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Non-farm income and labor markets in rural Ethiopia

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ABSTRACT

Ethiopia's economy is rapidly transforming. However, the extent to which this is affecting off-farm income and labor markets in rural areas is not well understood. Based on a large-scale household survey in high potential agricultural areas, we find that total off-farm income (defined as wage and enterprise income) makes up 18 percent of total rural income. Wage income in both the agricultural and non-agricultural sectors accounts for 10 percent of total household income, equating in importance to livestock income. We show off-farm income and wage income to be relatively more important for the poor and female and youth-headed households. We further find that real rural wages increased by 54 percent over the last decade, mostly driven by high agricultural growth. While this wage increase is good news for the poor, it also induces adjustments in agricultural production practices, including increased adoption of labor-substituting technologies such as herbicides and mechanization. However, it also relaxes liquidity constraints in the off-season for some households, consequently leading to higher productivity.

I. INTRODUCTION

Stimulating the off-farm economy in rural areas of developing economies is considered an important step towards structural transformation of such economies. In particular, the development of well-functioning rural labor markets is increasingly seen as crucial for economic growth and for the creation of livelihood opportunities for young people, e.g., Fox et al. 2013. It is therefore important to understand how the off-farm sector and labor markets operate and to what extent their transforming influence is being felt. Moreover, rural wage increases are strongly linked with poverty reduction, since the majority of the population who are poor reside in rural areas and regularly depend on such wages for their livelihood (Ravallion 2000; Lanjouw and Lanjouw 2001).

We examine this issue in Ethiopia where the economy is changing fast. Having started from a low base, the Ethiopian economy still remains dominated by the agricultural sector, and the majority of the population still makes a living in this sector. While rapid transformation has occurred in different sectors (Bachewe et al. 2015; World Bank 2015), the implications of these changes on the off-farm economy is unclear. It has been shown in other settings that changes in off-farm income increasingly become important in rural areas as economies transform (Haggblade et al. 2007).

This study provides new insights on the off-farm sector and labor markets in rural Ethiopia using recent large-scale datasets. While researchers have explored this issue in the past, the studies were based on relatively small surveys or the data was outdated (Holden et al. 2004; Dercon and Krishnan 1996; Block and Webb 2001). In particular, this study addresses the following four research questions: First, what is the importance of the off-farm sector in rural Ethiopia and within the off-farm sector in particular, how important are labor markets? Second, what are the factors associated with rural income diversification? Third, are rural wages changing over time? Fourth, what are the drivers and the implications of these changes?

We find that off-farm income makes up 18 percent of total rural household income in high potential agricultural areas of the country. Total wage income and agricultural wage income account for 10 percent and 7 percent, respectively, of total household income. In these rural areas, wage income is as important as livestock income, the latter accounting for 10.7 percent of household income. Hired labor is especially prevalent during specific periods of activity in the year, i.e. during plowing, weeding and harvesting. We further find that off-farm income is more important in these high potential agricultural areas than in other rural areas, and that rural wages, driven by agricultural growth, are on the rise. These developments have important implications on poverty and on agricultural production practices. In particular, they affect incentives for the adoption of labor-saving technologies, such as herbicides and mechanization, as well as improve access to income in the lean period of the year when household food stocks may be depleted, possibly leading to improved agricultural productivity in the main season.

The paper is organized as follows. In the next section, we briefly describe the datasets used. Sections 3 to 6 deal with the four research questions posed. We analyze rural off-farm income in Section 3. In Section 4, we look specifically at agricultural hired labor use and agricultural wages and their associated factors. In Section 5, we study trends in rural wages between 2001 and 2014 in Ethiopia. The results of our analyses on the drivers of change of real rural wages as well as the implications of these changes also are discussed in Section 5. We conclude in Section 6.

2. DATA

For the descriptive and econometric analyses in this work, we mainly use two data sources, complemented by a number of other datasets. First, we use price data collected by the Central Statistical Agency of Ethiopia (hereafter CSA) (CSA 2015a). CSA has been collecting monthly retail price data and data on prevailing wages since 1996 from about 120 markets, which were sampled to represent almost all administrative zones of the country.[1] From this dataset, we use nominal wages of casual laborers and prices of a number of consumer food and non-food items. We compute real wages using the Regional General Price Index data from CSA (CSA 2015b), as well as using a Poor-Persons' General Prices index that we created. The latter index is constructed using retail prices for 26 food and non-food items coupled with data from CSA's Household, Income, Consumption, and Expenditure Survey (HICES) dataset of 2004/05 (CSA 2007), which provides information on the expenditure shares of the 26 items (Headey et al 2012). We define the poor as the bottom two quintiles of households based on their aggregate expenditure.

Second, we analyze data collected through the Agricultural Growth Program of Ethiopia (hereafter AGP) baseline survey. This dataset was collected in four regions of the country: Tigray, Amhara, Oromiya, and Southern Nations, Nationalities, and Peoples (SNNP). The survey was conducted in May 2011 and covered close to 8,000 households, who were sampled to represent over 9 million households in 93 woredas or districts (Berhane et al. 2013). Information on agricultural production in the AGP baseline survey dataset pertains to the 2010/11 main agricultural season.

The AGP baseline survey dataset is complemented with data from several other sources, including IFPRI's Ethiopia Strategy Support Program (ESSP) Teff Producers dataset; the ESSP Coffee Producers dataset; the Feed the Future (FtF) midline impact evaluation survey; and from the Ethiopian Rural Socioeconomic Survey (ERSS). The Teff Producer dataset was collected in 2012 from 1,200 households in five major commercial teff producing administrative zones of Amhara and Oromiya regions. The Coffee Producer dataset, which includes about 1,600 households in five major coffee producing areas of Oromiya and SNNP, was collected in 2014. The FtF impact evaluation dataset, collected in 2015, and the ERSS dataset, collected in 2014, are two large-scale datasets that are used in the following section to provide additional insight into the importance of off-farm income in rural areas.[2] We also use the World Development Indicators data (World Bank 2014) on real national GDP and on value-added in the agriculture, manufacturing, and services sectors in our analyses of the drivers of rural wages.[3] Similarly, we use Zonal Poverty Head Count Index data obtained from Hill and Tsehaye (2014) in our investigation of the welfare implications of real wages.

In all of the surveys considered, data were gathered at the household level through comprehensive survey instruments on crop production and sales for a complete agricultural year, which includes two cropping seasons (*meher* and *belg*); on livestock production and sales; on agricultural and non-agricultural wage income; and on enterprise income for the 12 months preceding the survey period. While in some of the surveys, information on rental income and income transfers was collected, these data were not used, as these types of income constitute a relatively small share of total income and were not collected in all surveys. Therefore, for the purpose of this study, *total household income* is defined as the sum of net crop, livestock, and enterprise income, plus total wages earned from agricultural and non-agricultural labor.

Crop income is computed as the total value of crop output less the variable costs of production. Variable costs include money spent to purchase inputs such as fertilizer and improved seeds; to rent farm machinery or draft animals; to hire farm workers, or other crop production-related costs. Similarly, *livestock income* is computed as the value of livestock sold or slaughtered and the value of livestock products, such as milk, honey, butter, and other products, less the variable costs of livestock production. Livestock production variable costs include wages paid to hire herding labor and costs incurred for veterinary and other related services. In each of the surveys, price data collected at the community level are used to compute the value of crop and livestock production. *Net enterprise income* is computed as the difference between gross enterprise income for a business and total costs incurred for purposes of running the business. It is to be noted that the definition of income for our purposes is different than monetary income, and in particular, incomes from crop and livestock production include both the value of home-consumed products and the value of sold quantities.

[1] CSA datasets leave out three of the five zones of Afar and six of the nine zones in Somali regions.

[2] These surveys were designed to be representative of the Zone of Influence of FTF interventions in the country and of rural areas nationally, respectively.

[3] For exact definitions, see World Bank (2014).

3. OFF-FARM INCOME IN RURAL AREAS

In this section we investigate the importance of off-farm income in rural areas using different data sources. The contribution of these income sources is described in both an international context and across regions in Ethiopia for different categories of households. We also present the results of our analyses of factors that are associated with participation in different income generation activities.

3.1. Off-farm income in Ethiopia

Table 3.1 summarizes the data from the AGP baseline survey on the proportion of households with members employed in off-farm (agricultural and non-agricultural wage labor and enterprise) activities, and those engaged in crop and livestock production. The table also summarizes the contribution of each source to total household income.[4]

Table 3.1: Importance of off-farm income in rural areas, estimates from the AGP dataset

Income source	All regions	Tigray	Amhara	Oromiya	SNNP
Contribution of source to total income (%)					
Crop	71.4	59.8	69.6	72.2	73.3
Livestock	10.7	13.7	13.6	10.1	8.3
Agricultural wage income	6.6	7.8	9.1	5.9	5.1
Non-agricultural wage income	3.1	9.4	2.4	3.5	2.5
Enterprise income	8.1	9.3	5.3	8.3	10.9
Households earning some income by type (%)					
Crop income	94.1	87.1	93.6	94.2	95.5
Livestock income	60.2	63.1	74.4	57.5	48.9
Agricultural wage income	21.4	16.3	29.0	20.2	15.9
Non-agricultural wage income	8.1	21.5	6.9	8.6	7.0
Enterprise income	25.4	20.2	18.0	28.8	28.1

Source: Authors' computation using the Agricultural Growth Program of Ethiopia baseline survey data (2011).

Several interesting findings are seen. First, the share of off-farm income is relatively low compared to shares observed in other settings (Reardon et al. 2007), and off-farm income is significantly related to the agricultural sector. Crop income makes up 71 percent of total household income. Wage income makes up 10 percent of total household income, which is about the same share that households derive from livestock and livestock products. Enterprise income accounts for 8 percent of household income. If we divide incomes between agricultural and non-agricultural sources, however, we note that only 11 percent of total household income is not related to the agricultural sector – non-agricultural wage income accounts for only 3 percent of total household income.

Second, when we examine the share of households that obtain some income from each income category, the number of households engaged in crop or livestock production is high, 94 percent and 60 percent, respectively. About 21 percent of the rural households earned income from agricultural wage labor and 25 percent and 8 percent of the households were engaged in business enterprises and non-agricultural wage labor, respectively.

Third, we see relatively little variation over the different regions. Crop income is relatively more important in Oromiya and SNNP regions, at 72 and 73 percent, respectively, compared to Tigray (60 percent) and Amhara (70 percent). Rural households in Tigray are somewhat more diversified with respect to income sources. Agricultural wage income as a share of total income is highest in the Amhara region (9 percent), possibly linked to seasonal migration to cash-crop producing areas – such as sesame.

To see how the results on income sources from the AGP survey compares to other recent large-scale datasets in the country, we examine information on income sources for rural households in the FtF and ERSS datasets (Table 3.2). Overall, we note the same orders of magnitude by income source: crop income makes up 80 percent and 71 percent of total household income in the FtF and ERSS dataset, respectively. However, in both cases, livestock income is evaluated to be

[4] In this study we focus on agricultural wage labor, which we view as distinct from other rural wage labor and business activities, thereby eliminating discrepancies that may arise due to differences in definitions of rural and agricultural.

more important than was observed in the AGP dataset, accounting for 11 percent and 20 percent of total income in the FtF and ERSS datasets, respectively. Off-farm income accounts for 7 percent and 9 percent, respectively, which is significantly smaller than in the AGP dataset (18 percent). Overall, these results confirm that the off-farm economy is small in rural Ethiopia.

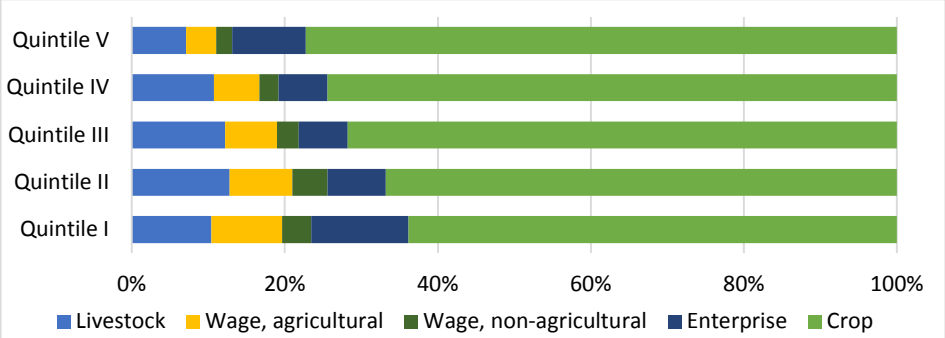
Table 3.2: Importance of off-farm income in rural areas, alternative estimates from FtF and ERSS datasets

Contribution of source to total income (%)	Four [AGP] regions	Five regions (including Somali)	Tigray	Amhara	Oromiya	SNNP	Somali
Feed to Future (FtF) data set							
Crop	82.0	80.4	74.6	82.1	82.1	84.4	28.3
Livestock	11.3	12.7	19.1	12.0	11.3	7.2	61.2
Agricultural wage	1.5	1.5	1.3	1.7	1.7	1.0	0.8
Non-agricultural wage	1.6	1.6	1.5	1.5	1.8	1.4	3.7
Enterprise	3.7	3.8	3.6	2.7	3.2	5.9	6.0
	Four [AGP] regions	**All of Ethiopia, excluding Addis**	**Tigray (6.1%)**	**Amhara (27.8%)**	**Oromiya (38.3%)**	**SNNP (21.7%)**	**All other regions (6%)**
Ethiopian Rural Socioeconomic Survey (ERSS) data set							
Crop	71.3	69.0	65.0	69.7	71.7	74.4	31.6
Livestock	19.6	21.1	22.2	20.9	19.4	17.3	45.9
Casual labor	2.0	2.0	3.3	1.9	1.8	2.1	2.5
Salaried workers	3.6	4.1	5.6	3.4	4.1	2.5	11.2
Enterprise	3.5	3.8	4.0	4.0	2.9	3.8	8.8

Source: Authors' computation using the Feed to Future (FtF) and the Ethiopian Rural Socioeconomic Survey (ERSS) data sets.

We further explore how different factors are associated with different shares of off-farm income. To do so, we look at simple graphs and then rely on regression analysis. First, we look at how the share of income sources varies by income level. To do so, we divide all households into five income quintiles and calculate shares of total income by income source for each (Figure 3.1).

Figure 3.1: Contribution of different income sources to overall income, by income quintile



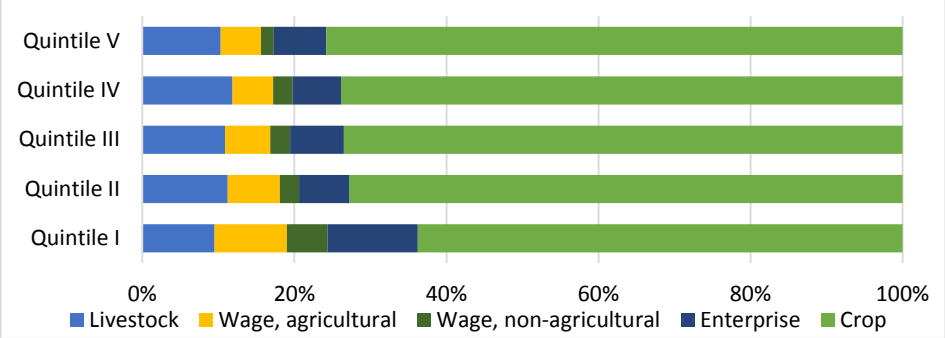
Source: Authors' computation using the AGP baseline survey data (2011).

Income from crop production is the lowest (at 64 percent) for households in the poorest income quintile (Quintile I in Figure 3.1) and the contribution of crop income increases with total income. On the other hand, the contribution of livestock and non-agricultural wage income is higher in the bottom two income quintiles and declines with increases in total income. Agricultural wage income also contributes the highest in the lowest income quintile, with its contribution declining with increases in total income. Finally, enterprise income is more important in the lowest and highest income quintiles, constituting a lower share of total income in the middle income quintiles. The higher contribution of enterprise income in the lowest income quintile may appear to contradict the assumption that establishing businesses require considerable initial investments. However, the businesses in which households within the highest and lowest income quintiles are engaged, partly explains the apparent contradiction. For instance, brewing and selling local liquor and ale, which require relatively

lower initial investments, are the two most important business activities in the lowest income quintile, while trading activities in grain and livestock are important for households in the highest income quintile. Overall, the off-farm sector is more important for the poor than for the rich, suggesting that 'push' factors might still be relatively more important in rural areas for engagement by households in the rural off-farm income sector than are 'pull' factors (Reardon et al 2006; USAID 2011).

Second, we also consider the contribution of income sources across land endowments as an alternative measure of wealth. Similar to the previous exercise, we look at the share of income sources for five quintiles of land ownership, ranked from poor to rich. Figure 3.2 shows that the contribution of crop and livestock income significantly increases with land endowment. The contribution of the three off-farm income sources (agricultural wage, non-agricultural wage, and enterprise income) generally declines with land size. In particular, the contribution of each of the three income sources is nearly twice or higher for households in the lowest land quintile (Quintile I) relative to those in the highest quintile.

Figure 3.2: Contribution of different income sources to overall income, by land endowment quintile



Source: Authors' computation using the AGP baseline survey data (2011).

Third, we look at female and youth headed households.[5] Table 3.3 shows the contribution of different sources of income to the overall income for male-youth, female-youth, male-mature, and female-mature headed households. Off-farm income sources are relatively more important for youth-headed households. Off-farm income makes up 21 percent and 23 percent of total income for male-youth and female-youth headed households, respectively. This compares to 15 percent and 17 percent of male-mature and female-mature headed households, respectively.[6] The younger households might have to rely more on these off-farm sources of income as they often own less land than the more established households (Headey et al. 2014). The enterprise income and agricultural wage labor income especially are relatively important sources of off-farm income for youth-headed households. Notably, the female-headed households overall rely more on off-from income than do male-headed households.

Table 3.3: Importance of wage income in rural areas, by gender and age of household heads

Income source	All HHs	Male-youth	Male-mature	Female-youth	Female-mature
Contribution of source to total income (%)					
Crop	71.4	68.0	74.3	65.0	72.9
Livestock	10.7	10.7	11.0	12.2	9.7
Agricultural wage income	6.6	7.4	5.4	9.9	6.9
Non-agricultural wage income	3.1	3.5	2.8	3.2	3.1
Enterprise income	8.1	10.4	6.6	9.7	7.3
Households earning some income by type (%)					
Crop income	94.1	93.6	96.0	88.6	93.2
Livestock income	60.2	61.2	62.6	60.6	54.2
Agricultural wage income	21.4	24.1	20.3	21.5	19.7
Non-agricultural wage income	8.1	9.5	8.1	6.7	6.7
Enterprise income	25.4	32.0	21.7	27.7	22.2

Source: Authors' computation using the AGP baseline survey data (2011).

[5] As these households were an explicit target of the AGP, they were oversampled in order to detect impact of the program on these particular households.

[6] "Young" was defined as below 35 years of age.

Fourth, Table 3.4 indicates the different types of enterprises that rural households are involved in. We see significant differences by income quintile. Selling homemade local liquor, producing handicrafts, trade in grains or other crop outputs, selling local ale, and selling prepared food items are important for households in the lowest income quintile in the order given. On the other hand, a higher proportion of households in the highest income quintile are engaged in selling grains or other crop outputs, livestock and livestock products, local liquor, retail non-agricultural items, and handicrafts. Several of the activities that a larger proportion of households in the highest income quintile are engaged in, such as trade in grains and livestock and livestock products, require substantial investment, while the production and sales of local liquor, handicrafts, and food items, enterprises in which poorer households are engaged, require a relatively lower investment.

Table 3.4: Percent of households engaged in different business enterprises, by income quintile.

Business activity	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	All
Weaving/spinning	5.6	9.0	1.8	0.5	1.6	3.2
Milling	0.1	1.2	0.1	0.2	3.3	1.2
Handicrafts	16.5	16.2	17.2	14.2	6.6	13.5
Trade in grains and other crop items	13.3	12.2	11.9	17.1	22.3	16.0
Trade in livestock and livestock products	6.4	3.7	10.3	13.1	15.8	10.8
Trade in non-agricultural merchandise	4.6	9.4	9.2	10.1	12.4	9.8
Transport (by pack animal)	0.0	0.1	0.2	0.2	2.6	0.8
Tella (local ale)	11.8	4.6	4.4	4.1	4.5	5.1
Araqi (local liquor)	19.7	18.3	22.0	21.3	15.1	19.1
Prepared food (bread/*enjera*)	6.8	2.5	4.9	0.9	2.8	3.2
Other businesses	15.2	22.8	17.8	18.3	13.0	17.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors' computation using the AGP baseline survey data (2011).

Finally, we look at the factors associated with involvement in off-farm income using a regression framework. Using Escobal's (2001) methodology, we run Tobit models that show the factors associated with the share of diversification (defined as the share of income from sources other than crop agriculture and livestock production). In particular, we look at agricultural and non-agricultural wage income and enterprise income. We also conduct the analysis using as the dependent variable an aggregate measure of income diversification that accounts for both the number and share of income sources: the Herfindahl diversification index (HDI), which is defined as: $HDI_i = 1 - HI_i = 1 - \sum_j^n \left(\frac{Y_{ij}}{\sum_{j=1}^K Y_{ij}}\right)^2$ in which the term in parentheses is the contribution of income from source j (Y_{ij}) to total income ($\sum_{j=1}^K Y_{ij}$).

First, the results provided in Table 3.5 show a strong association between income sources and the age and the education of the head of household. Crop and livestock income are positively associated with the age of the household head, while agricultural wage and enterprise income are negatively related to age. Diversification (HDI) is negatively associated with the age of the household head. This suggests that households with younger heads are more likely to rely on off-farm income sources to assure their livelihoods. Diversification is also positively related to the education of the household head and to the number of members in the household. Enterprise and non-agricultural wage income, which require more skills than agricultural labor, are positively associated with the heads' education, while the latter is negatively associated with self-employed and hired agricultural labor income.

Second, there is a strong gender component to off-farm income. The proportion of females among total household members of working age (16-65 years) is negatively associated with both categories of hired labor. This could be because female members of households in rural areas spend more time on household chores and have limited time to engage in hired labor. This is in addition to the fact that females, particularly younger girls, are generally discouraged from working as hired labor because in many communities it is socially unacceptable for these young girls to work outside of the household. We find that the number of females engaged in hired labor is about half (56 percent) the number of males.

Table 3.5: Factors associated with the contribution of farming, business enterprise, and wage employment to total income

Variables	Self-employment, agriculture (crop + livestock)		Self-employment, non-agriculture (enterprise)		Wage employment, agriculture		Wage employment, non-agriculture		Herfindahl diversification index	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Household variables										
Gender of household head (=1 if male)	0.932	2.355	-3.439	3.316	1.914	3.020	2.434	5.000	0.028*	0.015
Age of household head (years)	0.407***	0.056	-0.543***	0.081	-0.378***	0.073	-0.110	0.118	-0.003***	0.000
Education of head	-3.002***	0.747	5.742***	1.023	-2.283**	0.988	5.276***	1.505	0.018***	0.005
Household size	-0.335	0.413	0.122	0.575	0.435	0.538	2.113**	0.883	0.011***	0.003
Proportion of females in working age	5.370	4.454	10.295	6.268	-16.570***	5.752	-17.640*	9.445	-0.030	0.029
Farm characteristics										
Purchased at least one input on credit	-0.239	2.110	0.268	2.958	-3.561	2.807	7.820*	4.122	0.026*	0.014
Total cultivated area (hectares)	4.149***	0.985	-0.426	1.345	-2.741**	1.324	-7.684***	2.081	-0.011	0.006
Total cultivated area-squared	-0.239***	0.088	0.102	0.116	0.066	0.127	0.481***	0.163	0.000	0.001
Land quality index	1.138***	0.382	-1.400***	0.529	-0.500	0.498	-0.255	0.784	-0.006**	0.002
Tropical livestock units	2.161***	0.240	-1.370***	0.326	-1.951***	0.343	-5.416***	0.703	-0.012***	0.002
Location										
Travel time to nearest 50K town (minutes)	0.032***	0.006	-0.018**	0.008	-0.006	0.007	-0.087***	0.013	-0.000***	0.000
Distance from Addis Ababa (00 km)	1.524*	0.885	-5.482***	1.275	2.996***	1.116	-6.132***	2.020	-0.014**	0.006
Total district population[a]	0.024*	0.014	-0.048**	0.019	-0.003	0.018	0.046	0.030	-0.000	0.000
Zonal poverty head-count index[b]	-0.144**	0.066	0.565***	0.094	-0.283***	0.085	0.016	0.155	0.001*	0.000
Amhara	18.840***	3.360	-24.408***	4.951	21.050***	4.307	-73.010***	7.550	-0.093***	0.022
Oromiya	17.810***	3.652	-8.727*	5.157	14.460***	4.753	-68.950***	8.075	-0.090***	0.024
SNNP	15.050***	2.973	1.749	4.243	3.295	3.875	-72.620***	6.757	-0.086***	0.019
Constant	50.950***	7.449	-13.316	10.475	-20.860**	9.685	-1.588	15.654	0.195***	0.049
chi2	389		314		154		464		318	
Number of observations	7,178		7,178		7,178		7,178		7,178	

Source: Authors' analysis using the AGP baseline survey data (2011) except those with superscripts a and b, which are from CSA (2014) and Hill and Tsehaye (2014).
Coefficients with superscripts ***, **, and * are significant at 1%, 5%, and 10% levels, respectively.

Third, a greater quantity and better quality of agricultural assets lead to less diversification. As implied in the discussion above, total household land area is positively associated with agricultural income and negatively with agricultural and non-agricultural wage income. Higher land quality, computed from self-reported soil fertility and slope measures by the respondent, is positively associated with agricultural income and generally negatively associated with diversification. The number of tropical livestock units (livestock measured in terms of number and type of cattle) is positively associated with agricultural income, while it is negatively related to the remaining income sources (wage and enterprise income) as well as to diversification.

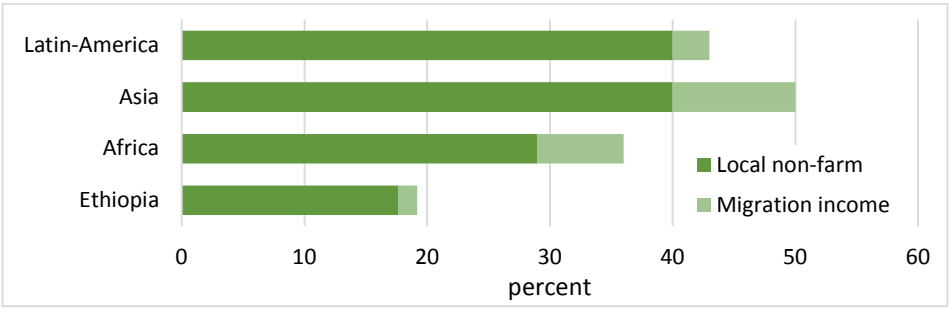
Fourth, as noted in other settings and countries, the distance to cities is often an important factor associated with income diversification in rural areas (Deichmann et al. 2009; Fafchamps et al. 2005, 2003; Jacoby and Minten 2007). This emerges from our data analyses as well. Diversification and enterprise income decline with distance from both Addis Ababa, the capital, and the nearest urban center of 50,000 or more inhabitants, while agricultural income increases with distance from urban centers. Agricultural and non-agricultural wage employment are positively and negatively associated with distance from Addis Ababa. The size of the coefficients indicates that households located 100 kms from Addis have 11 percent less income from the non-agricultural sector (5 percent less from self-employment and 6 percent less from wages as indicated by the coefficients in Table 3.4) than households living close to Addis.

Finally, the Zonal Level Poverty Head Count index is also positively related to diversification overall, suggesting again that push factors are important for household income diversification in rural Ethiopia.

3.2. Off-farm income in Ethiopia in an international context

Comparing off-farm income patterns for rural households in Ethiopia with those in other countries provides a broader perspective. First, we compare the importance of the rural off-farm sector with other countries. Reardon et al. (2007), working in a large number of developing countries, find that off-farm income made up 36 percent of total income in Africa, 50 percent in Asia, and 43 percent in Latin America (Figure 3.3). They further show that most off-farm income comes from local off-farm sources and less from wage income obtained through migration. In the case of Ethiopia, we find that the off-farm sector accounts for 18 percent of total rural household income. This share currently is significantly smaller than the African average. As shown in Figure 3.3 in more developed continents, the share of this off-farm sector is expected to increase with anticipated growth in Ethiopia's economy.

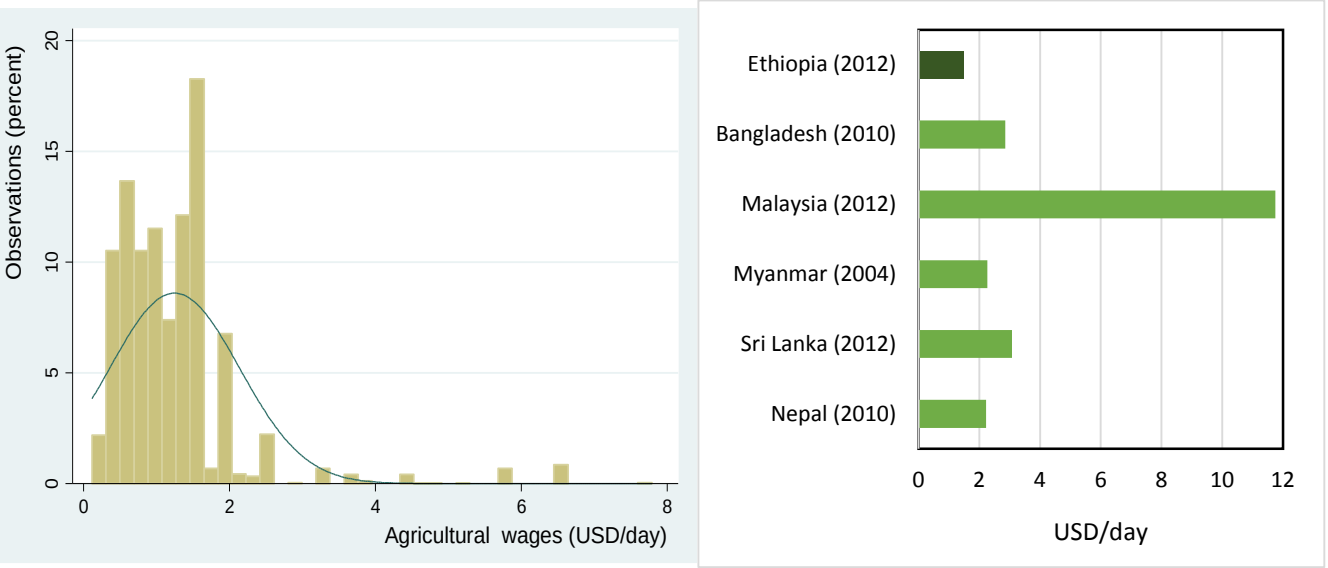
Figure 3.3: Off-farm income as share of total income in rural areas, from local sources and from migration income



Source: Reardon et al. 2007 and for Ethiopia the migration income (transfer) and local non-farm numbers for are from ERSS and AGP baseline survey datasets, respectively.

Second, we look at wage levels using the AGP data. The distribution of agricultural wages paid in US dollars (USD) during the survey period are shown in the left panel of Figure 3.4. An average wage of agricultural workers in these high potential areas was 19.5 Birr or 1.27 USD per day. Average wages of all rural workers, including non-agricultural labor, are slightly lower at 19 Birr (1.24 USD) per day. Wage data from other countries, obtained from Wiggins and Keats (2014) and Zhang et al. (2014), are shown in the right panel of Figure 3.4. Unfortunately, these data provide only an indication of wages paid in a number of Asian countries, and data from the African continent are sparse. In any case, we find that wages in Ethiopia are significantly lower than in those Asian countries for which data is available. It is estimated that average unskilled labor (daily) wages in Nepal, Bangladesh and Myanmar during similar periods were 0.95, 1.59, and about 1.00 USD higher, respectively, than average daily wages in Ethiopia. Agricultural wages in Ethiopia were only 57, 44, and 56 percent of the average agricultural wages paid in these respective countries.

Figure 3.4: Frequency distribution of agricultural wages in Ethiopia (left), and agricultural wages in Ethiopia compared to a number of other countries in USD/day (right)



Source: Wiggins and Keats 2014; Zhang et al. 2014

4. AGRICULTURAL WAGES AND AGRICULTURAL LABOR MARKET USE

In this section we investigate the contribution of hired-in labor in total agricultural labor; seasonality in agricultural labor use; and some of the factors that explain agricultural wages. We also study factors associated with participation in rural labor markets, particularly from the demand side.

4.1. Agricultural wage labor

In Table 4.1, we summarize the share of crop producing households that relied entirely on family or on hired labor, and those that used both types of labor (family and hired). Three important results can be extracted from the table. First, family labor is by far the most important contributor to agricultural work – hired labor contributes to only 7 percent of all agricultural work in the four major regions. Second, there is important regional heterogeneity in terms of the share of hired-in labor to total labor used in agriculture. The share of hired-in labor is highest in Tigray region where it makes up 14 percent of all labor, and lowest in Amhara region, constituting only 4 percent. The low levels of hired-in labor in Amhara is surprising given the relatively larger importance of agricultural wage income in the region. This result possibly indicates the importance of seasonal migration in the region to work on commercial farms. Third, the proportion of farms that exclusively rely on hired-in labor is low at only 1 percent. The vast majority of households rely exclusively on family labor in crop production – more than three-quarters of these farms exclusively use family labor for crop production. Nearly 23 percent of households used a combination of family and hired-in labor in crop production over the preceding agricultural year. In Table 4.1, we further disaggregate these results by crop types. There are surprisingly few differences in hired-in labor use between crop types, ranging from 4.5 percent for pulses to 7.5 percent for oilseeds.

Table 4.1: Share of hired labor and households using hired labor for crop production

Region/crop type	All households		Households using only family labor (%)	Households using only hired labor (%)	Households using family and hired labor (%)
	Share of family labor (%)	Share hired (%)			
All regions	93.0	7.0	76.1	1.1	22.8
Tigray	86.1	13.9	62.2	3.5	34.3
Amhara	96.1	3.9	81.4	0.3	18.3
Oromiya	93.0	7.0	72.5	0.4	27.1
SNNP	90.6	9.4	78.8	3.0	18.2
Crops					
Teff	92.8	7.2	78.0	0.9	21.1
Barley	92.8	7.2	84.6	1.7	13.7
Wheat	92.6	7.4	80.5	1.4	18.1
Maize	95.1	5.0	85.3	0.7	14.0
Sorghum	93.3	6.7	81.5	1.1	17.4
Pulses	95.5	4.5	88.6	1.0	10.4
Oilseeds	92.5	7.5	84.4	1.5	14.1

Source: Authors' computation using the AGP baseline survey dataset (2011).

We further triangulate this issue using other available datasets, mainly those from the Teff Producer and Coffee Producer surveys. These surveys hold more detailed information on the type of labor use for the different agricultural activities during the year, as well as information on the importance of exchange labor that is prevalent in some regions. The latter information was not collected in the AGP surveys, as all non-paid labor use was aggregated under the family labor category. The results are presented in Table 4.2. Note that the larger farms are over-sampled in both these surveys in order to ensure that a representative picture for the total quantity produced and commercialized would emerge.

Table 4.2: Share of labor arrangements for different activities

Practice	Teff			Coffee		
	Family	Hired	Exchange	Family	Hired	Exchange
Tree management	-	-	-	88	4	9
Mulching	-	-	-	83	7	10
Tilling	85	7	8	63	12	25
Manure and organic input use	93	4	3	92	3	5
Sowing and fertilizer use	86	6	7	85	6	9
Weeding	73	10	16	70	11	19
Herbicide and pesticide application	76	23	1	-	-	-
Harvesting	41	32	27	68	19	13
Post-harvesting activities	69	7	24	98	1	1
Threshing and winnowing	57	11	32	-	-	-
Total	63	14	22	68	14	18

Source: Authors' computation using Teff Value-Chain survey (2012), and Coffee Value Chain survey (2014).

Family labor accounted for 63 percent and 68 percent of all labor used in major teff and coffee producing areas, respectively. Additionally, labor exchange or other forms of social labor accounted for 22 percent and 18 percent of the total labor used in the respective producing areas. The share of exchange labor in total agricultural labor use is even more important than hired labor in these contexts, the latter standing at 14 percent. While exchange labor is invariably important, we note that there are important variations in its use over space. Figure 4.1 depicts the information on the share of hired-in, family, and exchange labor by distance to Addis Ababa as measured in terms of the cost of transporting a quintal of grain to the capital city. The figure shows that households in areas closer to Addis Ababa rely more on hired-in labor than they do on

exchange labor, while the reverse holds in areas farther away from Addis Ababa. This graph suggests that households shift to wage and market labor arrangements in more commercialized and better connected areas in the country.[7]

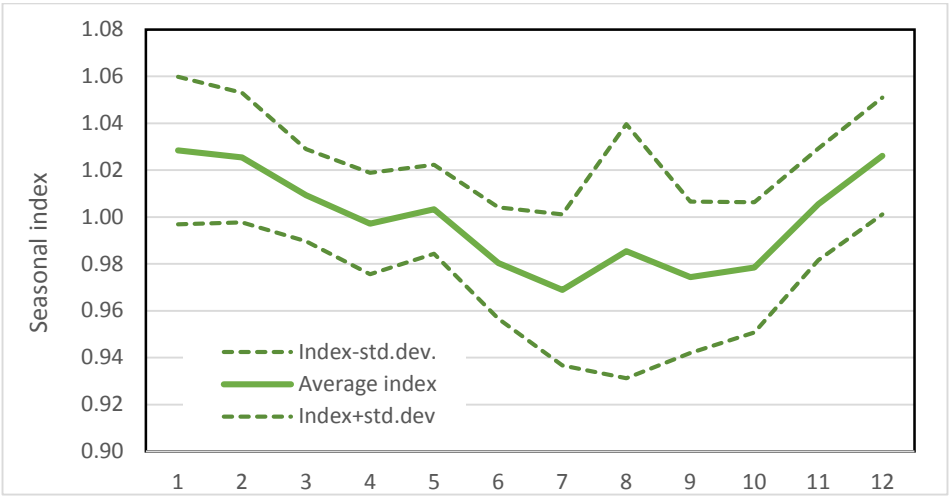
Figure 4.1: Labor arrangements and remoteness

Source: Authors' computation using the teff producer survey (2012).

Table 4.2 further shows that there also exist significant seasonal variations in hired-in labor use. Hired-in labor is much more important during harvest periods in both major teff and major coffee producing areas. Hired-in labor was also relatively important during the tilling and weeding periods. Out of the total labor used in teff and coffee production, 41 percent and 68 percent, respectively, was accounted for by family labor, while 32 percent and 19 percent of the required labor use was accounted for by hired-in labor in teff and coffee production, respectively.

The fact that hired-in labor is more important during the harvest period indicates a tightening of rural labor markets in the period of the survey(s). We use CSA wage data to check the extent of seasonality in rural wages, which likely is driven by seasonal changes in demand (Figure 4.2). We analyzed the wage data for the last ten years to assess seasonal variation, finding that wages are slightly higher at the end and at the beginning of the year – around the harvest period of the main *meher* agricultural season – and lower in the middle of the year, usually referred to as the slack season. However, the differences are not very large (an amplitude of 5 percent) and the seasonal wage differences are not significant at conventional statistical levels.

Figure 4.2: Seasonal movements in real rural wages (July 2004 – June 2014; average yearly price is 1.0)



Source: Authors' computation using CSA wages data (CSA 2015).

[7] A similar picture shows up for a switch to land rental agreements from sharecropping as households live closer to Addis.

4.2. Factors associated with agricultural wages

In this section we investigate factors associated with wage levels and test if and to what extent agricultural workers' wages vary with type of agricultural work, worker characteristics, and locational factors. In the econometric analyses conducted in this and the following sections, we use the AGP baseline survey dataset. We complement this data with an urban dummy variable constructed from CSA's woreda population predictions (CSA 2014) and zonal poverty head count (HC) index data from Hill and Tsehaye (2014). Specifically, we estimate the following linear regression equation:

$$ln\, wage_j = \propto_0 + \beta_1 X + \beta_2 Y + \beta_3 Z + e_j \quad (1)$$

where *j* indexes worker j. *X* is a vector of *type of work* (including four types of agricultural activities: planting, weeding, harvesting, and herding, where the fifth activity, land preparation, is the omitted category), *Y* are worker characteristics, and *Z* reflect location characteristics. The disturbance term, e_j, is assumed to be identically and independently normally distributed with zero mean and constant variance. The variables are defined in Table 4.3 where we also provide results of the regression analysis.

The results in Table 4.3 indicate that workers that hired-out labor for planting earn lower wages (13 percent lower) relative to those that worked on land preparation, while wages of agricultural laborers engaged in weeding and harvesting earned 12 percent and 17 percent more, *ceteris paribus*. Wages for livestock herding were not statistically different from those engaged in land preparation. The results also indicate that male workers are paid 8 percent more than females, controlling for the type and location of the work. Moreover, the age of the worker has a significant negative effect, possibly indicating that the productivity of older workers is presumed to be lower.

Table 4.3: Region, activity, and gender factors associated with rural wages

Dependent variable: log of agricultural wages (birr/day)		
Variable	**Coefficient**	**SE**
Planting	-0.133***	0.047
Weeding	0.121***	0.036
Harvesting	0.171***	0.031
Herding	-0.119	0.149
Gender of worker (=1 if male)	0.079***	0.027
Worker age (years)	-0.002*	0.001
Distance to daily/periodic market (km)	-0.001***	0.000
Distance from Addis Ababa ('00 km)	-0.071***	0.015
Total district population	0.001***	0.000
Poverty HC index	-0.015***	0.001
Amhara	-0.048	0.055
Oromiya	-0.546***	0.058
SNNP	-0.377***	0.047
Constant	3.461***	0.096
F-statistics	39	
Number of observations	2,365	

Source: Authors' analysis using the AGP baseline survey data (2011), CSA (2014), and Hill and Tsehaye (2014).
Coefficients with superscripts ***, **, and * are significant at 1%, 5%, and 10% levels, respectively.

The results further indicate that location matters significantly for wage formation. Wages increase with urban proximity. A further 100 kilometres away from Addis reduces agricultural wages by 7 percent. Remoteness from the local market is also associated with the payment of significantly lower wages, but these effects are small. Furthermore, agricultural wages decline with the Poverty Head Count index in the administrative zone, even after controlling for location differences, indicating the strong link of agricultural wage levels with poverty measures. This suggests that in areas where a higher proportion are poor, the resulting lower wages from a higher labor supply means that the poor might rely relatively more on these labor markets for their livelihoods. Region dummy variables used in the analysis imply that agricultural wages are relatively higher in Tigray.

4.3. Factors associated with agricultural labor use

We further look at factors associated with hired-in agricultural labor use. For this, we use a Tobit model to investigate whether household and location specific factors explain the proportion of hired-in labor out of total labor. The regression equation we estimate is given as:

$$y_h = \propto_0 + \beta_1 X + \beta_2 Y + \beta_3 Z + e_j \quad (2)$$

where *h* indexes households; y_h stands for the dependent variable; *X* indicates a vector of household demographic variables (including gender, age, and education of the household head, household size, dependency ratio (the ratio of number of household members under 15 and over 65 years of age to those between 15 and 65), and the ratio of females among household members of working age (between 15 and 65 years of age)); and *Y* includes a number of farm characteristics.[8] Finally, we include a battery of location variables in *Z*, similar to the ones used in the previous regression.

Table 4.4: Factors associated with of hired-in labor use (Tobit regression)

Dependent variable: share of hired-in labor		
Variables	**Coefficient**	**SE**
Household variables		
Gender of household head (=1 if male)	-4.10	2.624
Age of household head (years)	-0.08	0.062
Education of head	4.60***	0.840
Dependency ratio	0.15***	0.041
Household size	-3.57***	0.490
Proportion of females in working age	14.79***	5.115
Farm characteristics		
Total cultivated area (hectares)	12.47***	1.088
Total cultivated area-squared	-0.70***	0.100
Land quality index	1.82***	0.431
Tropical livestock units	1.30***	0.224
Household obtains production information	5.01***	1.324
Model farmer in last 5 years? (=1 if yes)	7.01**	3.295
Visited by extension agent (=1 if yes)	0.94	1.959
Location		
Travel time to nearest 50K town (minutes)	-0.02***	0.006
Distance from Addis Ababa (00 km)	-4.14***	0.943
Urban (=1 if woreda population>=50,000)	73.03***	12.680
Zonal poverty head-count index	0.22***	0.073
Amhara	-30.29***	3.365
Oromiya	-38.69***	3.746
SNNP	-20.61***	3.212
Constant	-105.30***	15.190
Chi-squared	576.1	
Number of observations	7,257	

Source: Authors' analysis using the AGP baseline survey data (2011), except those with superscripts a and b, which are from CSA (2014) and Hill and Tsehaye (2014). Coefficients with superscripts ***, **, and * are significant at 1%, 5%, and 10% levels, respectively.

The results in Table 4.4 indicate that household characteristics are important for decisions on labor markets. First, the share of hired-in labor decreases with the dependency ratio and vice versa for household size. As household size increases, there is more labor available and the likelihood of hiring in labor is therefore reduced. A higher share of elder and younger

[8] *Area* measures the total cultivated area of the household. *TLU*, which stands for Tropical Livestock Units, normalizes the number of livestock a household owns in cattle units. *Model farmer* takes a value of 1 if the household head was selected as a model farmer in the last 5 years. *Production information* takes a value of 1 if the head obtained production information from radio, newspaper, or information boards. *Extension* takes a value of 1 if the household was visited by extension agents at least once in the last 12 months. The *Land Quality* index is computed by multiplying perceived fertility and slope of land; where fertility ∈ [1=infertile, 2=semi-fertile, 3=fertile] and slope ∈ [1=steep, 2=gentle, 3=flat]. This index therefore ranges from 1 to 9, from the poorest (1) to the best (9) land quality. Household level land quality index is computed as a plot area weighted sum of land quality indices of the different plots households cultivated.

people - and therefore a higher dependency ratio - reduces labor supply, *ceteris paribus*, leading to more hiring in of labor to work on the land. The education levels of household heads also shows a significant association with reliance on labor markets. More educated household heads are more likely to hire in labor, since they are more likely to be engaged in alternative activities outside of their farms and therefore would need substitute labor to run their farms.

Second, the characteristics of the farm also determine how the household will participate in agricultural labor markets. The size of the farm is an important factor associated with labor market participation. The bigger the farm, the more likely the household will use hired-in labor. An increase in the size of the farm by one hectare leads to an increase of the share of hired-in labor by 12 percent. However, the proportion of hired-in labor increases with cultivated area non-linearly. We further find that households that cultivate better quality land are more likely to hire wage laborers, possibly because they want to cultivate the better quality land more intensively. Moreover, the proportion of hired-in labor increases with livestock ownership. The greater proportion of hired-in labor may result not only from the need to use more labor to care for livestock, but also due to the wealth of owning a larger herd.

Third, we look at the effect of location variables. Holding other factors constant, farmers in zones with a higher incidence of poverty are more likely to hire agricultural workers, possibly because of the lower wage in such zones as well as the higher supply of wage labor. The proportion of hired-in labor increases in urban areas and with proximity to Addis Ababa. The latter is consistent with better functioning labor markets in areas closer to large population centres, along with incentives for more intensive cultivation of land. Better functioning labor markets also imply employment opportunities, other than agricultural labor, in areas closer to Addis Ababa. This may be the reason for the result in Table 4.4 that implies a decline in the importance of wage income with proximity to Addis Ababa. All regional dummies are further significant and negative, which indicates that the proportion of hired-in labor is lower in Amhara, Oromiya, and SNNP compared to Tigray.

The previous analysis shows that wage labor is relatively less important in agricultural production than family labor but that there is significant heterogeneity over space and season. We find that agricultural labor markets are much more important in more urbanized and relatively better connected areas and during specific times of the year. We also find that the level of wages that are paid respond to these factors. In the next section, we investigate the changes in these rural wage levels over time.

5. RURAL WAGES: CHANGES, DRIVERS, AND IMPLICATIONS

5.1. Changes in rural wages

In this section we describe trends in real wages of unskilled or casual labor in both rural and urban areas. This is important for at least three reasons. First, since rural wages benchmark the wages paid in the manufacturing and service sectors, trends in rural-urban wage gaps over time will have important implication to Ethiopia's transformation from a largely agrarian towards a manufacturing-led economy. Second, rising wages have important implications on rural development and overall poverty reduction given the potential increase in the cost of food production and food prices resulting from rising wages. An important question is whether increases in wages in the future more than compensate for welfare losses due to subsequent food price increases. Third, changes in rural wages often trigger changes in farming systems by, for example, driving the introduction of labor saving mechanization, or bringing about changes in farm sizes, partly because the use of machinery reduces the advantage of small-scale farm operations in labor supervision (Otsuka et al 2014). In the case of Ethiopia, the latter depends on the extent to which land is consolidated and how this is facilitated in the future. To understand some of these issues, we use data on the daily wages of unskilled laborers collected by CSA on a monthly basis during the period July 2004 to December 2015. We return to each of these points in Section 5.3.

We first discuss trends in wages expressed in US dollars (USD) and in US Consumer Price Index (CPI) deflated real USD. However, this deflation method might be imperfect because of changes in the overvaluation of the Birr-dollar exchange rate over time (World Bank 2014). We, therefore, also rely on other deflation methods. First, we use the regional general CPI (GCPI) from CSA (2014b). Second, we use the poor persons' general CPI (PP-GCPI). The PP-GCPI is constructed using expenditure shares on 26 food and non-food items of households in the lowest two income quintiles, which we define as poor households, obtained from CSA (CSA 2007) and retail prices for those items (CSA 2016a) (see Headey et al. 2012).

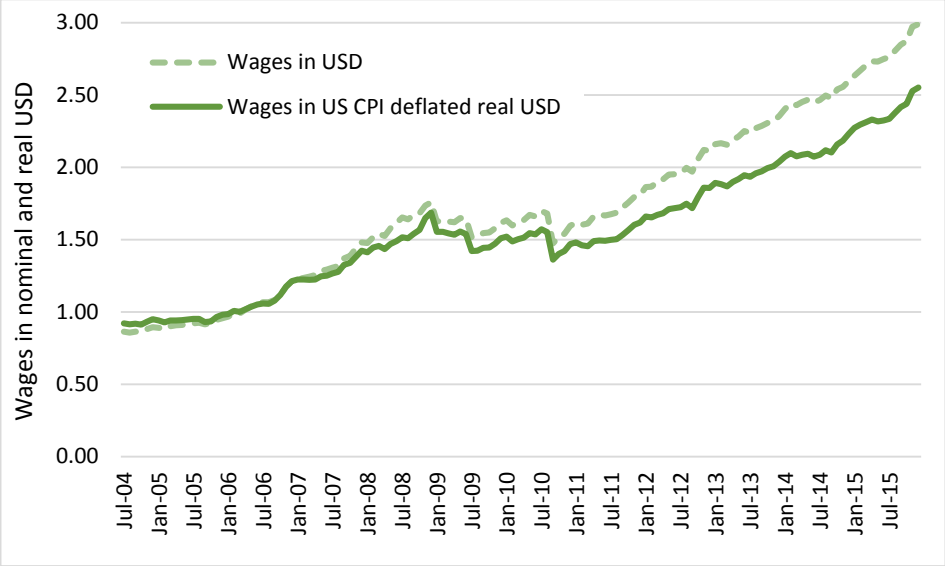
The poor persons' general and food-price indices are computed using the formula:

$$P_{w,t} = \sum_{n=1}^{N} s_{n,w} \cdot \bar{p}_{n,w,t} \quad (3)$$

where *w* denotes the woreda, *t* denotes the month of observation, and *n* denotes the food and non-food items, $s_{n,w}$ denotes the expenditure share of item *n* in woreda *w*, and $\bar{p}_{n,w,t}$ is the average market price of *n* in *w* during *t*. The index is set with December 2011 as the base period. Note also that the expenditure shares are regional averages and given for urban and rural areas separately. We compute the indices separately for rural and urban woredas. We further use CSA's population census of 2007 to categorize a woreda as urban if its population is 50,000 or higher.

Figure 5.1 depicts the daily wages of casual laborers expressed in nominal USD and real USD.[9] These figures are important as they show what international investors would pay to employ unskilled labor in the country. Therefore, they are indicators of the competiveness of Ethiopia in labor-intensive industries. Figure 5.1 shows that wages of unskilled laborers increased dramatically during the July 2004 to December 2015 period, with daily wages tripling in the period considered. Specifically, wages expressed in USD and real USD per person per day, which averaged 0.86 and 0.92 in the third quarter of 2004, grew to nearly 3.00 and 2.50 in the last quarter of 2015, respectively. Growth in the respective wages averaged 11.4 percent and 9.2 percent per year, or 0.9 percent and 0.8 percent per month. However, the growth was not consistent over this period and there was a slight decline in wages between January 2009 and September 2010 (see Appendix Figure 1). This might have been linked to the rapid devaluation of the Birr in that period (World Bank 2014).

Figure 5.1: Wages of unskilled laborers per day in nominal USD and real USD, July 2004 to December 2015

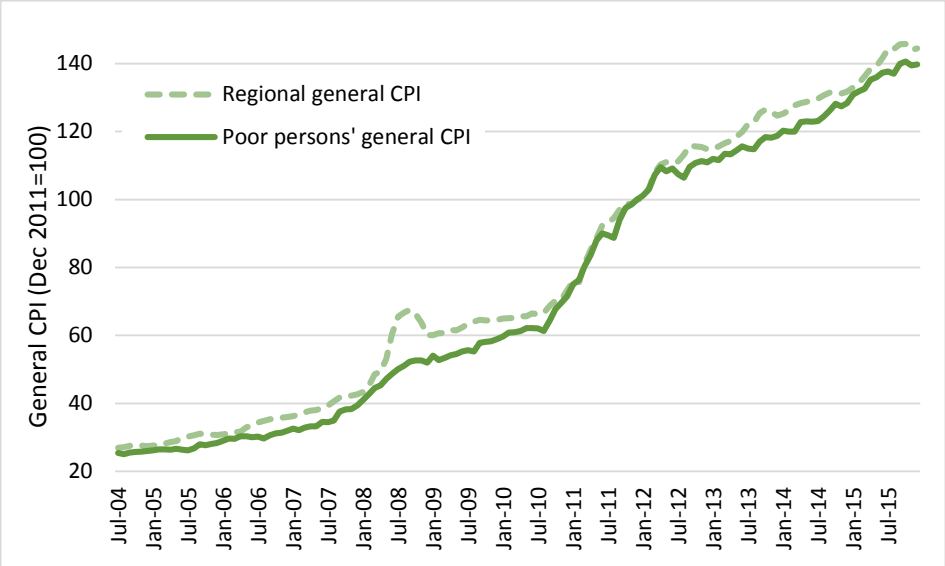


Source: Authors' computation using CSA nominal wages data (CSA 2016a), National Bank of Ethiopia (2016), and US Bureau of Labor Statistics (2016).

To improve our assessment of local wage and price situations and to evaluate changes in the purchasing power of agricultural wage labor, we are able to depict real wages of unskilled laborers obtained by deflating nominal wages using both the regional average General CPI (GCPI) and the poor person's general CPI. Both of these indices are plotted for the period July 2004 to October 2015 in Figure 5.2. The General Consumer Price Index on average increased at 1.3 percent per month or at 16.6 percent per year over this period. Average annual growth in the GCPI was similar across regions, ranging from 15.4 percent per year in Tigray to 17.6 percent in Oromiya. Average monthly growth in the GCPI was the highest in 2008 and second highest in 2011 in all regions, except Afar and Benishangul-Gumuz. Monthly growth in GCPI averaged 3 percent in 2008 and 2.4 percent in 2011, while the slowest growth was observed in 2004 (0.3 percent) followed by 2014 (0.5 percent).

[9] In Annex Table 1 we provide average daily wages expressed in nominal USD and real USD as well as those deflated using regional and poor persons' CPIs for each of the years during 2004-2015. Average monthly growth rates of the corresponding wages are presented in Annex Table 2.

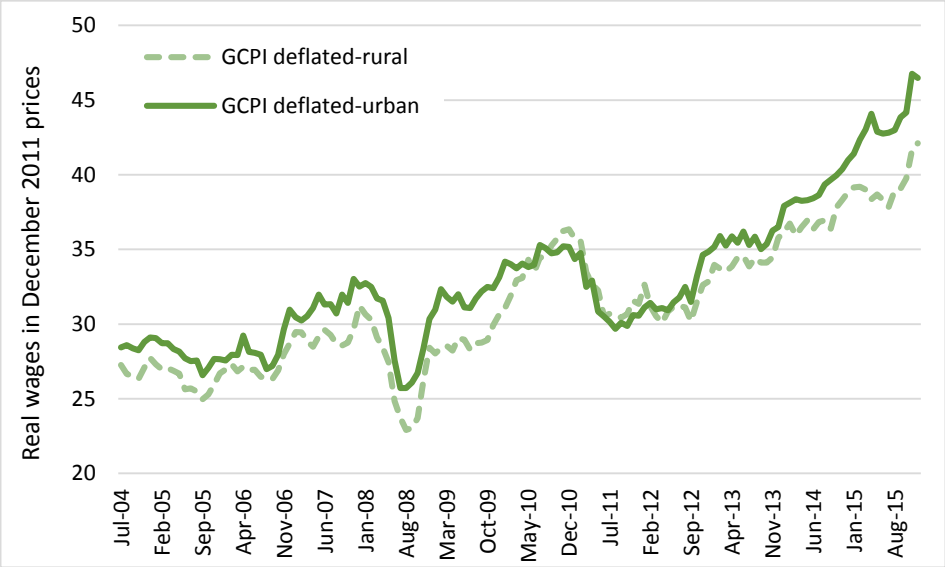
Figure 5.2: Monthly inflation, July 2004 to December 2015, regional and poor persons' general Consumer Price Indices (CPI)



Source: Regional general CPI from CSA (2016b); Poor persons' general CPI constructed from CSA retail price data (2016a).

In Figure 5.3, we present urban and rural wages deflated by the General CPI. We note a significant increases in real wages during the period: GCPI deflated real wages of unskilled labor in rural areas increased from 27.3 Birr in the third quarter of 2004 to 41.2 Birr in the last quarter of 2015 (total growth of 54 percent), while in urban areas, it increased from 28.4 to 46.5 Birr (total growth of 63 percent) (Appendix Table 1). Generally, we note that the urban-rural wage gap has been low during most of the period. We see that wages in urban areas were on average 5.5 percent higher (and even narrower (3 percent) if 2008 and 2009 were excluded, during which time the gap averaged 10 percent). This wage gap is significantly lower than those noted in other countries (Zhang et al. 2014; Yang et al. 2013). However, the wage gap has been widening in recent years. While wages were at equal levels in early 2011, the rural-urban wage gap stood at 11 percent in the last quarter of 2015.

Figure 5.3: Regional general CPI (GCPI) deflated daily wages of unskilled laborers in rural and urban areas, in Dec 2011 Birr per day, July 2004 to December 2015

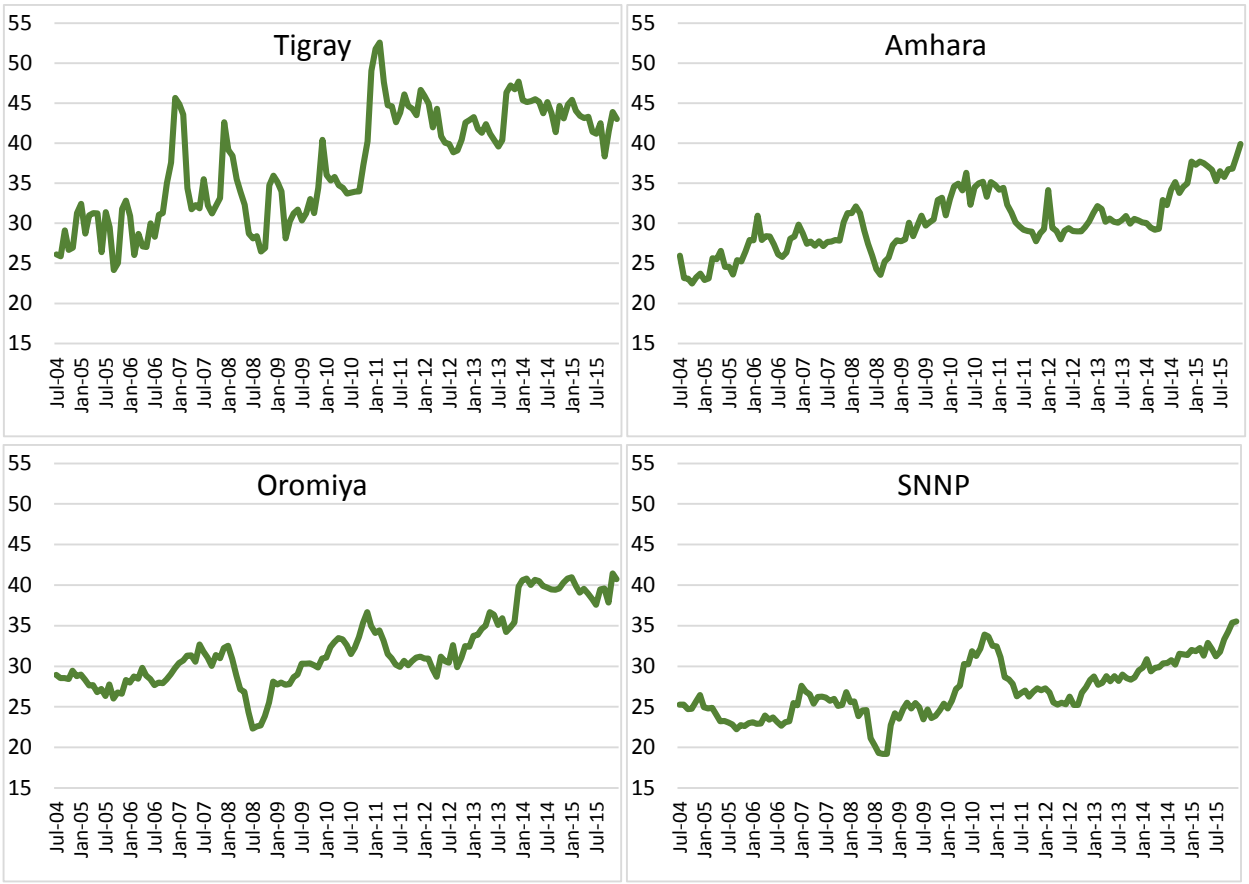


Source: Authors' computation using CSA nominal wages data (2016a) and CSA regional GCPI data (2016b)

We look further at the evolution of wages in rural areas by the four major rural regions. In Figure 5.4 we illustrate trends in real wages across these regions, and in Appendix Table 3 we summarize the data on levels and growth rates of

real wages for all rural regions. Notably, there was significant growth in real wages in all four main regions, but we see some divergence over time, especially because of the higher growth of rural wages in Tigray and Amhara regions. SNNP is the region where least growth was noted among the main four regions – it had the lowest real wage at the end of 2015. We note that real wage growth rates in the four agriculturally important regions was generally lower relative to the remaining four regions (Gambela, Benishangul-Gumuz, Afar, and Somali; see Appendix Table 3). Finally, we also note that real wages declined in the first nine months of 2015 in Tigray (at 1.7 percent), in Afar (at 1.1 percent) and in Amhara and Oromiya (at 0.3 percent). While this requires further investigation, it may have been due to the considerably lower rainfall experienced in these regions over the last two years.

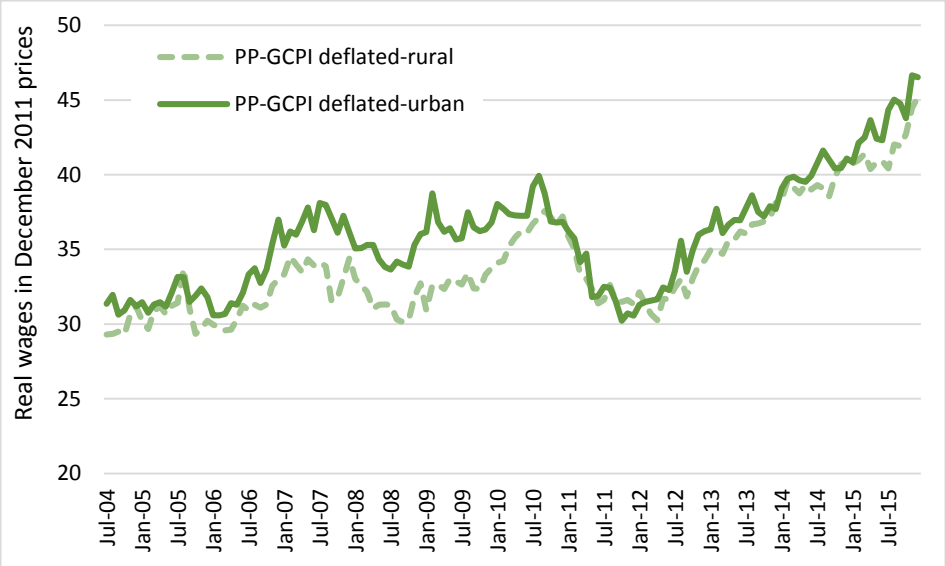
Figure 5.4: Rural real wages in the different regions in the country, in Dec 2011 Birr per day, July 2004 to December 2015



Source: Authors' computation using CSA nominal wages data (2016a) and CSA regional GCPI data (2016b)

In Figure 5.5, we further provide daily real wages of unskilled labor deflated by the Poor persons' general CPI (PP-GCPI). PP-GCPI deflated average real wages of unskilled labor were 29.4 in rural areas and 31.5 Birr in urban areas in the third quarter of 2004. This increased by an average of nearly 16 Birr and 15 Birr in the last quarter of 2015 or by about 3.5 percent and 3.2 percent per year in rural and urban areas, respectively (Appendix Table 1). Similar to GCPI deflated wages, the PP-GCPI deflated urban-rural real wage gap was higher during 2008 and 2009, during which it averaged 11 percent, whereas the wage gap has been 4.2 percent during the rest of the period. Growth in PP-GCPI deflated real wages were mostly similar to the growth pattern in GCPI deflated real wages, indicating significant welfare improvements for such labor over time. However, the difference in PP-GCPI deflated real wage levels between urban and rural areas has in recent periods become smaller, indicating higher prices of goods for consumption in these urban areas. We further note a significant decline in real wages during 2008 and between the middle of 2010 and 2011 when inflation rates in the country were high and wage adjustments were significantly lower (Headey et al. 2012). For instance, real wages declined at 0.4 percent per month in 2008 and at 1.4 percent per month in 2011 in rural areas, while in urban areas it stagnated in 2008 and declined at a slightly higher rate in 2011.

Figure 5.5: Poor persons' general CPI (PP-GCPI) deflated daily wages of unskilled laborers in rural and urban areas, in Dec 2011 Birr per day, July 2004 to December 2015



Source: Authors' computation using nominal wages data from CSA (2016a)

5.2. Drivers of change in wage levels for unskilled labor

The Ethiopian economy has shown significant growth over the last decade – growth in real gross domestic product (GDP) averaged 11 percent during the 2004-2013 period (World Bank 2014). In this section we investigate whether real wages of unskilled labor in rural areas were impacted by this growth in the overall and sectoral GDP. For this purpose we use the World Development Indicators data (World Bank 2014) on real [aggregate] GDP and real value added in agriculture, manufacturing and industry, and services, together with Poor Persons' General CPI deflated real wages, which we computed using CSA data (CSA 2016a, CSA 2007). The equation we estimate is given as:

$$\ln Real\ wage_t = \beta_0 + \beta_1 \ln Y_t + e_t \qquad (4)$$

where $Real\ wage_t$ represents the PP-GCPI deflated real wages in rural areas during year *t* with $t \in [1999, \ldots, 2012]$ and Y_t stands for real GDP and real value added in agriculture, manufacturing and industry, and services.

Before we start the econometric analysis, in Appendix Figures 2 to 5 we present the evolution of zonal average real wages (the variable on the left in equation (4.1)) in the four main agricultural regions, as well as the value of grain output per farm holder per zone, as a proxy of labor productivity in grain production (the variable on the right in equation (4.1) expressed in per farmer units). The figures in the Appendix show strong positive associations between real wages and value of grain output per farm holder. This shows that the wage-GDP relationship works at lower levels of aggregation.

The results of the econometric analyses are shown in Table 5.1. Each of the entries in the table are obtained by regressing the explanatory variables listed in the first column on PP-GCPI deflated real wages of rural areas. Real wages in rural areas are shown as average annual real wages in rural administrative zones. We categorize zones as *rural* using the four criteria defined in the first row of the table. The data are aggregated at administrative zone levels (the first sub-regional administrative level) because markets sampled in CSA's data collection are representative of administrative zones.

The results in Table 5.1 indicate that real wages in rural areas increase at 22 percent of the increase in aggregate GDP in rural administrative zones where zones are defined as rural if an average woreda in the zone has a population of less than 30,000. For the remaining three criteria used to define rural zones, the elasticity of real wages with respect to GDP is generally lower, ranging from 12 to 18 percent. The results also indicate that the elasticity of rural real wages with respect to real agriculture sector value added (GDP), was 24 percent in predominantly rural areas with woredas averaging less than 30,000 population. The elasticity ranged between 15 and 20 percent when this relationship was computed for rural areas defined with more zones of larger populations. The elasticity of wages with respect to manufacturing (and industry) was 19 percent (17 percent) or higher in predominantly rural zones, with the elasticity of real wages in this sector being lower in

zones with larger populations. The elasticity of real wages with respect to the services sector value added was the lowest of all, being 15 percent in predominantly rural areas and 12 percent or lower in zones with larger populations.

Two observations are notable about these results. First, the elasticity of real wages is highest with respect to agricultural value added. This is likely because of the large importance of agriculture in most of the zones considered. Second, despite the value added in agriculture accounting for less than 50 percent of the GDP during the period analyzed, the elasticity of real rural wages with respect to aggregate GDP, is close but less than the elasticity of agricultural GDP, particularly in predominantly rural areas. The latter means that wages in rural areas respond most to changes in output that is locally produced, seemingly as most of the local population is engaged in these activities.

Table 5.1: Estimates of growth – unskilled real wage elasticity for rural populations in Ethiopia between 1999 and 2012 using different definitions of rural areas, by economic sector

Dependent variable: real wages in rural areas where rural areas are defined as:				
Explanatory variable	**Avg. woreda population in zone <30K**	**Avg. woreda population in zone <50K**	**Rural areas[a]**	**Non-urban regions[b]**
Real GDP	0.22***	0.18***	0.15***	0.12***
	(0.031)	(0.030)	(0.036)	(0.044)
Real agricultural GDP	0.24***	0.20***	0.17***	0.15***
	(0.032)	(0.028)	(0.034)	(0.043)
Real manufacturing GDP	0.19***	0.16***	0.14***	0.12***
	(0.026)	(0.022)	(0.027)	(0.034)
Real industry GDP	0.17***	0.14***	0.12***	0.10***
	(0.025)	(0.023)	(0.027)	(0.033)
Real services GDP	0.15***	0.12***	0.11***	0.09***
	(0.024)	(0.022)	(0.026)	(0.031)

Source: Authors' analysis using CSA (2014a), CSA (2007), and The World Bank (2014). Coefficients with superscripts ***, **, and * are significant at 1%, 5%, and 10% levels, respectively.

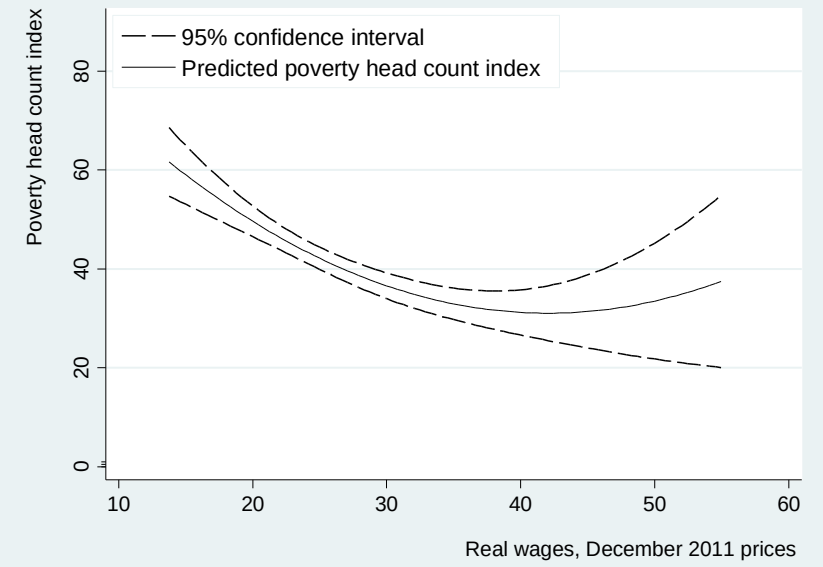
Notes: a) Woredas other than those that comprise the urban centers of Addis Ababa, Harari, or Dire Dawa regions or the cities of Mekele, Gondar, Bahir Dar, Dessie, Adama, Bishoftu, Kersa, Jigjiga, and Hawassa; and b) Regions other than Addis Ababa, Harari, or Dire Dawa.

5.3. Implications of wage changes

In this section we point to some of the likely implications of trends in rural wages and patterns in agricultural labor use observed in the sections above. In particular, we discuss the link between agricultural wages and rural poverty on the one hand, and adjustments in agricultural production practices, such as labor-saving modern inputs, agricultural mechanization, and increase in the likelihood of using of modern inputs due to alleviated seasonal liquidity constraints, on the other hand.

First, an important implication of the transformation of rural and agricultural labor markets is its role in poverty reduction (Ravallion 2000). We investigate this effect first using Figure 5.6, which plots a quadratic function of the predicted poverty Head Count Index (HCI) against real wages, both of which are zonally aggregated and pertain to the years 1996, 2000, 2005, and 2011. The figure demonstrates that increases in real wages are strongly correlated with a decline in poverty. This negative relationship is particularly strong at lower real wages. Similar patterns have been observed in other settings, e.g., Ravallion 2000.

Figure 5.6: Correlation of prevailing real wages and poverty head count index by administrative zone for Ethiopia



Source: Authors' computations using CSA (2014a), (2014b), and Hill and Tsehaye (2014).

We also use the same data to econometrically test whether zonal level poverty HCI is related with real wages levels following Lanjouw and Murgai (2009). The general equation we estimate is given as:

$$\ln Poverty\ HCI_{j,t} = \beta_0 + \beta_1 \ln Real\ wage_{j,t} + \eta_j + \tau + e_{j,t} \quad (5)$$

where $Poverty\ HCI_{j,t}$ stands for poverty HCI of zone *j*, such that $j \in [1, 2, \ldots, 56]$ in year *t*, with $t \in [1996, 2000, 2005, 2011]$; η_j represents fixed effects of zone *j*; and τ stands for a time trend variable. We estimate OLS and fixed-effects specifications of equation (5) whereby in the OLS specification the zone fixed-effect variables (η_j) are either replaced by region dummies or dropped.[10] We provide results of the analyses in Table 5.2.

The results indicate that the elasticity of poverty HCI with respect to real wages is negative and significant in all specifications. Moreover, the elasticities from the OLS and fixed-effects specifications are close to each other. Elasticities from specifications that include a time trend range between -44 percent and -57 percent, and those without time trends are unit elastic, while the OLS specification without time trends and region dummies is midway between the latter two.

Table 5.2: Strength of the association between zonal level poverty head count index and real wages

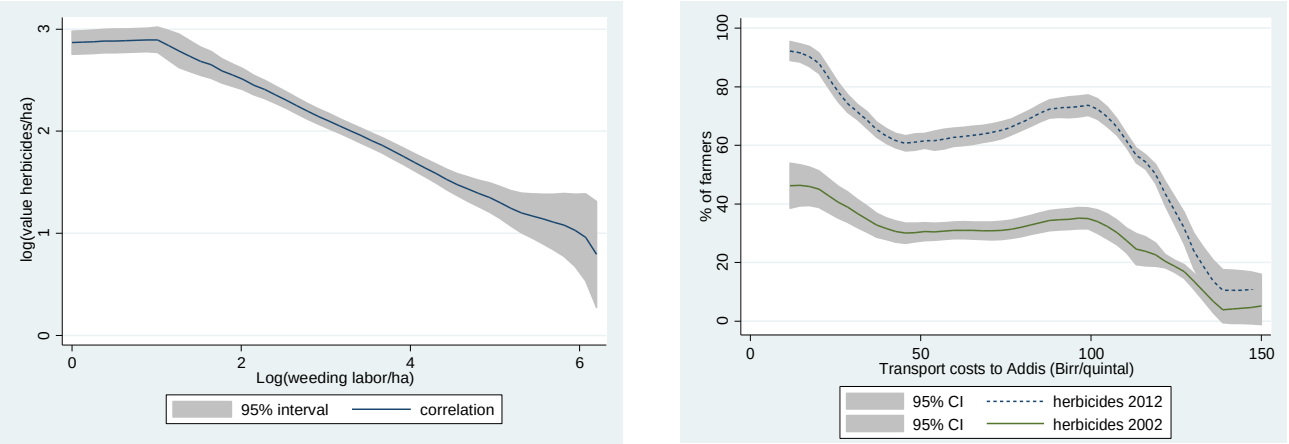
Dependent variable: Zonal poverty head count index in 1996, 2000, 2005, and 2011	OLS, including				Fixed Effects, including	
Variable/statistics	**Region dummies and time trend**	**Region dummies**	**Time trend**	**No dummies and trend**	**Time trend**	**No trend**
Log of real wages	-0.574***	-0.988***	-0.505***	-0.761***	-0.444*	-1.086***
	(0.179)	(0.161)	(0.134)	(0.130)	(0.229)	(0.189)
Time trend	-0.141***		-0.146***		-0.149***	
	(0.031)		(0.030)		(0.033)	
Constant	6.027***	7.264***	5.482***	6.094***	5.288***	7.159***
	(0.615)	(0.578)	(0.423)	(0.426)	(0.719)	(0.619)
F statistics	8.4	6.4	31.0	34.3	28.5	33.0
Probability of F	0.00	0.00	0.00	0.00	0.00	0.00
F stat.-region dummies	2.4	2.7				
Probability of F-region	0.02	0.01				

Source: Authors' analysis using CSA (2014a), (2014b), and Hill and Tsehaye (2014). Coefficients with superscripts ***, **, and * are significant at 1%, 5%, and 10% levels, respectively

[10] Note that, except for the constant term, estimates of the OLS with zonal dummies are identical with those from the fixed-effects specification.

Second, we note increasing substitution of labor with labor-saving modern inputs such as herbicides over time in Ethiopia (Bachewe et al. 2015; Minten et al. 2013). In Figure 5.7, it is shown that when herbicides are used, the weeding efforts are significantly lower, indicating substitution between those input factors. The tightening of the labor markets might contribute to the increasing use of herbicides in the country. For example, Figure 5.7 shows the increasing adoption of herbicides in major commercial teff areas in the country: 31 percent of the teff farmers used herbicides 10 years prior to the survey, but this figure increased to 63 percent in 2012. Commercially-oriented and well-connected farming areas show a particularly strong uptake of such herbicides, possibly linked to the higher wages that are paid in such areas.

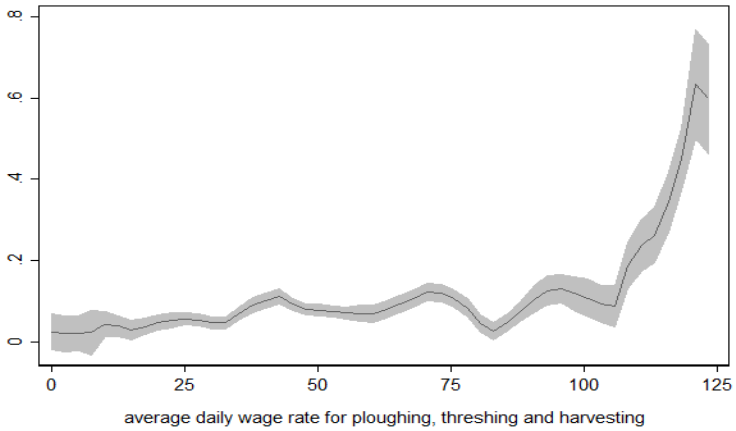
Figure 5.7: Association between use of weeding labor and value of herbicides used (left); prevalence of herbicide use by teff producers in 2002 and 2012 as a function of transport costs to Addis Ababa (right)



Source: Authors' computations using ESSP Teff Producer survey data (2012).

Third, higher rural wages often provide incentives for mechanization in agriculture (Binswanger 1986; Diao et al. 2014; Yang et al. 2013). Most surveys in Ethiopia do not collect data on mechanization, so we cannot assess the extent to which mechanization is used in different parts of the agricultural production process. In a rare exception, Berhane et al. (2015) analyze the use of mechanized services in major production zones in the country. They find that about 9 percent of agricultural smallholders used mechanized services at some period during the agricultural season, mostly for plowing (5 percent) and relatively less for harvesting (3 percent) and threshing (2 percent). While the adoption of these mechanized services is still relatively low, Berhane et al. (2015) show a strong threshold effect in the use of mechanized services and the reported daily wages in the community (Figure 5.8). While a slight upward trend is seen in the use of mechanization by smallholders for wage-levels up to 100 Birr per day (just over 5 USD), use of mechanized services significantly expand after that wage threshold is reached. Yang et al. (2003) have found similar strong effects of wage increases on the adoption of mechanization in agriculture in China. However, it should be noted that Ethiopia is currently still far away from that threshold.

Figure 5.8: Prevalence of use of agricultural mechanization and prevailing daily agricultural wage rates in Ethiopia



Source: Berhane et al. 2015

Note: Local polynomial regression. The shaded area represents the 95-percent confidence interval. The vertical axis measures the share of farmers who are using machines to plough, thresh or harvest.

Fourth, as shown in other studies, off-farm income might lead to a relaxation of credit constraints in the period of the cropping season when agricultural inputs are required, and therefore might lead to improved agronomic practices. Reardon et al. (1994) and Lamb (2004) show that such off-farm income sources might lead to significant farm investments and higher use of modern inputs, leading to higher agricultural productivity. In Table 5.3, we test the extent to which households that have off-farm income in Ethiopia are more likely to use modern inputs, such as fertilizer, improved seeds, and agro-chemicals. We find that only in the case of chemical fertilizer use is off-farm income associated with a higher likelihood of using chemical fertilizer. However, the association is weak, as the coefficient is only significant at the 10 percent level.

Table 5.3: Factors associated with modern input adoption – probit model

	Fertilizer		Improved seeds		Herbicides/pesticides	
Variables	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Household variables						
Gender of household head (=1 if male)	-0.146***	0.051	0.108**	0.052	0.260***	0.048
Age of household head (years)	-0.000	0.001	-0.002	0.001	0.001	0.001
Education of head	0.061***	0.021	-0.011	0.020	-0.041**	0.021
Household size	0.009	0.011	0.007	0.010	0.040***	0.011
Farm characteristics						
Total cultivated area (hectares)	0.003	0.013	0.046***	0.012	0.076***	0.016
Land quality index	-0.019*	0.010	0.025**	0.010	-0.034***	0.010
Used fertilizer in last two years (=1 if yes)	1.465***	0.044	0.435***	0.060	0.376***	0.053
Received advice on fertilizer application	0.495***	0.044	0.373***	0.042	0.108**	0.046
Fertilizer used (=1 if yes)			0.834***	0.059	0.218***	0.057
Improved seeds used (=1 if yes)	0.901***	0.062			0.031	0.062
Pesticides used (=1 if yes)	0.255***	0.059	0.045	0.065		
Irrigation used (=1 if yes)	0.059	0.087	0.238***	0.076	0.359***	0.112
Assets/credit/income sources						
Number of oxen	0.094***	0.019	0.044***	0.015	0.097***	0.021
HH purchased at least one input on credit	1.268***	0.063	0.071	0.054	0.262***	0.065
Number of mobile phones in HH	0.128**	0.058	0.023	0.053	-0.027	0.058
HH owns radio or TV (=1 if yes)	0.102**	0.048	0.112**	0.046	-0.131***	0.049
HH earned non-farm income (=1 if yes)	**0.070***	**0.042**	**0.031**	**0.041**	**0.007**	**0.041**
Location						
Total rainfall during *meher*	0.285***	0.068	1.015***	0.067	-0.224***	0.069
Travel time to nearest 50K town (mns)	-0.001***	0.000	-0.001***	0.0002	0.000	0.000
Distance from Addis Ababa (00 KMs)	-0.020	0.023	0.108***	0.024	0.019	0.023
Urban (=1 if urban in 2014)	0.101*	0.053	0.235***	0.051	0.367***	0.057
Zonal poverty head-count index	-0.005***	0.002	0.005***	0.002	-0.002	0.002
Amhara	0.329***	0.094	0.071	0.096	0.136	0.094
Oromiya	0.479***	0.112	-0.696***	0.114	0.449***	0.110
SNNP	-0.256**	0.108	-0.626***	0.112	-0.230**	0.098
Constant	-3.466***	0.479	-9.678***	0.476	1.828***	0.490
chi2	4,594		2,022		989	
Number of observations	6,940		6,940		6,940	

Source: Authors' analysis using the AGP baseline survey data (2011) except those with superscripts a and b, which are from CSA (2014) and Hill and Tsehaye (2014). Coefficients with superscripts ***, **, and * are significant at 1%, 5%, and 10% levels, respectively.

6. CONCLUSIONS

As economies develop and shift away from agrarian subsistence to commercial agriculture and increasingly to non-agriculture based economic activities, labor markets emerge and increasingly become a critical part of the economy in providing livelihoods for many people (Fox et al. 2013). In the initial stages of this transformation, and especially so in rural areas, these labor markets are important for poverty reduction as well as for assuring employment for the rural youth, an increasing concern in Africa, given its rapidly growing population and its 'youth bulb'. In the case of Ethiopia, the economy is

undergoing rapid transformation, mostly driven by rapid agricultural growth. However, priorities are shifting in the planning process and there is increasing emphasis on stimulating the manufacturing sector as an anticipated source of growth in future decades. This is illustrated in the new phase of the Ethiopian Government's Growth and Transformation Plan. Given that such shifts will have important implications on labor markets, it is important to understand rural and agricultural labor markets. Our paper aims to fill this knowledge gap and contributes to greater insight into understanding likely future trends in these markets.

We find that off-farm income in the high potential agricultural areas in Ethiopia where the AGP is being implemented makes up almost 18 percent of household income and that wage labor income accounts for 10 percent. Wage income is estimated to be as important as livestock income in these areas. We further estimate that in these high potential agricultural zones of the country, only 7 percent of the agricultural production is carried out by hired labor. These high potential zones have significantly higher off-farm sectors than other rural areas in Ethiopia. We also find that there is considerable heterogeneity in rural unskilled labor markets over space and time. Agricultural labor markets are relatively much more important in better connected areas and in urban areas, which is also reflected in higher wages in these areas. This suggests that connectedness and urbanization are among the driving forces towards improved labor markets. Moreover, we note strong seasonality with peaks in hired labor use and wages in the harvest period. While wages of unskilled labor in rural areas of Ethiopia are still low relative to the international context, real wages are on the rise, measured both in US dollars and Birr. This is seemingly driven by an improvement in agricultural performance, which also leads to a reduction in poverty. This development in labor markets is gradually leading to an increasing push towards the adoption of labor-saving technologies in agriculture, such as mechanized services – though starting from a low base – as well as to a widespread use of herbicides that save on weeding labor.

These findings have important implications on policy. First, low wages have been an asset for attracting investors to Ethiopia, and they have contributed to the success of investments in labor-intensive industries, such as in floriculture. However, our results indicate that Ethiopia may gradually lose that edge before it further matures as the wage gap between rural and urban areas narrows and future cheap labor sources disappear. Ethiopia therefore needs to make sure that the skills of its young population are upgraded so that industries can develop in those areas where labor productivity is higher. Second, the higher costs of labor as well as the increasing commercialization of agriculture will require increasing adoption of labor-saving technologies in the sector. It is therefore important that Ethiopia proactively implements policies that allow for the provision of such appropriate technologies at low cost. Third, flexible and responsive labor markets require easier migration to those areas with employment opportunities. Therefore migration needs to be encouraged through more flexible land tenure and more secure land rental rules. Such policies could also facilitate the consolidation of small farms, given the introduction of labor-saving technologies. Furthermore, this may subsequently reduce the incentives to operate small farms which have the traditional advantages over larger farms of decreased costs of labor supervision.

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APPENDICES

Appendix Table 1: Real wages and wages in USD, July 2004 to December 2015

Year	Wages in USD[a]	Wages in US CPI deflated real USD[b]	Regional general CPI deflated (rural)[c]	Regional general CPI deflated (urban)[c]	Poor persons'-general CPI deflated-(rural)	Poor persons'-general CPI deflated-(urban)	Poor persons' food CPI deflated (rural)	Poor persons' food CPI deflated (urban)
2004	0.87	0.92	26.9	28.6	29.9	31.3	35.9	37.6
2005	0.92	0.95	26.2	27.9	30.8	31.8	35.8	37.8
2006	1.06	1.07	27.1	28.3	30.9	32.7	34.7	37.1
2007	1.32	1.28	29.3	31.4	33.5	36.7	35.9	38.0
2008	1.62	1.51	26.6	29.1	31.5	34.7	29.8	32.0
2009	1.59	1.50	28.9	31.9	32.7	36.6	32.5	35.7
2010	1.61	1.49	34.1	34.5	36.2	37.8	37.8	38.9
2011	1.69	1.52	32.1	31.4	32.6	32.7	31.8	32.0
2012	1.97	1.73	31.3	32.1	32.2	33.4	32.4	33.7
2013	2.24	1.94	34.2	35.7	36.1	37.3	37.9	39.9
2014	2.48	2.11	37.0	39.0	39.4	40.3	41.5	43.6
2015	2.79	2.37	39.3	43.6	41.8	43.7	43.4	46.2
Average	1.72	1.56	31.3	33.0	34.1	35.9	35.8	37.7

Source: Authors' computation using nominal wages data from CSA (2015a) and a) National Bank of Ethiopia (2015); b) National Bank of Ethiopia (2015) and US Bureau of Labor Statistics (2015); and c) CSA (2015b).

Appendix Table 2: Average monthly and annual growth rates in real wages and wages in USD, 2004 to 2015

Year	Wages in USD[a]	Wages in US CPI deflated real USD[b]	Regional general CPI deflated (rural)[c]	Regional general CPI deflated (urban)[c]	Poor persons'-general CPI deflated-(rural)	Poor persons'-general CPI deflated-(urban)	Poor persons' food CPI deflated (rural)	Poor persons' food CPI deflated (urban)
2004	0.7	0.6	0.4	0.5	1.3	-0.1	1.0	0.8
2005	0.6	0.3	-0.3	-0.4	-0.2	0.2	-0.5	0.0
2006	2.0	1.8	0.6	1.0	0.7	1.3	0.5	0.6
2007	1.7	1.3	0.7	0.4	0.4	-0.2	-0.3	-1.1
2008	1.4	1.4	-0.6	-0.5	-0.4	0.0	-1.0	-0.2
2009	-0.6	-0.9	0.6	0.8	0.3	0.2	1.0	0.8
2010	-0.02	-0.1	1.4	0.5	0.8	0.0	0.9	0.1
2011	1.1	0.8	-1.2	-1.1	-1.4	-1.5	-1.6	-1.8
2012	1.3	1.2	0.4	1.1	0.8	1.5	1.0	1.8
2013	0.9	0.8	0.7	0.4	0.9	0.4	1.2	0.8
2014	0.8	0.8	0.7	1.0	0.6	0.7	0.5	0.7
2015	1.2	1.1	0.7	1.1	0.8	1.1	0.8	0.8
Average monthly	0.93	0.77	0.35	0.39	0.35	0.32	0.25	0.25
Average annual	11.4	9.2	3.8	4.2	3.3	3.4	2.3	2.5

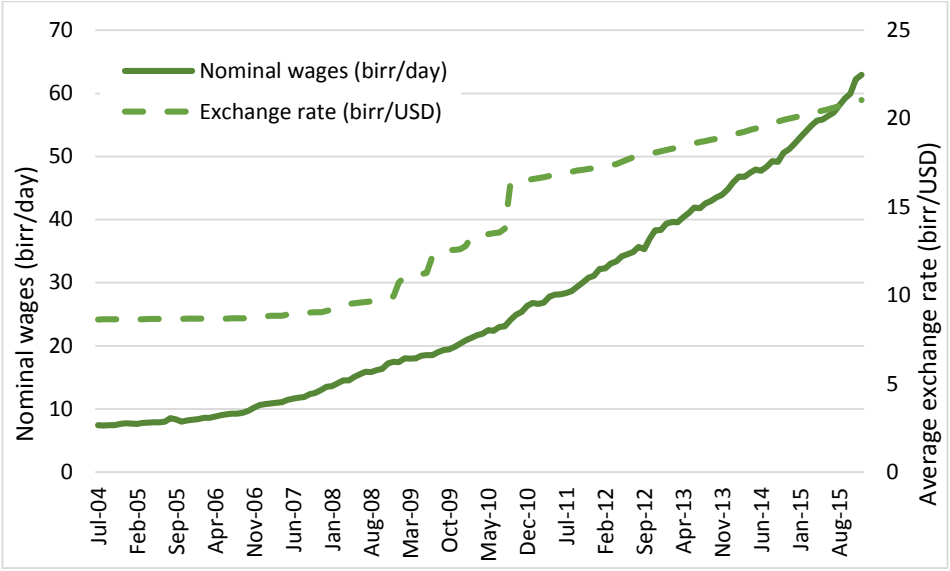
Source: Authors' computation using nominal wages data from CSA (2015a) and a) National Bank of Ethiopia (2015); b) National Bank of Ethiopia (2015) and US Bureau of Labor Statistics (2015); and c) CSA (2015b).

Appendix Table 3: Annual trends in real wages in rural regions of the country, July 2004 to December 2015

Year	Tigray	Afar	Amhara	Oromiya	Somali	Benish.-Gumuz	SNNP	Gambella
				Average GCPI deflated real wages				
2004	27.7	25.8	23.6	28.8	37.9	24.9	25.4	30.9
2005	29.7	25.5	25.1	27.4	33.5	26.4	23.5	30.5
2006	31.6	28.9	28.0	28.6	33.1	26.3	23.6	28.0
2007	35.5	30.7	28.2	31.2	38.7	26.5	26.2	28.0
2008	32.4	30.9	27.6	26.3	36.9	26.4	22.5	27.4
2009	32.6	33.3	30.2	29.2	40.2	28.6	24.6	28.9
2010	36.5	39.1	34.4	33.3	44.8	36.9	30.1	37.1
2011	46.1	35.2	30.4	31.5	43.8	30.8	28.0	36.8
2012	41.8	32.6	29.8	30.9	47.4	33.6	26.2	34.8
2013	43.2	28.0	30.6	35.5	58.4	37.8	28.5	37.3
2014	44.4	35.6	32.8	40.2	61.3	38.3	30.5	38.1
2015	42.6	47.8	37.1	39.4	63.9	38.7	32.8	45.8
Average	37.3	32.8	30.0	31.9	44.9	31.4	26.8	33.6
				Average growth rate in GCPI deflated real wages (%)				
2004	4.1	-0.2	-1.6	-0.1	-2.0	2.8	0.9	3.8
2005	1.2	0.4	1.5	-0.1	-0.8	-0.5	-1.1	-0.4
2006	3.3	1.1	0.7	0.4	0.2	-0.6	0.8	0.1
2007	0.1	0.9	0.4	0.7	2.6	2.2	0.6	0.1
2008	-1.0	-0.4	-0.8	-1.0	0.3	-0.1	-0.6	1.6
2009	1.3	1.8	1.0	0.8	-0.2	1.2	0.5	-0.1
2010	1.9	0.4	1.1	1.1	0.5	2.0	2.2	3.2
2011	-0.3	-1.4	-1.4	-0.9	0.9	-2.2	-1.5	-2.1
2012	-0.6	-0.6	0.8	0.4	1.0	1.8	0.4	0.8
2013	1.0	0.6	-0.3	1.8	1.7	0.3	0.4	-0.1
2014	-0.4	4.4	2.0	0.2	0.0	0.1	0.5	2.0
2015	-0.24	1.8	0.5	0.0	1.3	0.9	1.1	1.5
Average monthly	0.67	0.56	0.36	0.26	0.55	0.56	0.30	0.73
Average annual	4.4	6.7	4.5	3.4	5.3	4.6	2.9	4.2

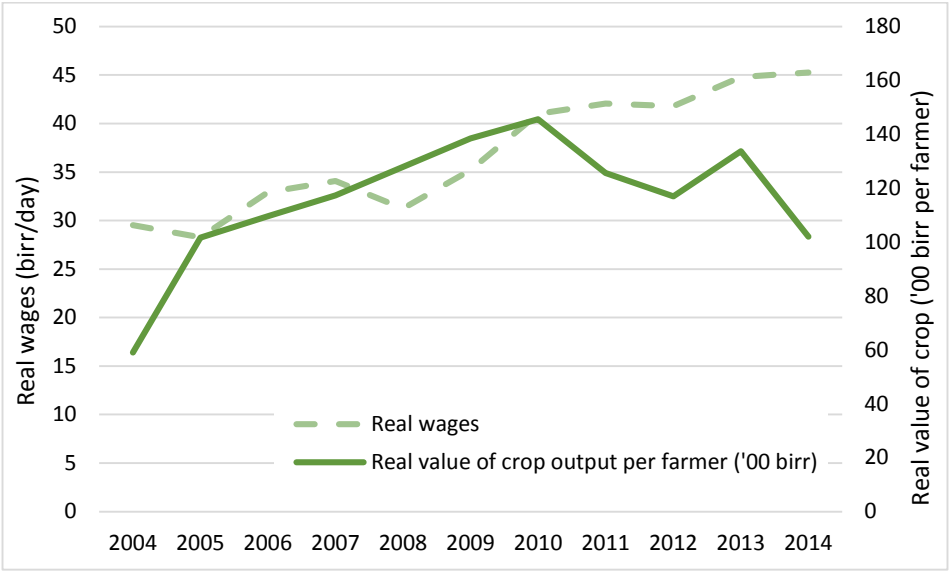
Source: Authors' computation using nominal wages data from CSA (2015a) and CSA (2015b).

Appendix Figure 1: Average monthly nominal wages and exchange rate, July 2004 to December 2015



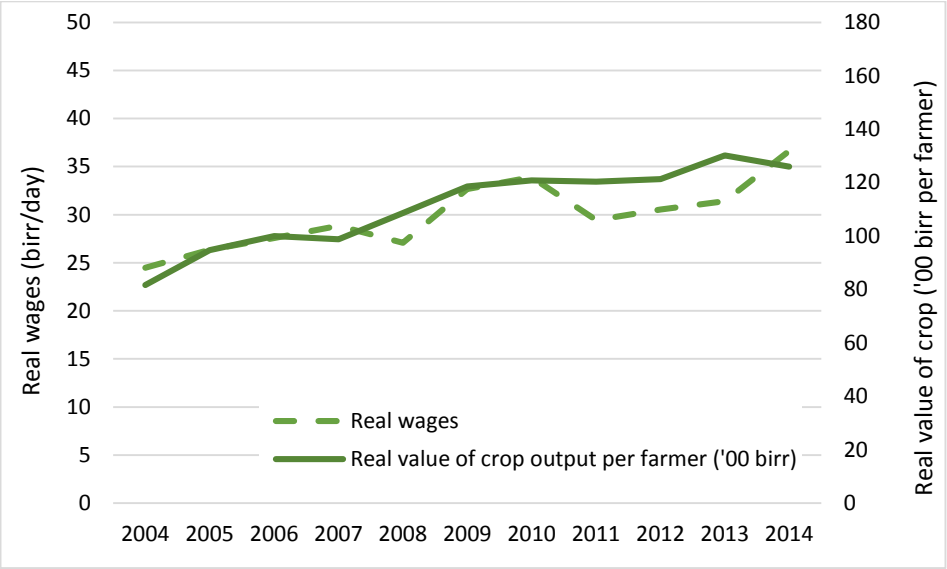
Source: Authors' computation using nominal wages data from CSA (2015a) and National Bank of Ethiopia (2015)

Appendix Figure 2: Real wage and value of output per holder in Tigray region, 2004 to 2015



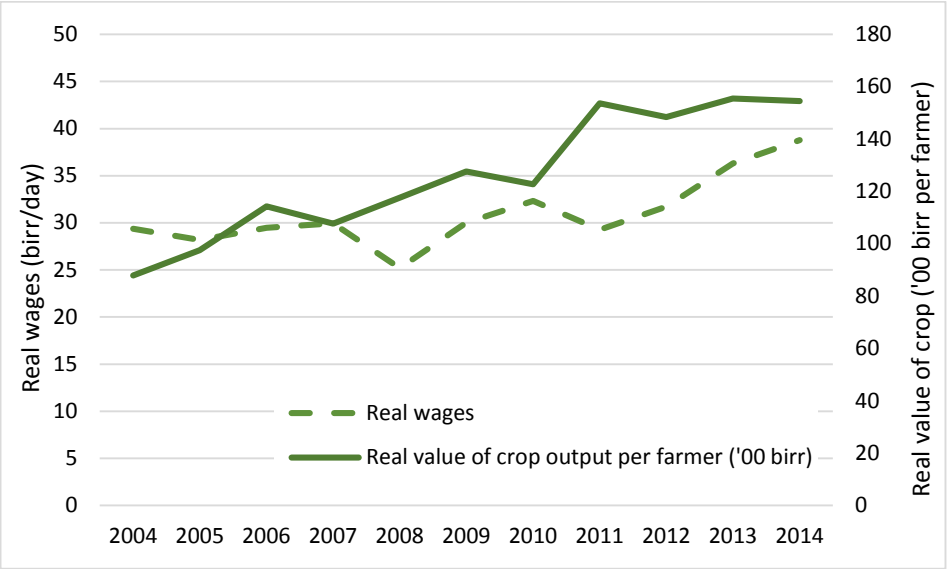
Source: Authors' computation using CSA data on wages (CSA 2015a), producer prices (CSA 2014), consumer price index (CSA 2015b), and crop production (CSA, Volume I 2014-13)

Appendix Figure 3: Real wage and value of output per holder in Amhara region, 2004 to 2015



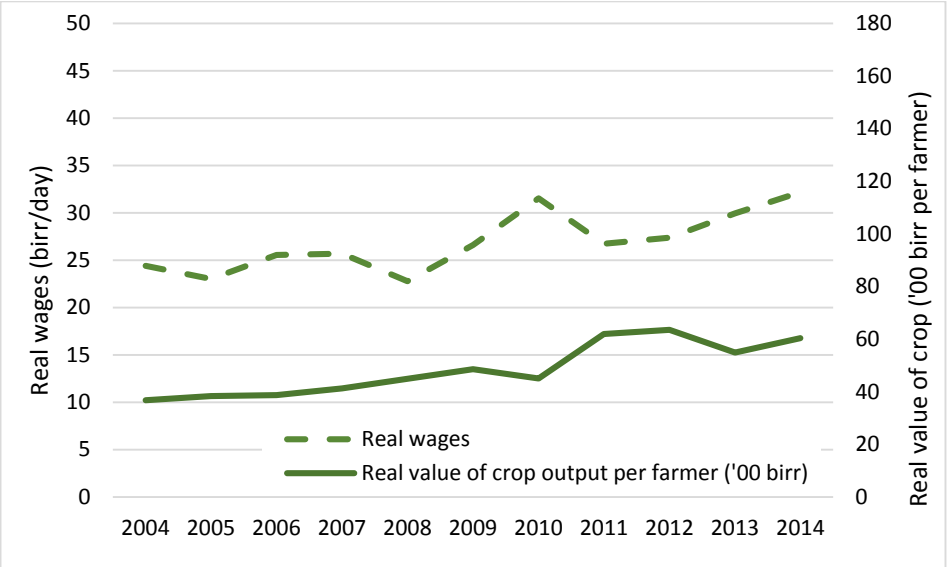
Source: Authors' computation using CSA data on wages (CSA 2015a), producer prices (CSA 2014), consumer price index (CSA 2015b), and crop production (CSA, Volume I 2014-13)

Appendix Figure 4: Real wage and value of output per holder in Oromiya region, 2004 to 2015



Source: Authors' computation using CSA data on wages (CSA 2015a), producer prices (CSA 2014), consumer price index (CSA 2015b), and crop production (CSA, Volume I 2014-13)

Appendix Figure 5: Real wage and value of output per holder in SNNP region, 2004 to 2015



Source: Authors' computation using CSA data on wages (CSA 2015a), producer prices (CSA 2014), consumer price index (CSA 2015b), and crop production (CSA, Volume I 2014-13)

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