al. (2014) instead use the average farm size as alternative proxy of land pressure. Following these authors, average farm sizes were collected from the Bureau of Agriculture in each of the villages and are included in the regressions as a measure of rural population density. [8]

(c) Estimation issues

An important confounding effect that might drive the relationship between urban proximity and agricultural intensification outcomes but is much more difficult to control for than omitted variable bias is unobserved heterogeneity. Capitals or big cities in developing countries do not develop randomly over space and cities are likely to emerge in areas that are characterized by favorable agro-ecological conditions and agricultural potential. For example, Motamed et al. (2014) show that urbanization happens earlier in places with higher agricultural potential. On the contrary, rural hinterland areas are often characterized by mountainous geography and arid climatic conditions (Reardon and Timmer 2014). Unobserved agricultural potential poses important estimation problems. Unfortunately, we do not directly observe agricultural potential but to some extent, we control for this effect through the agro-ecological indicators included in the above models. A related problem is that farmers' settlement in the hinterland might also not be random, even if we control for observed differences between farmers. Agglomeration effects and new geographic economy theories suggest that individuals tend to settle in places close to growing urban areas as they offer better economic opportunities (Fafchamps and Shilpi 2003). While we are not able to deal with these endogeneity problems directly, we address each issue indirectly in the working paper version by showing that there is no significant heterogeneity in land productivity and farming ability across space.[9]

Results

(a) Non-parametric regressions

We start the empirical section with presentations of non-parametric regressions. These local polynomial smoothing regressions do not require that the functional form of a relationship is specified in advance and help to explore relationships in the data without preconditions. Figure 2 suggests a negative correlation between the transportation cost to Addis Ababa and the output price of teff. Graph 1 shows that the price of teff decreases from 1,150 ETB per quintal in villages nearby Addis to 950 ETB per quintal in the most remote villages, closely following transportation costs from Addis (Minten et al. 2016). There is also a clear negative relation between the local wage rate paid in the village and urban remoteness. Graph 2 shows that the village wage rate drops from 45 ETB per day to 25 ETB per day from less to more remote villages, a decrease of more than 50 percent. As land cannot be sold in Ethiopia, we can only look at land rental prices, as an indicator of implicit land values. Land rental prices also show clear downward patterns over space, as would be expected (Jacoby, 2000). Also in this case do prices drop to half for the most remote villages. Finally, prices of DAP (graph 4) and Urea (Graph 5) fertilizer are not correlated with urban proximity. This is not surprising, given that chemical fertilizer distribution is coordinated and regulated by the government and that prices and margins are fixed by them (Rashid et al. 2013).[10] Hence, these figures suggest that more remote farmers receive significantly lower prices for their teff output, but at the same time also face lower prices for labor and land.

We further look at correlations between urban proximity and input use. We observe increasing application rates of chemical fertilizer and improved varieties by farmers living close to the urban center (Figure 3). Farmers close to the capital use more than 120 kg DAP per hectare (graph 1), while those further away use only half of that amount. The use of urea (kg per hectare) also drops by more than half for the most remote households. The effect of urban proximity is the most pronounced for the use of improved teff seeds: graph 3 shows that the application of improved seeds drops to almost zero kg per hectare at the right end of the transport cost distribution. Graph 4 suggests that there is no clear relationship between urban remoteness and the use of agrochemicals. We see that the total use of labor (including family, hired and shared labor) on the plot is increasing over transportation cost in graph 5. Hence, farmers more closely located to an urban city use less labor per hectare. As indicated in our model, with growing distance from the urban center, demand for farm labor is reduced because of lower output prices and productivity (the second and third term), but at the same time demand for labor increases with lower rural wages (first term is positive).

Figure 4 further reports how transportation cost is related with different input ratios in teff production. Graph 1 shows that the ratio of agrochemicals over labor tends to decline when transportation costs increase. Similarly, the ratio of the plow ownership index over labor tends to decline over distance in graph 2. These two graphs suggest that labor is substituted for plowing and agrichemicals, especially herbicides as this is a substitute for weeding labor. Graph 3 and 4 shows that the ratio of fertilizer over land and improved seeds over land is negatively correlated with urban remoteness. Hence, farmers closely located to an urban center use their land more intensively.

Finally, Figure 5 shows how intensification varies with transportation cost. Graph 1 shows that the land productivity drops from 1,100 kg per hectare to 800 kg per hectare over the sample. Similarly, teff labor productivity (kg per day) drops with greater transportation cost in graph 2. Close to Addis Ababa, farmers are able to achieve more than 12 kg of teff per person-days of labor supplied in teff production, which decreases to 6 kg for farmers at the far right of the distribution. Graph 3 reports the cost of agricultural inputs in teff production. It shows a clear reduction in expenditures in teff production when households are located further away from Addis Ababa. Graph 4 further shows that the profits (in ETB per hectare) from teff production also decrease with urban remoteness from Addis Ababa. Profits from teff production close to Addis Ababa are above 8,000 ETB per hectare which drops to half that level (almost 4,000 ETB per hectare).

These non-parametric graphs on the three outcome vectors show overall a striking relationship with urban proximity. In the next section, we will explore these relationships more in depth relying on a multi-variate regression approach.

(b) Multi-variate regression analysis

We estimate equations (6) – (8) following the two empirical strategies described in the methodology section.[11] The upper panel of each regression output table in the remainder of the paper reports the reduced form estimation where urban proximity is the only independent variable. This reduced form (just as the graphs in the previous section) however does not take into account other factors that might explain intensification outcomes. To control for these confounding effects, the lower panel in each table reports the results of a less parsimonious model, where other drivers of agricultural intensification as well as control variables are included. To improve readability of the results, we only report the regression coefficients of urban proximity, average farm sizes, and distance to an asphalt road (as a measure of market access). For the effect of urban proximity, we distinguish between the direct, indirect (through input and output prices) and total effect, as calculated from equation (9).

The upper panel of table 4 reports the regression results for teff output price (column 2), wage rate (column 3), land rental rate (column 4) and DAP and urea prices (column 5-6). All prices were transformed into natural logarithms, and coefficients are multiplied by thousand to ease interpretation. For each price variable, we see that the results of the non-parametric regressions are confirmed in the reduced forms (presented in panel one). We find evidence of a significant negative relationship between teff prices, wages and land rental prices with increasing transportation costs to Addis Ababa. In contrast, urban remoteness has no significant effect on prices of DAP and urea. These conclusions remain if we include other determinants and control variables in the less parsimonious model in the lower panel. The effective price that farmers receive for one quintal teff is significantly lower for more remote farmers. An increase of transportation cost by 50 ETB per quintal directly reduces the price of teff received for one quintal by 4 percent. Moreover, farmers close to Addis Ababa face higher labor costs and land rental costs. The results also show that farm size at the village level, as a measure of land pressure, is significantly and positively related with village level prices of rental rates and fertilizer, but not with teff output prices and wages. Distance to an asphalted road seems to be an important determinant for fertilizer prices, but not for the other prices.

The regression results of equation (7) for different inputs used are reported in Table 5. All variables are measured as the average plot level usage in per hectare terms. The reduced form estimation in the upper panel shows that the use of DAP (column 2), urea (column 3) and improved seeds (column 4) is negatively related with transportation costs. On the other hand, the use of agro-chemicals (column 5) does not seem to be related with transportation cost, while a positive correlation between labor use (column 6) and remoteness is found. In the less parsimonious model, the direct effect of transportation costs remains significant negatively related with the application of urea and improved seeds. However, we see that the estimated direct effect on DAP usage becomes insignificant and that labor use is now weakly negatively related with transportation costs. Moreover, we also observe a significant negative indirect effect of transportation costs through output, wage and land rental prices on DAP and urea application. As a consequence, we find a significant negative total effect of transportation cost on the use of agricultural inputs, except for agrochemicals which is estimated to be unrelated with urban proximity. For example, an increase of 50 ETB per quintal in transportation costs decreases (on average) the use of urea by 19 kg per hectare and the use of improved seeds by 6 kg per hectare – all things equal. Table 5 further shows that the average farm size in the village is not a significant driver of increased usage of modern inputs but only (weakly) significantly related with the use of urea. Population pressure is however significantly related with the plot level use of labor (as also found by Headey et al. 2014). Increasing distance from an asphalt road has further a negative effect on DAP usage and the use of improved seeds.

We further analyze how input ratios in teff production change with increasing transportation costs in Table 6. The reduced form regression coefficients suggest that the ratio of the plough equipment index over land (column 3), the ratio of fertilizer over land (column 4), and ratio of improved seeds over land (column 5) is significant negatively correlated with transportation costs. No significant relation is observed for the ratio of agrochemicals over labor (column 1), probably because agrochemicals usage does not change over distance (table 5). Once we control for other determinants in the less parsimonious model, the ratios of fertilizer over land and improved seeds over land remain negatively related with transportation cost. There is also a significant indirect price effect of distance on the ratio of fertilizer over land. Hence, table 6 suggests that farmers close to an urban city substitute land by improved inputs, compared to the more remote farmers. Population pressure is not related with any of these indices, but the distance to an asphalt road is negatively correlated with the ratio of agrochemicals and the ratio of the plough equipment index over labor.

Finally, table 7 shows the estimation results for different intensification outcomes in teff production. The estimation results are reported for teff yields (kg per hectare) in the second column and for labor productivity (kg per person-days) in the third column. In the reduced form setting, transportation cost is (weakly) negatively related with teff yields and (strongly) with labor productivity. Once we control for other determinants and controls in the less parsimonious model (lower panel), we see that the direct effect of urban proximity remains significant for teff yield but this does not hold for labor productivity. The indirect price effect is significant for both outcomes, and as a consequence, the total effect of transportation cost on teff land and labor productivity is significantly negative. The last two columns of table 7 report the estimation results for agricultural input expenditures (including labor) and profits (net revenues) from teff production, both measured in ETB per hectare. In both the reduced form and the less parsimonious model estimation, the direct effect of transportation cost is negative and highly significant. Moreover, the indirect effect of transportation cost through prices is significant, resulting in a negative total effect. An additional transportation cost of 50 ETB per quintal leads to a drop in teff profits of (on average) 2,000 ETB. Surprisingly, neither the average farm size at the village level nor distance to an asphalt road have a significant effect on expenditures or profits in teff production. Population pressure is therefore not a significant driver of increased intensification outcomes in these settings.

Conclusions

We provide evidence on strong heterogeneity in staple food production practices, modern input application, factor market development, profitability, and output market use between those villages that supply Addis Ababa and those that are remote. Hence, we show that urban proximity should be considered as a main determinant of the process of agricultural intensification and transformation in developing countries. Because of fast and increasing urbanization in a large number of countries in SSA, our results therefore suggest that cities are an important new engine for agricultural intensification in SSA countries. Moreover, we show the importance of urban market demand as drivers for agricultural transformation in the staple food sector and these findings have therefore important implications on programs aiming to stimulate transformation as the location of these efforts is important in ensuring likelihood of success.

Our results further show the importance of increasing investments in roads and other physical infrastructure to reduce farmers' transportation costs to link them to markets. Investments in better road and port infrastructure and the takeoff of containers have been shown to decrease transaction costs of domestic and international trade and therefore stimulate farmers' market participation (Poulton et al. 2006, Barrett 2008, Iimi et al. 2015). Similarly, new communication systems make information exchange, search costs and communication less costly (Pingali 2007). Reduced transportation and transaction costs lead to higher agricultural production, consumption and income; and eventually to lower poverty rates (Jacoby 2000, Khandker et al. 2006, Stifel and Minten 2008, Gollin and Rogerson 2010; Dercon et al. 2009;

Stifel et al. 2015). Our results show that once farmers are better connected with urban cities, farmer will likely have the needed incentives to intensify their agricultural production.

Finally, despite substantial investments in urban services and infrastructure, the land tenure policy has been a restrictive factor in rural-urban migration in the Ethiopian hinterland (Headey et al. 2014). Land is owned by the government and rural farmers can only obtain land conditional on residence within the village. Moreover, transfer of land rights through sales and exchange are not allowed which limits transferability of land between migrants and non-migrants (Zewdu and Malek 2013, World Bank 2015). Land tenure insecurity and fear of losing the allocated land have further discouraged rural outmigration which has undermined farmers' incentives to make land investments, crucial to increase productivity levels, and slowed down the reallocation of labor to non-farm and other remunerative activities in the urban sector (Deininger et al. 2011, Chamberlain and Schmidt 2012, De Brauw and Mueller 2012). Moreover, this land tenure system has slowed down the rate of urbanization and thus the growth of cities in Ethiopia. Our results show that such policies might unintentionally restrain farmers from reaping the benefits of increased urban demand for food and the positive urban consumption – rural production linkage.

References

Barrett, C. B. 2008. Smallholder market participation: Concepts and evidence from eastern and southern Africa. Food Policy, 33(4), 299-317.

Berhane, G., Paulos, Z., and K. Tafere. 2011. Food grain Consumption and Calorie Intake Patterns in Ethiopia. ESSP II Working Paper 23. International Food Policy Research Institute (IFPRI). Addis Ababa, Ethiopia.

Binswanger, H., and Pingali, P. 1988. Technological priorities for farming in sub-Saharan Africa. The World Bank Res Obser, 81-98.

Boserup, E., 1965. Conditions of Agricultural Growth. Aldine Publications, Chicago.

Cameron, A. C., & Trivedi, P. K. 2010. Microeconometrics using stata (Vol. 2). College Station, TX: Stata Press.

Chamberlin, J., and Schmidt, E. 2012. Ethiopian agriculture: A dynamic geographic perspective. Food and Agriculture in Ethiopia: Progress and policy challenges, 74, 21.

Chamberlin, J., and Jayne, T. S. 2013. Unpacking the meaning of 'market access': evidence from rural Kenya. World Dev, 41, 245-264.

Christiaensen, L., Demery, L., and Kuhl, J. 2011. The (evolving) role of agriculture in poverty reduction—An empirical perspective. J Dev Econ, 96(2), 239-254.

De Brauw, A., and Mueller, V. 2012. Do limitations in land rights transferability influence mobility rates in Ethiopia?. J Afr Econ, 21(4), 548-579.

De Janvry, A., Fafchamps, M., and Sadoulet, E. 1991. Peasant household behaviour with missing markets: some paradoxes explained. Econ J, 101(409), 1400-1417.

Debertin, D. L. 2012. Agricultural production economics Second edition. New York, Macmillan.

Dorosh, P., and Thurlow, J. 2014. Can cities or towns drive African development? Economy wide analysis for Ethiopia and Uganda. World Dev, 63, 113-123

Cali, M., and Menon, C. 2012. Does urbanization affect rural poverty? Evidence from Indian districts. The World Bank Econ Rev.

CSA (Central Statistical Agency). 2007. Population and housing census 2007. Addis Ababa, Ethiopia.

CSA (Central Statistical Agency). 2012. Agricultural Sample Survey: Area and Production of Major Crops, Meher Season. Vol. I. Addis Ababa, Ethiopia.

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. Am J Agr Econ, 91(4), 1007-1021.

Deichmann, U., Shilpi, F., and Vakis, R. 2009. Urban proximity, agricultural potential and rural non-farm employment: Evidence from Bangladesh. World Dev, 37(3), 645-660.

Deininger, K., Ali, D. A., and Alemu, T. 2011. Impacts of land certification on tenure security, investment, and land market participation: evidence from Ethiopia. Land Econ, 87(2), 312-334.

Djurfeldt, A. A. 2015. Urbanization and linkages to smallholder farming in sub-Saharan Africa: Implications for food security. Glob Food Sec, 4, 1-7.

Dorosh, P., and Thurlow, J. 2014. Can cities or towns drive African development? Economy wide analysis for Ethiopia and Uganda. World Dev, 63, 113-123.

Dorosh, P., Wang, H. G., You, L., and Schmidt, E. 2010. Crop production and road connectivity in Sub-Saharan Africa: a spatial analysis. World Bank Policy Research Working Paper Series, Vol.

Fafchamps, M., and Shilpi, F. 2003. The spatial division of labour in Nepal. J Dev Stud, 39(6), 23-66.

Fafchamps, M., and Shilpi, F. 2005. Cities and Specialisation: Evidence from South Asia. Econ J, 115(503), 477-504.

Fresco, L. O. 1986. Cassava in shifting cultivation: a systems approach to agricultural technology development in Africa. Royal Tropical Institute.

Hayami, Y., and Ruttan, V., 1985. Agricultural Development: An International Perspective. Johns Hopkins University Press, Baltimore, MD.

Headey, D. D., and Jayne, T. S. 2014. Adaptation to land constraints: Is Africa different? Food Policy, 48, 18-33.

Headey, D., Dereje, M., and Taffesse, A. S. 2014. Land constraints and agricultural intensification in Ethiopia: A village-level analysis of high-potential areas. Food Policy, 48, 129-141.

Iimi, A., You, L., Wood-Sichra, U., & Humphrey, R. M. 2015. Agriculture Production and Transport Infrastructure in East Africa.

Kedir, M., Schmidt, E., Tilahun, H. 2015. Production Patterns and Fertilizer Use. Mimeo.

Jacoby, H. G. 2000. Access to markets and the benefits of rural roads. Econ J, 713-737.

Jayne, T. S., Chamberlin, J., and Headey, D. D. 2014. Land pressures, the evolution of farming systems, and development strategies in Africa: A synthesis. Food Policy, 48, 1-17.

Josephson, A. L., Ricker-Gilbert, J., and Florax, R. J. 2014. How does population density influence agricultural intensification and productivity? Evidence from Ethiopia. Food Policy, 48, 142-152.

Khandker, S. R., Bakht, Z., and Koolwal, G. B. 2009. The poverty impact of rural roads: evidence from Bangladesh. Econ Dev Cult Change, 57(4), 685-722.

Keys, E., and McConnell, W. J. 2005. Global change and the intensification of agriculture in the tropics. Global Environ Change, 15(4), 320-337.

Muyanga, M., and Jayne, T. S. 2014. Effects of rising rural population density on smallholder agriculture in Kenya. Food Policy, 48, 98-113.

Minten, B., and Kyle, S. 1999. The effect of distance and road quality on food collection, marketing margins, and traders' wages: evidence from the former Zaire. J Dev Econ, 60(2), 467-495.

Minten, B., Koru, B., and Stifel, D. 2013. The last mile (s) in modern input distribution: Pricing, profitability, and adoption. Agr Econ, 44(6), 629-646.

Minten, B., Tamru, S., Engida, E., and Kuma, T. 2015. Transforming staple food value chains in Africa: The case of teff in Ethiopia. The Journal of Development Studies, 1-19.

Minten, B., Tamru, E., Engida, E., Tadesse, K. 2016, Feeding Africa's cities: The case of the supply chain of teff to Addis Ababa, Econ Dev Cult Change, forthcoming

Pingali, P. 2007. Agricultural growth and economic development: a view through the globalization lens. Agr Econ, 37(s1), 1-12.

Pingali, P. L., Bigot, Y., and Binswanger, H. P. 1987. Agricultural mechanization and the evolution of farming systems in Sub-Saharan Africa. Johns Hopkins University Press.

Poulton, C., Kydd, J., and Dorward, A. 2006. Overcoming market constraints on pro-poor agricultural growth in Sub-Saharan Africa. Dev Pol Rev, 24(3), 243-277.

Reardon, T., and Timmer, C. P. 2014. Five inter-linked transformations in the Asian agrifood economy: Food security implications. Glob Food Sec, 32, 108-117.

Reardon, T., Tschirley, D., Minten, B., Haggblade, S., Timmer, P., and Liverpool-Tasie, S. 2013, (November). The Emerging "Quiet Revolution" in African Agrifood Systems. In Brief for "Harnessing Innovation for African Agriculture and Food Systems: Meeting Challenges and Designing for the 21st Century (pp. 25-26).

Renkow, M., Hallstrom, D. G., and Karanja, D. D. 2004. Rural infrastructure, transactions costs and market participation in Kenya. J Dev Econ, 73(1), 349-367.

Schmidt, E., and Kedir, M. 2009. Urbanization and Spatial Connectivity in Ethiopia: Urban Growth Analysis Using GIS (No. 3). International Food Policy Research Institute (IFPRI).

Solomon, A., and Mansberger, R. 2003. Land policy, urban-rural interaction and land administration differentiation in Ethiopia. In 2nd FIG Regional Conference.

Stifel, D., and Minten, B. 2008. Isolation and agricultural productivity. Agr Econ, 391, 1-15.

Tsakok, I. 2011. Success in agricultural transformation. Cambridge: Cambridge University.

Tschirley, D., Haggblade, S., and Reardon, T. 2013. Africa's Emerging Food System Transformation.'. East Lansing: Michigan State University Global Center for Food System Innovation.

Zewdu, G. A., and Malek, M. 2013. Implications of land policies for rural-urban linkages and rural transformation in Ethiopia. Food and Agriculture in Ethiopia: Progress and Policy Challenges.

United Nations (UN) Population Division. 2010. World Urbanization Prospects: The 2009 Revision. New York: UN

United Nations (UN) Population Division. 2014. World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352). New York: UN

von Grebmer, K., Bernstein, J., de Waal, A., Prasai, N., Yin, S., and Y. Yohannes. 2015. 2015 Global hunger index: Armed conflict and the challenge of hunger. Bonn, Germany; Washington, D.C. and Dublin, Ireland: Welthungerhilfe; International Food Policy Research Institute (IFPRI)

von Thünen, J. 1826, The Isolated State, English edn, London, Pergamon Press.

Wiggins, S. 2000. Interpreting changes from the 1970s to the 1990s in African agriculture through village studies. World Dev, 28(4), 631-662.

Wiggins, S. 2014. African Agricultural Development: Lessons and Challenges. J Agr Econ, 65(3), 529-556.

World Bank. 2008. Agriculture Development Report 2008: Agriculture for Development. The World Bank. Washington, DC, USA.

World Bank. 2015. Ethiopia Urbanization Review: Urban Institutions for a Middle-Income Ethiopia, World Bank, 2015.

Tables and figures

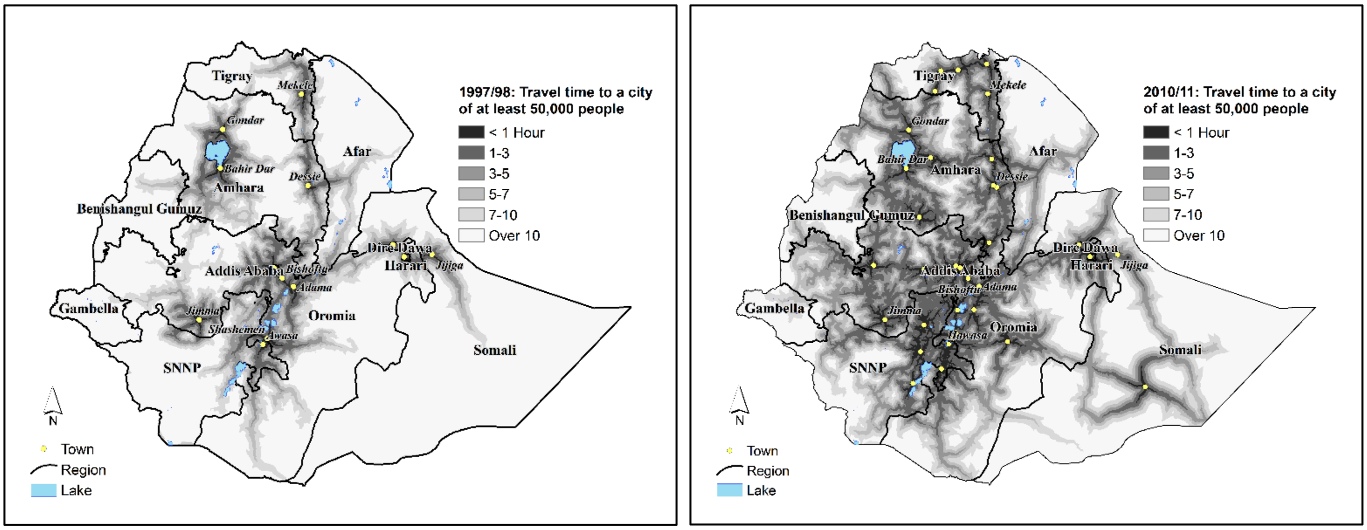


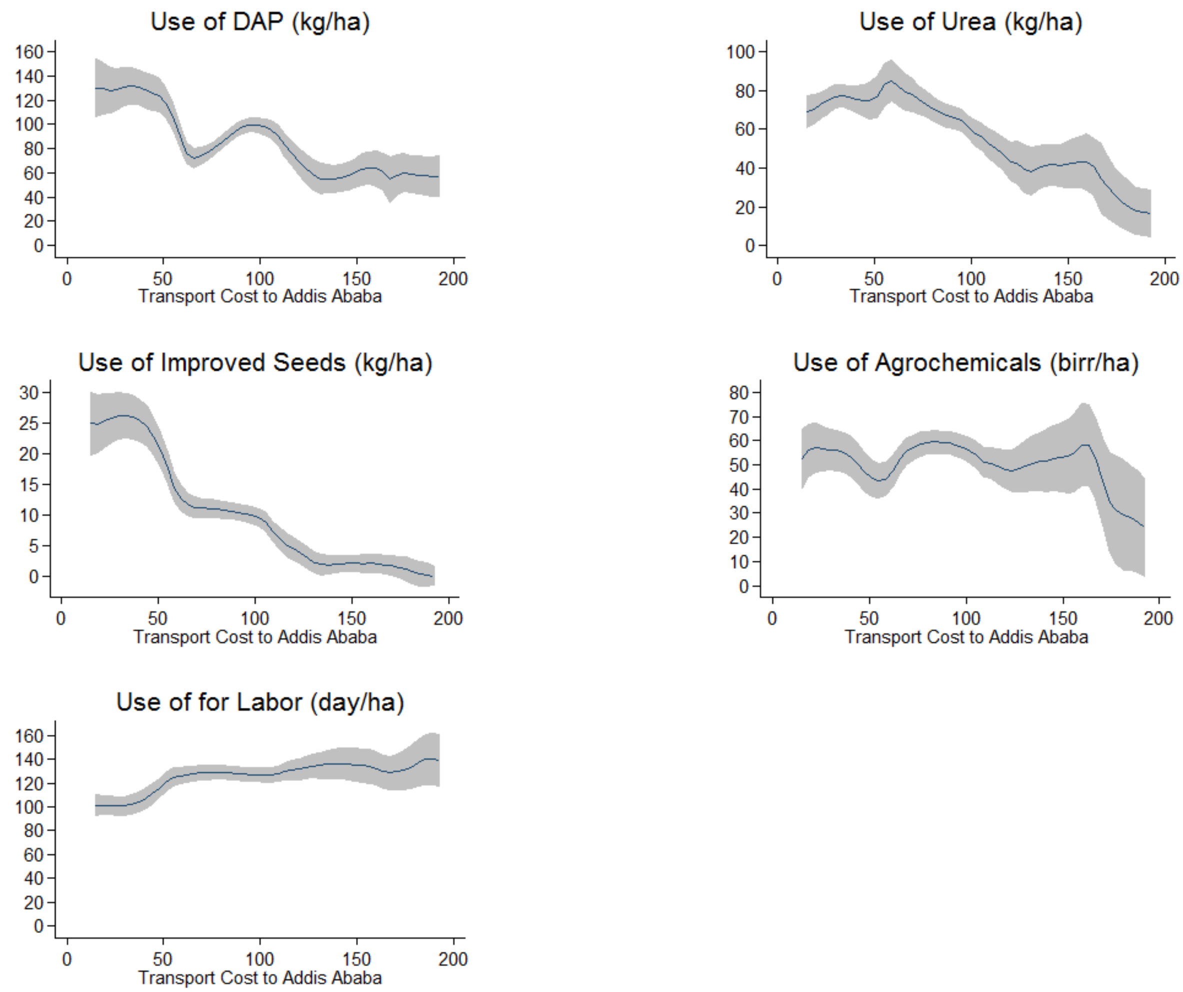
Figure 1: Travel time to a city of at least 50,000 people (1996/97 and 2010/11)

Source: Kedir et al., 2015

Figure 2: Correlation of transportation cost with village prices

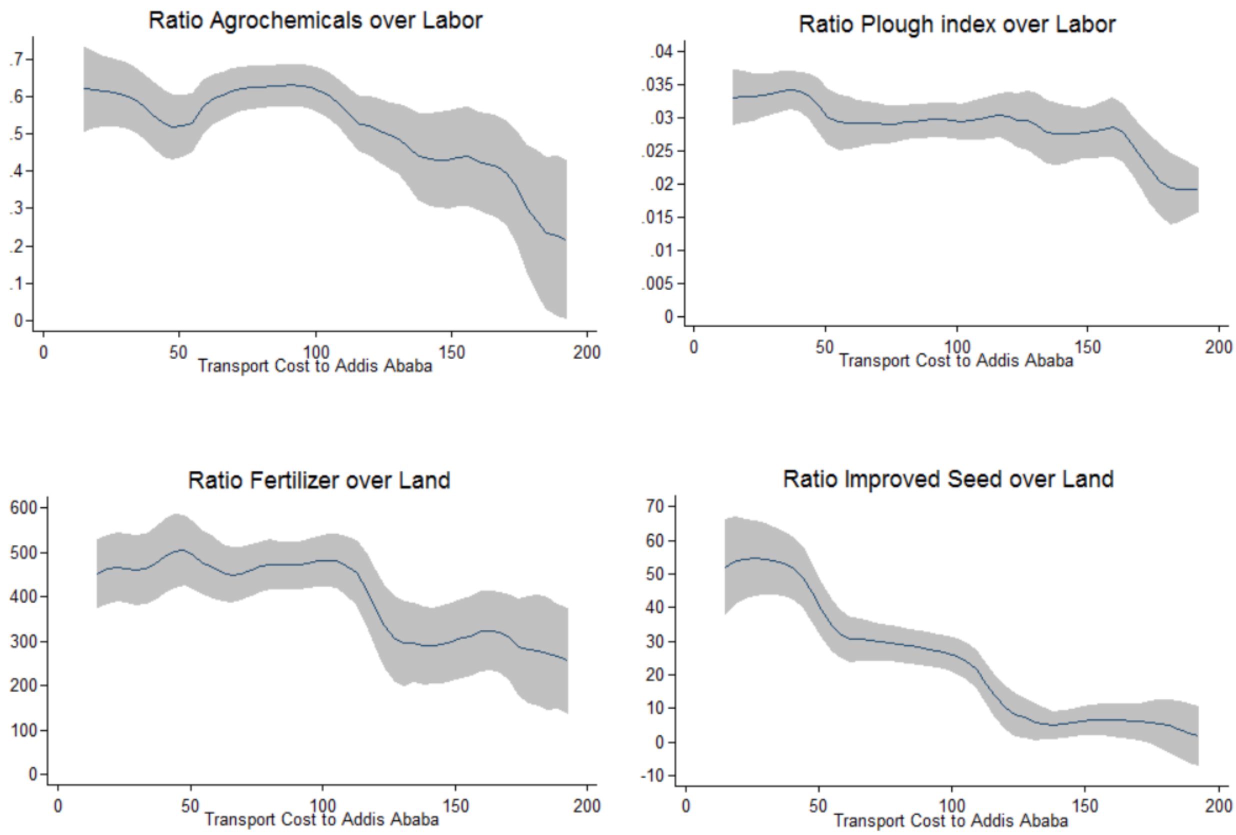
Notes: the solid lines represent local polynomial smoothing estimates of transportation cost (x-axis) on output and input prices (y-axis).

Figure 3 Correlation of transportation cost with application of agricultural inputs



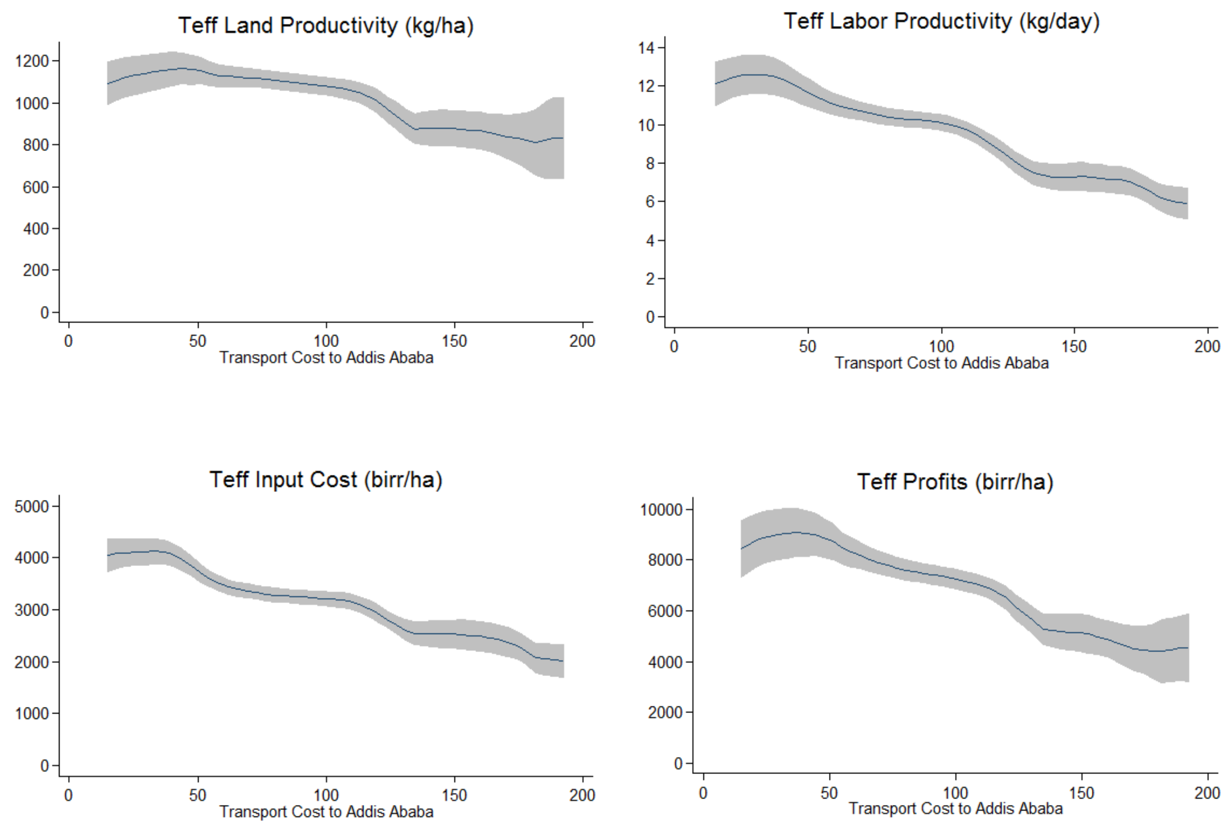
Notes: See Figure 2.

Figure 4 Correlation of transportation cost with input ratios and factor monetization



Notes: See Figure 2.

Figure 5: Correlation of transportation cost with intensification outcomes



Notes: See Figure 2.

Table 1: Basic descriptive statistics and comparison with non-teff producers

Descriptive variable	Unit	Surveyed farmers (n=1,200)	LSMS teff farmers (n=441)	LSMS non-teff farmers (n=1,748)	Probit coefficient
Age of head	years	45.41	46.62	46.16	-0.02**
Gender of head	male=1	0.95	0.93	0.78	0.52
Educated head	yes=1	0.54	0.31**	0.21	-0.15
Household size	number	6.33	5.78*	5.04	-0.02
Orthodox religion	yes=1	0.87	0.86	0.93	0.38
Head is married	yes=1	0.94	0.92	0.76	-0.38
Land owned	ha	2.00	1.66	1.48	0.11
Altitude	log meter	7.65	7.67	7.66	0.96*
Farm income	log ETB	6.5	8.06	7.57	-0.04
Livestock income	log ETB	7.42	7.38	7.23	-0.05
Herbicide use	yes=1	0.65	0.64	0.43	0.34
Pesticide use	yes=1	0.13	0.11	0.26	0.02
Own Mobile phone	yes=1	0.30	0.30	0.22	-0.02
Own TV	yes=1	0.03	0.04	0.02	1.54*
Received loan	yes=1	0.39	0.44	0.46	0.18
Constant					-7.54*

*Notes: The asterisks in column 4 report the results of a (village level clustered) t-test with null hypothesis that the difference in mean values between surveyed and LSMS teff farmers is zero (n=1,641). 'Probit coefficient' in column 5 report the coefficients from a Probit estimation of the probability to be active in teff production (n=2,189). *** p<0.01, ** p<0.05, * p<0.1.*

Table 2: Sample means of outcome variables

Variable	Unit	Mean	Median	SD
	Prices			
Price of teff	ETB per quintal	1,047	1,043	117
Wage rates	ETB per day	37	37	12
Land rental rate	ETB per ha	4,702	4,716	127
Price of DAP	ETB per quintal	1,390	1,411	131
Price of Urea	ETB per quintal	1,133	1,162	110
	Agricultural inputs and indices			
Use of DAP	kg per ha	91	82	75
Use of Urea	kg per ha	64	50	67
Use of Improved Seeds	kg per ha	12	0	20
Use of Agrochemicals	ETB per ha	54	40	63
Use of for Labor	day per ha	126	108	75
Ratio Agrochemicals over Labor	.	0.57	0.39	0.74
Ratio Plough index over Labor	.	0.03	0.02	0.03
Ratio Fertilizer over Land	.	445	240	667
Ratio Purchased seed over Land	.	28	0	66
Share of Purchased seeds in total	%	16	0	33
Share of hired labor in total	%	11	1	18
Share of rented land in total	%	11	0	25
	Intensification outcomes			
Teff Land Productivity	kg per ha	1,071	978	600
Teff Labor Productivity	kg per day	10	9	6
Teff Input Cost	ETB per ha	3,277	2,879	1,859
Teff non-labor Input Cost	ETB per ha	2,514	2,243	1,560
Teff Profits	ETB per ha	7,384	6,228	5,880

Number of observations in each model is 1,200. 'SD' is the standard deviation.

Table 4: Estimation results of prices

Prices	log of teff prices (ETB/quintal)	log of wage (ETB/day)	log of land rent (ETB/ha)	log of DAP price (ETB/quintal)	log of urea price (ETB/quintal)
REDUCED FORM MODEL					
Transportation Cost (ETB/quintal)	-0.86***	-3.06***	-0.18***	-0.02	-0.01
	(0.22)	(0.89)	(0.03)	(0.26)	(0.30)
Constant	7,021.88***	3,839.17***	8,471.07***	7,233.32***	7,028.78***
	(18.49)	(86.08)	(2.89)	(23.77)	(26.88)
R-squared	0.066	0.106	0.050	0.000	0.000
LESS PARSIMONIOUS MODEL					
Transportation Cost (ETB/quintal)	-0.55***	-2.48**	-0.13***	0.31	0.46
	(0.20)	(1.14)	(0.04)	(0.29)	(0.35)
Farm Size at village level (ha)	2.55	52.54	1.78	39.41***	40.43***
	(7.95)	(47.64)	(1.52)	(14.36)	(14.93)
Distance to asphalt road (minutes)	-0.04	0.16	0.00	0.13***	0.10***
	(0.03)	(0.15)	(0.01)	(0.04)	(0.04)
Constant	6,875.39***	3,955.94***	8,480.41***	7,144.66***	6,936.68***
	(65.38)	(401.56)	(10.94)	(113.26)	(99.33)
R-squared	0.126	0.161	0.282	0.202	0.180

*Notes: Number of observations in each model is 1,200. Standard errors are reported in parentheses below the coefficient: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. The coefficients are multiplied by 1,000 to ease presentation.*

Table 5: Estimation results of agricultural input use

Teff outcome	DAP (kg/ha)	Urea (kg/ha)	Improved Seed (kg/ha)	Agrochemicals (ETB/ha)	Labor (person-days/ha)
REDUCED FORM MODEL					
Transportation Cost (ETB/quintal)	-0.47***	-0.37***	-0.19***	-0.06	0.23**
	(0.13)	(0.08)	(0.04)	(0.14)	(0.09)
Constant	132.27***	96.32***	28.19***	58.74***	106.01***
	(13.70)	(10.33)	(4.20)	(12.80)	(9.09)
R-squared	0.045	0.036	0.106	0.001	0.011
LESS PARSIMONIOUS MODEL					
Transportation Cost (ETB/quintal)					
Direct effect	-0.21	-0.35***	-0.10***	0.04	-0.20*
	(0.13)	(0.12)	(0.04)	(0.14)	(0.12)
Indirect effect	-0.11**	-0.13**	-0.02	0.04	0.01
	(0.06)	(0.05)	(0.01)	(0.04)	(0.03)
Total effect	-0.32**	-0.47***	-0.12***	0.08	-0.18*
	(0.14)	(0.13)	(0.03)	(0.12)	(0.11)
Farm Size at village level (ha)	10.93	-2.15	3.02*	-6.14	-8.83**
	(7.28)	(4.47)	(1.68)	(4.59)	(4.08)
Distance to asphalt road (minutes)	-0.06***	0.01	-0.01**	-0.02	0.02
	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Constant	-653.83	-1,886.64*	-331.21	-415.01	1,195.41
	(1,166.76)	(1,088.00)	(239.87)	(926.91)	(917.03)
R-squared	0.167	0.291	0.210	0.167	0.169

*Notes: Number of observations in each model is 1,200. Standard errors are calculated using bootstrap estimation and are clustered at village level. Standard errors are reported in parentheses below the coefficient: *** p<0.01, ** p<0.05, * p<0.1.*

Table 6: Estimation results of input ratios and monetization of factor markets

Teff outcome	Ratio Agrochemicals over Labor	Ratio plough index over Labor	Ratio fertilizer over Land	Ratio purchased seed over Land
REDUCED FORM MODEL				
Transportation Cost (ETB/quintal)	-1.46	-0.05**	-1.31*	-0.39***
	(1.33)	(0.03)	(0.77)	(0.10)
Constant	699.94***	34.27***	558.15***	61.26***
	(134.60)	(2.46)	(80.92)	(11.46)
R-squared	0.004	0.003	0.004	0.039
LESS PARSIMONIOUS MODEL				
Transportation Cost (ETB/quintal)				
Direct effect	0.80	0.03	-2.30**	-0.32***
	(1.29)	(0.03)	(1.02)	(0.12)
Indirect effect	0.74	0.00	-0.73*	-0.04
	(0.51)	(0.01)	(0.38)	(0.04)
Total effect	1.55	0.03	-3.00***	-0.37***
	(1.22)	(0.03)	(1.01)	(0.11)
Farm Size at village level (ha)	-19.92	2.71	2.53	3.41
	(51.64)	(1.89)	(45.17)	(5.61)
Distance to asphalt road (minutes)	-0.32**	0.01*	-0.02	-0.03
	(0.14)	(0.01)	(0.17)	(0.02)
Constant	-1,638.09	228.39	438.77	-1,156.07*
	(9,543.94)	(360.69)	(9,494.65)	(697.91)
R-squared	0.224	0.089	0.164	0.103

*Notes: Number of observations in each model is 1,200. Standard errors are calculated using bootstrap estimation and are clustered at village level. Standard errors are reported in parentheses below the coefficient: *** p<0.01, ** p<0.05, * p<0.1. The coefficients in column 2 and 3 are multiplied by 1,000 to ease presentation.*

Table 7: Estimation results of intensification outcomes

Teff outcome	Yield (kg/ha)	Labor Productivity (kg/day)	Input Costs (ETB/ha)	Teff Profits (ETB/ha)
REDUCED FORM MODEL				
Transportation Cost (ETB/quintal)	-2.30*	-0.04***	-13.51***	-33.41**
	(1.30)	(0.01)	(3.14)	(14.19)
Constant	1,270.57***	14.05***	4,450.10***	10,284.90***
	(132.71)	(1.21)	(337.21)	(1,476.53)
R-squared	0.017	0.060	0.061	0.037
LESS PARSIMONIOUS MODEL				
Transportation Cost (ETB/quintal)				
Direct effect	-2.07*	-0.01	-8.12**	-26.41**
	(1.23)	(0.01)	(3.22)	(12.95)
Indirect effect	-1.57***	-0.01***	-4.53**	-11.85**
	(0.55)	(0.00)	(1.78)	(5.20)
Total effect	-3.65***	-0.03**	-12.63***	-38.43***
	(1.36)	(0.01)	(3.59)	(13.90)
Farm Size at village level (ha)	-32.89	0.27	128.06	191.81
	(53.28)	(0.50)	(138.36)	(531.68)
Market access	0.17	-0.00	-0.72*	2.13
	(0.16)	(0.00)	(0.42)	(1.77)
Constant	-36,885.13***	-348.29***	-31,673.99	-330,800.21***
	(5,902.61)	(61.75)	(24,580.35)	(68,549.27)
R-squared	0.209	0.190	0.217	0.171

*Notes: Number of observations in each model is 1,200. Standard errors are calculated using bootstrap estimation and are clustered at village level. Standard errors are reported in parentheses below the coefficient: *** p<0.01, ** p<0.05, * p<0.1.*

[1] The link between urban demand and specialization in agriculture stems back from the seminal work of Von Thünen (1826). Because of lower transportation costs, farmers living close to markets receive higher effective

market prices for their products, which increases the rented land value. Rural areas close to markets will therefore specialize in high value commodities; and market expansion will result in the development of different spheres of land uses and specialization of different agricultural products.

[2] Urban proximity has been shown to determine the specialization and organization of economic activities in rural areas (Fafchamps and Shilpi 2003, 2005, Deichmann et al. 2009). Rural resident close to urban centers and markets are more likely to be employed in non-farm wage and self-employment jobs, while more remotely located residents specialize in agricultural production.

[3] This sampling procedure was specifically designed to select a representative sample of commercial farmers but we cannot control for the selection effect in becoming a teff farmer. In the working paper version we use LSMS data to show that teff and non-teff producing farmer are similar in observable characteristics.

[4] ETB = Ethiopian Birr, 1 USD = ETB 18 on January 1, 2013

[5] However, the results for land prices should be interpreted carefully as land markets in Ethiopia are thin and underdeveloped, making land prices potentially an unreliable measure of factor scarcity.

[6] The majority of farmers performed more than one teff transaction, implying that we have a transaction panel for each household. On the contrary, land rental rates could only be calculated for those households that rented in or sharecropped teff land. However, the panel price formation models allow to impute the missing values of land rates using regression based imputation. The value of sharecropping was calculated as the value of the share of output on the plot that had to be paid to the land owner and used as land rental rate if the parcel was sharecropped.

[7] Following Headey et al. (2014) we construct an index on ownership of six plow components using Principal Component Analysis.

[8] We also perform several sensitivity analysis where we control of unobserved household effects, opportunity costs, non-linearities and other output markets. The results are robust to the different specifications. Results are available in the working paper version.

[9]The working paper can be downloaded at: http://feb.kuleuven.be/drc/licos/publications/dp/DP%20374%20compl.pdf

[10] For the same reason, the price of agrochemicals is assumed to be fixed but we have no data to test this empirical.

[11] In the working paper version, we also look at different welfare indicators. The results show that wage income, non-farm income, total crop income and household income per capita decrease over transportation costs.