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Rural Income Diversification in Ethiopia: Patterns, Trends, and Welfare Impacts

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Abstract

Increased diversification of rural households into the rural nonfarm economy is an important driver of economic growth and structural transformation in countries like Ethiopia where the vast majority of people live in rural areas and are largely dependent on seasonal agriculture. Some of the benefits of diversification include efficient utilization of asset endowments (e.g., labor during dry season) and reduction of risks. In this study we explore the patterns, trends, drivers, and welfare effects of diversification during the recent decade using three rounds of representative household data from the four main regions of Ethiopia. We used Cragg's Double-Hurdle model, a method that considers the two-step decision making process in diversification (i.e., participation and extent of participation), to identify the determinants of diversification and a fixed-effect and Instrumental Variable (IV) approaches to understand the links between diversification and household welfare. The descriptive results show that sample households generally adopt a livelihood strategy dominated by farming and that the level of diversification has been stagnant over the period of analysis considered. More importantly, the vast majority of households continue to draw a substantial share of their income from crop production, followed by livestock. The income from non-farm activities accounts only between 17-23% of the total income. The econometrics results show that diversification is positively associated with credit access, membership in social insurance, ownership of mobile phone, relative measure of household wealth, and population density. Conversely, access to relatively large, fertile, and irrigable land discourages diversification into nonfarm activities. The results on the link between income diversification and household welfare indicate a strong association between diversification and household total consumption expenditure, dietary diversity score, and housing/roof quality. In sum, the results imply the need for a deliberate effort to expand the nonfarm economy so as to tap its full potential for employment generation, income growth, welfare improvements. A starting point could be for agricultural and rural development policies and investments to go beyond promotion of cereal crop production and facilitate participation in high value crop, livestock, aquaculture production. Incentivizing investments in value addition activities that can create and enrich upward and downward linkages in the midstream segment of agricultural value chains is another potential avenue to boost rural nonfarm economy.

1. Introduction

A successful economic transformation involves, among others, a declining share of agriculture in gross domestic product (GDP), an increase in the share of GDP in manufacturing and modern services in urban areas, a decline in the share of agriculture in total employment, and rapid urbanization associated with migration of rural workers to urban settings (Hayami and Ruttan 1985; Timmer and Akkus 2008; Breisinger and Diao 2008). The literature has gone through several revisions regarding the importance of agriculture in the process of the transformation. Currently, the general consensus appears to be that transformation in agriculture, more broadly in the rural sector, plays an active role, and that success of structural transformation depends importantly on agricultural transformation in countries like Ethiopia where agriculture is the main base of the economy. In this respect, increased diversification of rural households into the rural nonfarm economy and high-value goods and services production is an important contributor for agricultural transformation and vice versa (von Braun and Feder 2007; Reardon et al. 2007). In particular, growth in the rural nonfarm sector is expected to have important implications for employment growth and the welfare of women and poor households given its small scale, low capital requirement, and amenability to home-based activity (Reardon et al. 2007).

The Ethiopian economy grew rapidly during 2004/05-2017/18, with GDP growing at 10.4 percent and per capita GDP at 7.6 percent per annum (National Bank of Ethiopia (NBE) 2019). Agriculture on average accounted for 44 percent of the GDP and was a major contributor to GDP until 2011/12, when it was surpassed by the services sector. Within agriculture, crop production is the most important. The share of crop production in agricultural GDP increased throughout of the period, for the most part, driven by increased productivity in cereals production (NBE 2019; Bachewe et al. 2018). There was an increase in per capita quantity consumed, particularly in urban areas, real expenditure, and share in total consumption expenditure of animal products, fruits, and vegetables. Despite these changes the share of livestock in agricultural output declined (NBE 2019), livestock productivity was stagnant (Bachewe and Taddesse 2019), and yields of high-value crops, particularly vegetables declined (CSA 2005-2019).

Whether the trajectory of growth in Ethiopian economy observed in the last 15 years is consistent with the stylized phases of economic transformation is open to argument. This report uses a micro/household level panel data that covered most the last decade to study the concomitant

transformation expected to occur in agricultural/rural sector. For that purpose, we study descriptively the patterns and trends of income diversification and participation in and share of different income sources in total income of rural households. We also use econometric analyses to study the pull and push factors associated with income diversification and importance of income sources and the association of income diversification with household welfare.

In general, households adopt agrarian-dominated livelihood strategy, and this has changed little over the period of analysis and the vast majority of households continue to draw a substantial share of their income from crop production, followed by livestock. The income from non-farm activities accounts only between 17-23% of the total income over the period considered and shows a downward trend. Interestingly, the highest share of non-farm income (23%) was in 2016 when El Niño caused droughts, which reduced crop income in most part of the country and presumably pushed households to augment their income from other sources.

The results on the determinants of income diversification shows that interhousehold differences in asset endowment (i.e., land including quality and access to irrigation, labor, experience, access to capital and information, etc.), proximity to small towns, and natural conditions (e.g., rainfall pattern) play a crucial role in driving household's choice of diversification strategies. For instance, while income diversification is positively associated with access to credit, mobile ownership, and asset/wealth, it is negatively associated with access to large, fertile, and irrigable land, which make crop production more profitable. Consistent with prior studies, the results on the link between income diversification and household welfare indicate a significantly higher consumption expenditure, a more diverse diet, and better housing (as measured by roof quality) among households with diversified income sources.

This remainder of the paper is organized as follows. The following section discusses the data and methods used in the study. Section 3 presents results of the descriptive analyses, which is followed by Section 4 that presents the results and discussions of the econometric analyses. The last section concludes with policy implications.

2. Data and methodology

2.1 Data

This study relies mainly on data collected in three rounds of household surveys conducted by the International Food Policy Research Institute (IFPRI) for the Agricultural Transformation Agency (ATA) of Ethiopia. The surveys were conducted in 2012, 2016, and 2019 and included 3,000, 4,991, and 5,311 sample households, respectively. These surveys were conducted to systematically assess the impact of the Agricultural Commercialization Clusters (ACC), a flagship project initiated by the ATA and implemented by the Ministry of Agriculture (MoA) and Regional Bureaus of Agriculture (RBoA). While the descriptive analyses section of the study includes all households with data in the relevant sections, the econometric analyses is based on 1,899 panel households that were interviewed in all three rounds.

Comprehensive survey instruments were used to collect household level data on crop production for a complete agricultural year that includes two cropping seasons (i.e., meher and belg), and livestock production[1], agricultural and non-agricultural wage income, enterprise income, remittances, and all other incomes for the 12 months preceding the time of the survey. For the purpose of this study total household income is defined as the sum of net crop, net livestock, total wages earned from agricultural and non-agricultural labor, enterprise income, remittance income, and other incomes. Net crop income is computed as the total value of crop output minus variable costs of production. Variable costs of crop production include money spent on purchased inputs such as fertilizer and improved seeds; rental of farm machinery and draft animals; and other crop production-related costs. Similarly, livestock income is computed as the value of livestock sold and slaughtered and the value of livestock products, such as milk, honey, butter, and others, less variable costs of livestock production.[2] Variable costs of livestock production include costs of buying animals, labor hired to care for animals, veterinary services, and other livestock related costs. In each round of surveys, price data collected from sales transactions are used to compute the value of crop and livestock production. Similarly, net enterprise income is computed as the

1 Detailed data on livestock production were not collected in the 2019 survey. Therefore, we impute livestock net income for 2019 based on a regression model estimating livestock net income as a function of herd size and herd size squared from 2016 survey data.

2 Other incomes include rental incomes, returns on investments, and incomes from sources not included in the remaining categories.

difference between gross enterprise income and total costs incurred for purposes of running the business.

In this study non-farm activities encompass all income generating activities other than production of primary agricultural outputs. This includes activities or income sources from business enterprises, non-agricultural wage labor, remittances, and other activities. Farming activities, on the other hand, include own farming (crop and livestock) plus agricultural wage labor. Off-farm incomes/activities include all incomes excluding income generated from own farming (crop and livestock). Note also that non-agricultural wage income includes income earned by working in business enterprises owned by others.

Table 1 provides a summary of sample households sociodemographic, economic, and location characteristics used in the econometric analysis. A number of the variables, such as age and education of the household head, household size, irrigation, access to credit, and livestock ownership (TLU), have values similar with those observed in other datasets. However, the proportion of female-headed households, which is about one-quarter of the total number of households in other datasets, is considerably lower in this particular dataset. It is also interesting to note the proportion of females among working age people, which is slightly higher than proportion of females in the general population (Bachewe et al. 2020). This dataset also differs from others in average farmland owned, which is considerably higher than the average land size of about 1 hectare observed in most datasets (Minten et al. 2020).

Table 1 Summary statistics of sample household (and location) characteristics

	2012	2016	2019
	(mean)	(mean)	(mean)
Gender of HH head (*1=female*)	0.16	0.16	0.16
Proportion of females in working age	0.53	0.54	0.53
Age of the HH head	46.01	48.93	50.84
Education level attained by the HH head	0.43	0.41	0.45
Education level attained by the spouse	0.19	0.20	0.21
Household size	5.50	5.72	5.56
Dependency ratio	1.50	1.51	1.47
Access to credit (*1=yes*)	0.29	0.28	0.16
Farmland owned (*hectare*)	1.75	1.77	1.79
HH has irrigable land (*1=yes*)	0.06	0.08	0.08
Social insurance (1=member in idir/iqub)[a]	0.08	0.79	0.74
Membership in Agri cooperative (*1=yes*)	0.43	0.52	0.45
HH owns mobile phone (*1=yes*)	0.33	0.56	0.64
Livestock ownership (*TLU*)	5.20	5.89	5.42
Time to weekly market (*minutes*)	82.38	67.80	64.79
Time to Woreda Admin center (*minutes*)	165.84	137.44	132.21
Number of obs.	1891	1877	1865

Source: Authors' analysis using the ACC Surveys of 2012, 2016, and 2019.
Note: a=The number for 2012 pertains only to membership in iqub.

2.2 Methods

Indicators

This study uses two related indicators. The first set of indicators are the share of income, net of variable costs, from different economic activities out of total household income. This includes the shares of incomes from crop production; livestock production; agricultural wage labor; non-agricultural wage labor; enterprise income; remittance/transfer income; and other income sources. The share of each economic activity j out of total income of household h is given as:

$$S_{hj} = \frac{Y_{hj}}{\sum_{j=1}^{J} Y_{hj}} \text{ where } j = 1, 2, \dots, J$$

where Y_{hj} is income of household h from source j and S_{hj} is the share in total income of source j for household h.

The second indicator, which is derived from the first set of indicators is the Herfindahl diversification index (HDI), also known as the Herfindahl–Hirschman diversification index, is given as:

$$HDI_h = 1 - HI_h$$

whereby $HI_h = \left(\sum_j^n {S_{hj}}^2 - (1/J)\right)/(1/J)$ and J is the total number of income sources. Measured in this manner HDI_i ranges between zero and one. A diversification index of zero ($HDI_h = 0$) occurs when a household decides to specialize in only one income generation activity. If households decide to participate in more than one activity, then $HDI_i > 0$ and its magnitude depends on the number of activities participated and importance of the activities in total income. A diversification index of one ($HDI_i = 1$) occurs when a household earns an equal share of its income from each source; for instance, when each of the five income sources a household participates account for 20 percent of the household's income.

The foregoing discussion on diversification imply that households' income generation decision is a two-part process. First, households decide whether or not to participate in the activity, such as crop production, and second, they decide on the importance of the income generation activity as a proportion of total income. However, unlike the decision to participate and share of income generated from one or more of the activities, which are decided upon directly, the decision to diversify and extent of diversification is decided indirectly.

As indicated above, one of the questions this study aims to address is assessing the impact of diversification on household welfare (i.e., the relationship between diversification and welfare outcomes). The study uses three indicators of household welfare: (i) households consumption expenditure per capita; (ii) household diet diversity score (HDDS); (iii) and roof quality (as proxy measure of household assets).

Estimation strategy

The econometric analyses on factors associated with such two-phased decision process is conducted using Cragg's (1971) model, often known as the Double-Hurdle model. Relative to alternative empirical models the double-hurdle model is particularly useful in cases such as ours

where the decision to participate in an economic activity is generated by a process that may differ from the process generating the income shares (Goodwin et al. 1993).

The intuitions for modeling participation and extent of participation as a two-step decision making process are as follows. Households participate in an economic activity if a) the net benefits from participating in the activity is positive ($B_h^* > 0$) or benefits of participation is higher than benefits from nonparticipation and b) they can (have access to) participate in the economic activity ($A_i^* > 0$). Both variables (net benefits of participation and access to participation) are unobservable (latent) variables. We only observe households that participate ($P_h = 1$). The participation (first-hurdle) equation is given as:

$$P_h = \propto_{p0} + \boldsymbol{\beta_p} X_h + \boldsymbol{\gamma_p} Y_h + \boldsymbol{\delta_p} C_h + \boldsymbol{\theta_p} T_h + u_h \text{ if and only if } (B_h^* > 0 \text{ and } A_i^* > 0) \quad (1)$$

$$P_h = 0 \text{ if } (B_h^* \leq 0) \text{ or } (B_h^* > 0 \text{ and } A_h^* \leq 0)$$

Where $u_h \sim N(0,1)$. The second hurdle is the equation that determines the extent of participation, which we measure here as a share of total income (S_h). This is given as:

$$S_h = \propto_{s0} + \boldsymbol{\beta_s} X_h + \boldsymbol{\gamma_s} Y_h + \boldsymbol{\delta_s} C_h + \boldsymbol{\theta_s} T_h + v_h \quad (2)$$

Where $v_h \sim N(0, \sigma^2)$. As indicated above equations pertaining to HDI equivalent to (1) and (2) obtain subsequent to decisions regarding other activities. Vectors X, Y, C, and T in the right-hand side of equations (1) and (2) above contain household demography, endowment, location, and temporal pull and push factors associated with participation and share of each economic activity. Accordingly, X is a vector of six household demographic variables: *gender*, *age*, and *education* of household head, and *education of spouse*, *household size*, and *proportion of females in working age household members* (the ratio of number of female household members between ages of 15 and 65 to total number of household members in that age bracket). Y is a vector of ten variables that represent farm/farmer characteristics and household endowment: *Total cultivated area*, *land quality index*[3], *share of high-value crops in crop income*, and *tropical livestock units*, which normalizes the number of livestock households own in cattle units. Included in Y is also *household wealth index* and dummy variables that take a value of 1 if the *household irrigated land*, *had access*

[3] Land quality index is computed by multiplying perceived soil fertility (1=infertile, 2=semi-fertile, 3=fertile) and slope of land (1=steep, 2=gentle, 3=flat). The index, therefore, ranges from 1 to 9, varying from the poorest to the best land quality.

to credit, owned a mobile phone, is a member of social insurance, and *is a member of agricultural cooperatives.*

The vector C stands for administrative zone dummy variables as well as three variables that represent the communities households resided in: *travel time to all weather roads, population density*, and *standard deviation of meher rainfall*. T stands for year dummies. The vector of parameters β, γ, δ, and θ, which are identified by the superscript 'p' in the participation equation and 's' in the share equation, are estimated using a user-written Stata code, craggit (Burke 2009). Although these parameters are estimated simultaneously using craggit, estimates of the participation equation are the same as those obtained from a probit model and estimates of the share equation are the same as those obtained from a truncated normal tobit model. The real advantage of the double hurdle model implemented via the craggit approach is it enables us to estimate the partial effect of an explanatory variable on the unconditional expected value of S_h, whether the explanatory variable is in equation 1, 2, or both (Burke 2009).

To understand the effect of income diversification on household welfare, we modelled our outcome indicators, viz., consumption expenditure per capita, household diet diversity score and roof quality (W_{it}) of household i at time t as a function of income diversification index at time t (HDI_{it}). The basic empirical model is estimated as:

$$W_{it} = \alpha + \delta HDI_{it} + \rho Z_{it} + \varepsilon_{it} \quad (3)$$

where Z_{it} is a vector of household, community, and location characteristics that may affect both household welfare and income diversification. Thus, it controls for household, community, and location (spatial) heterogeneity that potentially could confound the effect of income diversification on our welfare measures. The variables include age, gender, and education level of the household head, household size, dependency ratio, the value of durable assets, the size of livestock owned, size of land owned, access to credit, ownership of mobile phone, travel time to a weekly market, and travel time to the woreda administrative centres. Household fixed effects are included in all the estimations as observed and unobserved household, agro-ecological and other location characteristics might influence the welfare outcomes. The last term in the equation, ε_{it}, is the random error term clustered at the village (kebele) level.

In equation (3), δ captures the main relationships of interest. It represents the impact of HDI on the three household welfare indicators. Based on prior studies and theoretical insights, our hypothesis is that δ is positive. In other words, households with more diversified income source will have better welfare outcomes (e.g., Dercon and Christiaensen, 2011; Reardon et al., 2006). One main estimation concern of equation 3 is that HDI is likely to be endogenous, making the consistency of δ estimated using OLS questionable (Wooldrigde, 2013)[4]. To address this concern, we apply a panel fixed effect and an instrumental variable (IV) approach. The instruments used to identify household income diversification are the degree of income diversification in the community and two weather variables, the average rainfall and the variation in rainfall during the previous harvest season. The degree of income diversification in the community is used as a proxy for social norms and economic opportunities. It captures the attitude regarding the possibility and the potential benefit of diversification in the community. We measure income diversification in the kebele by the average kebele level diversification score excluding the household in consideration. This directly affects the diversification level of the particular household, but it does not affect the welfare outcomes directly.

The second and third instruments are the mean and the standard deviation of the amount of rainfall during the previous harvest season. In highly rainfall-reliant rural economies, the amount and variation of rainfall during the previous harvest periods are powerful predictors of the pattern of income diversification in the subsequent periods, as it can determine production decisions (and thereby share of agricultural income) and migration patterns (Barrett et al., 2001). However, while amount and variation of rainfall are exogenous to the household, their lagged values are less likely to affect the welfare outcomes directly during the current period.

The validity of the IV approach rests on two criteria. The first is the *relevance* criterion that demands that the instruments should be good predictors of the diversification indicator. To formally test for this criterion, HDI is estimated as a function of the instruments and other relevant household and community characteristics, including several household wealth measures. Table A8 in the Appendix shows the first stage regression results. From this result, it is evident that the

[4] HDI could be endogenous due to non-random distribution of diversification index, omitted variables bias or measurement error (e.g., income is measured in monetary terms)

instruments are relevant (i.e., good predictors of income diversification at household level). The partial F-statistic for the model is above 10, the minimum threshold value of the "rule of thumb" for valid instruments (Staiger and Stock, 1997). Moreover, the additional IV diagnostic tests presented at the bottom of the Table 4 affirm the validity of the instruments. The critical values of the Cragg-Donald test statistic reject the null hypothesis that the endogenous regressor is weakly identified. The Kleibergen-Paap test also rejects the hypothesis of under-identification, i.e., the minimal canonical correlation between the endogenous variable and the instruments is statistically different from zero. Furthermore, the Sargan-Hansen test (Hansen J test) could not reject the joint null hypothesis that the instruments are valid (i.e., that the instruments are uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation).

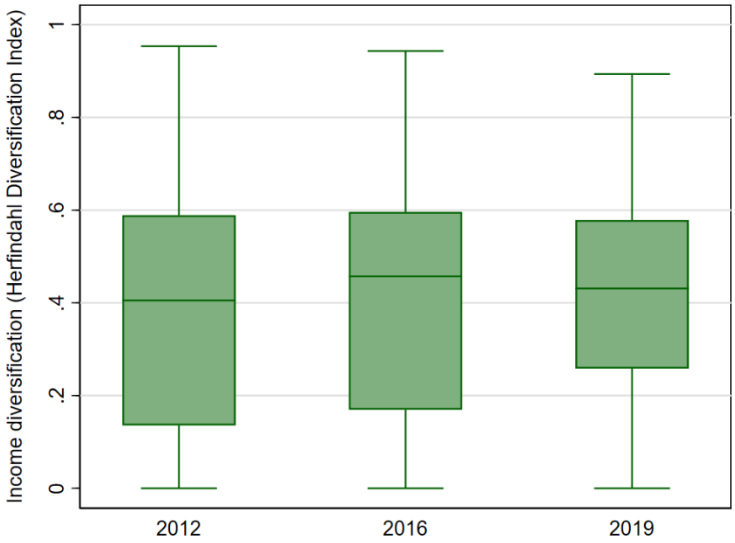
3. Descriptive results

This section describes patterns and trends in income diversification across rural sample households in Ethiopia using the ACC data collected in 2012, 2016, and 2019. Furthermore, the section provides a brief description of aforementioned household welfare measures.

3.1 Patterns and trends of rural income diversification

Figure 1 summarizes the Herfindahl income diversification index for all households. Two observations can be made. First, diversification of income generation activities, measured on a scale of 0 to 1, averaged less than 0.5 in all three years. Indeed, average Herfindahl diversification index (HDI) was below 0.5 across different household categories (Figures 2 and 3). The level of HDI calculated from this dataset is also comparable with that obtained from other datasets (see for e.g., Bachewe et al. 2020). Secondly, despite the slight increase in HDI in 2019 there is little change in diversification of income sources of rural households in Ethiopia. HDI averaged 0.38 in 2012 and 0.39 in 2016 while it increased to 0.41 in 2019. That is, HDI increased by seven percent during 2012-2019 or by one percent in an average year during the period. The median diversification index is above 0.4 across the three years (Figure 1).

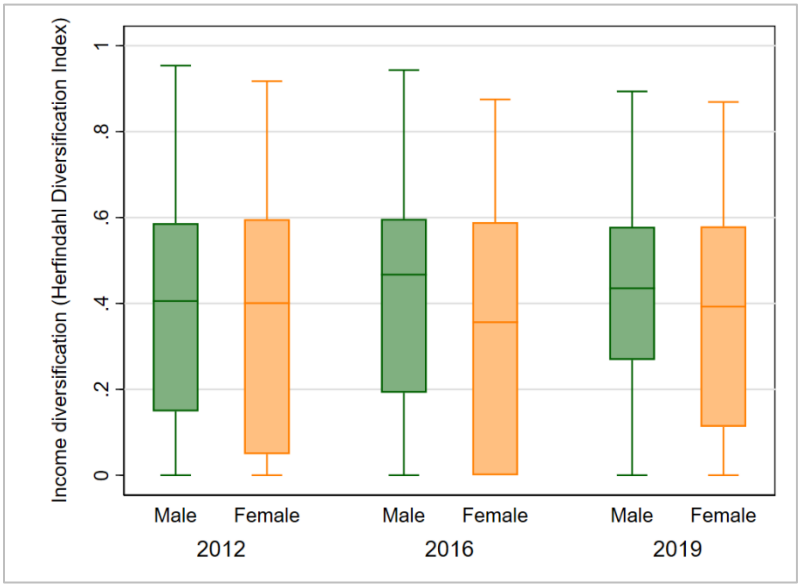
Figure 1 Income diversification (Herfindahl Diversification Index), by year



Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

Figure 2 presents the HDI by gender of the household head and indicates that households with female heads have lower levels of diversification and their HDI stagnated during the period. In contrast, the increase in HDI of male-headed households dominated the pattern observed in the overall sample.

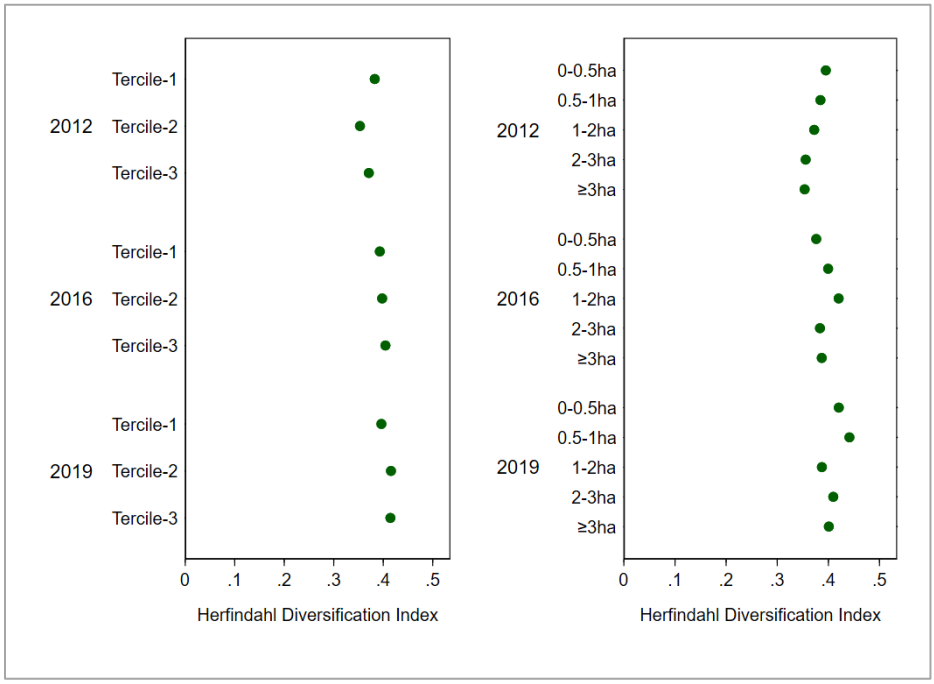
Figure 2 Income diversification (Herfindahl Diversification Index), by gender of the household head



Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

Figure 3 present the HDI by remoteness (as measured by distance tercile to the closest small city) and by farm-size category. Diversification of households in all three terciles of remoteness appears to clearly increase over time, although differences in diversification among households in different remoteness terciles are marginal. Households with smaller farms appear to have higher levels of diversification although the pattern is unclear in 2016, when El Niño caused drought affected most of the country adversely, implying that farm size may be linked with diversification only loosely during periods of crop failure.

Figure 3 Income diversification (Herfindahl Diversification Index), by remoteness and farm size



Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

Table 2 presents participation rates of households in the different income generation activities, shares of the income sources in total household income, and household average income.[5] Several observations can be made regarding these results. First, a considerably high proportion of rural households participate in crop production, and crop income accounts for the majority of rural household income. However, both participation in crop production and share of crop income are declining, albeit slowly. Second, both participation in and share of livestock income are increasing.

[5] Note that shares of the income sources that can be calculated from the average incomes in the table may differ from averages of the income shares calculated at household level.

Moreover, both of these observations are consistent with what was observed in other large household survey data in the country like the Feed-the-Future survey data (Bachewe et al. 2020). Participation in and share of crop income is more important for male- than female-headed households (Table A1 in the appendix). In contrast, the proportion of female headed households that participated in livestock production was higher than the proportion that participated in crop production in 2019 and the share of livestock income was higher for female-headed households than those with male heads in most years.

Third, participation in remittance income ranged between 7 and 9 percent and remittance income accounted for 2.1 to 2.9 percent of rural household income. Female-headed households participate twice as often in remittance income compared to male-headed households, and the share of remittance in their income is even higher (Table A1). Participation in and the share in total income of other income generating activities was more than double the income from remittances. Again, participation of female-headed households was over twice as higher, and the share of other income sources was over four times higher for female-headed households as for male-headed households.

Table 2 Participation in different income generating activities and contribution of each source of income to overall income

	Percent participated			Income received			Share of income		
	2012	2016	2019	2012	2016	2019	2012	2016	2019
Net crop income	93.7	87.9	89.6	14497	15772	23713	63.3	54.1	60.4
Net livestock income	78.1	78.5	91.0	3193	5076	5101	17.2	21.4	22.4
Agri wage income	7.8	4.7	2.4	167	162	68	2.0	1.5	0.5
Non-agri wage income	9.0	12.2	9.11	428	901	848	2.8	4.2	3.2
Enterprise income	30.9	29.5	21.5	1228	2121	1936	7.4	9.0	6.5
Remittance (transfer)	9.32	9.32	7.27	268	403	382	2.3	2.9	2.1
Other incomes	21.5	24.6	15.9	455	767	816	5.1	6.9	4.8
Total (income)	-	-	-	20237	25202	32864	100.0	100.0	100.0
Agricultural income	*98.5*	*97.8*	*98.4*	*17,859*	*21,010*	*28,882*	*82*	*77*	*83*
Non-farm income	*50.2*	*60.2*	*46.4*	*2,378*	*4,192*	*3,982*	*18*	*23*	*17*
Obs.	1,891	1,877	1,865	1,891	1,877	1,865	1,891	1,877	1,865

Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

Fourth, agricultural wage income is least important in terms of both participation and as a share of total income, in general. In relative terms, the proportion of female-headed households that participated in agricultural wage labor is at least twice as high and the share of agricultural wage in their total income is at least four times higher than among households with male heads. Non-

agricultural wage is close to agricultural wage in importance, with only remittance income coming in the middle of the two. Again, relative to male-headed households, female headed households' participation in non-agricultural wage labor is at least twice as great, and its share in total income is at least three times higher.

Fifth, based on participation and the share in total income, business (enterprise) activities are the third most important source of income after crop and livestock production. Moreover, enterprise income is even more important than wage income for female-headed households. This is consistent with what is observed in other household surveys (e.g., Bachewe et al. 2020). Participation and share of agricultural and non- agricultural wage as well as enterprise income is the highest in 2016, again indicating the influence of the drought caused by El Niño that reduced crop income and pushed households to augment their income with other sources.

Sixth, excluding its decline in 2016, agriculture's importance remained about the same in terms of participation and slightly increased in terms of its share of total income while non-farm activities declined in importance by both counts over the period considered. Over 98.4 percent of the households participated in agricultural (i.e., crop, livestock, and/or agricultural wage) in 2012 and 2019 and only slightly lower in 2016 at 97.8 percent. Consequently, the share of income from farming activities in total income was about the same in 2012 and 2019 and lower in 2016. In contrast, the proportion of rural households that participated in non-farming activities (i.e., non-agricultural wage, enterprise, remittance, and/or other) was 59 percent in 2012, 60 percent in 2016, while it was considerably lower at 46.4 percent in 2019. The share of non-farming activities in total income was 18, 23, and 17 percent in 2012, 2016, and 2019, respectively. This is considerably lower than the share of non-farm income in rural areas of Latin America (47 percent), Asia (51 percent), and Africa (37 percent) (Haggblade et al. 2007).

Overall, diversification of income sources among households in the ACC dataset has changed marginally over the period considered. The fact that most of the population in Ethiopia is young and that the diversification levels discussed pertain to the same set of households with previously young household members joining the labor force, indicates that an increasing proportion of the income was generated in agriculture and these workers did not lead to a meaningful diversification in income sources of the households.

Increased diversification of income sources among rural households is expected not only due to the push from demographic and resource endowment factors discussed but also due to pull factors such as transformation in agriculture and the overall economy and increased urbanization and industrialization. One can argue that specialization in income generation activities, rather than diversification, is concomitant to such economic transformations. However, the ACC data do not imply specialization either. Furthermore, the premise for that argument would imply increased income diversification at some level of aggregation. We assess this by conducting the analyses at community/kebele and district/woreda level. The results indicate that community (district) level HDI averaged 0.56 (056), 0.64 (0.65), and 0.53 (0.54) in 2012, 2016, and 2019, respectively. Two observations can be made about these numbers. First, although community and district income sources are more diversified than that of households', which is expected, the difference is not substantial. More importantly, HDI in 2019 is lower than that in 2012 implying that there was no overall change in community/district level income diversification that can be presented as evidence supporting the argument above. Secondly, HDI in 2016 was about 15 percent higher than that in either of the years, presumably the El Niño caused droughts in 2016 has forced households and apparently communities/districts to diversify out of crop production indicating that push factors are still important in Ethiopia.

3.2 Outcome measures

The rapid macroeconomic growth observed in Ethiopia since 2004 is also apparent in the fast growth in household income observed in the ACC data. The data reveal that household real income increased by a total of 62.4 percent during 2012-2019 or at 7 percent in an average year during the period. The summary statistics in Table 3 indicates that the rapid growth in income appears to have translated into improved household welfare. Household food and non-food consumption expenditure grew by a total of 182 and 170.5 percent during 2012-2019 or at average annual rate of 30.4 and 28.4 percent, respectively. Total consumption expenditure increased at average annual rate of 22 percent per annum, which is more than twice the rate of growth in household income. Welfare, measured also in terms of household dietary diversity, is higher in 2019 than in 2012. More importantly, dietary diversity was the highest in 2016, which again goes back to the 2015/16 El Niño caused droughts when households may have to depend on market purchased, more diversified, food. Roof quality has also been used as a measure of improvements in welfare (as a

proxy measure to asset building). The ACC data indicates that nearly three quarters of the households have corrugated metal roofs in 2019 relative to about half of the households in 2012.

Table 3 Household welfare measures

	2012	2016	2019
Household dietary diversity score (HDDS)	5.83	6.02	5.98
Consumption expenditure per capita (*birr, 2016 prices*)			
Food expenditure	2971.7	4981.2	8385.9
Non-food expenditure	909.7	1727.8	2460.6
Total expenditure	4,426.2	6,845.0	10,256.7
Share of food in total expenditure	0.65	0.73	0.78
Roof quality (*1= corrugated metal*)	0.51	0.65	0.73

Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

4. Econometric results

In this section we present and discuss the main results. The first subsection presents the results from our fixed effect and IV estimates on the link between income divarication and welfare outcomes at household level. The subsequent subsection presents the household and community level push and pull factors associated with income diversification based on the results from Cragg's double-hurdle model.

4.1 Impact of rural income diversification on household welfare

The descriptive results on the patterns of diversification indicates that sizable share of sample households chosen to allocate their assets and efforts across a variety of activities, presumably to broaden economic opportunities and cope/manage risk exposures. Since diversification itself is not the end goal, in this subsection, we examine whether diversification strategies eventually lead to an increase in income and welfare at household level. Table 4 presents the results on the link between diversification strategies and welfare outcomes from the household fixed effect and IV (2SLS) estimates.

The result clearly show that income diversification has a strong positive effect on consumption expenditure per capita, household dietary diversity, and roof quality (a proxy indicators for housing quality/asset building). For instance, the estimates from the fixed effects model show that a one standard deviation increase in income diversification index leads to 13 percent growth in

consumption per capita; 0.24 increase in number of food groups consumed; and a 4.8 percentage point increase in housing quality. It is also interesting to see that the result of the FE and IV-2SLS estimations are consistent, although the coefficient is slightly larger in the case of the IV model. Such differences between FE and IV methods could be due to potential measurement errors. We know that while measurement errors can lead to an attenuation bias towards zero in the linear model coefficients, instrumental variable approaches often mitigate such problems (Gujarati 2003; Angrist and Pischke 2009).

Tale 4 also reveals that welfare outcomes are significantly correlated with many other covariates. Consistent with other empirical studies, diet quality (HDDI) is strongly correlated to membership in social insurance (i.e., iddir and equb) and standard wealth indicators— size of land owned ownerships of livestock and durable assets. On the other hand, consumption expenditure and housing quality are positively correlated with age of the household head and mobile ownership.

Table 4 Rural income diversification and household welfare

	Consumption expenditure per capita		HDDS		Roof quality	
	FE	IV (2SLS)	FE	IV (2SLS)	FE	IV (2SLS)
Income diversification index	0.131**	2.210**	0.240**	1.746	0.048*	0.647**
	(0.059)	(1.112)	(0.109)	(1.317)	(0.025)	(0.297)
Gender of HH head (*1=female*)	0.153*	0.150	-0.011	-0.013	0.089**	0.088**
	(0.086)	(0.099)	(0.106)	(0.112)	(0.041)	(0.043)
Proportion of females in working age	0.053	0.001	0.049	0.012	0.021	0.006
	(0.086)	(0.095)	(0.121)	(0.135)	(0.030)	(0.032)
Age of the HH head	0.015***	0.013***	-0.010***	-0.011***	0.004***	0.003***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)
Education level attained by the HH head	0.078*	0.068	-0.024	-0.031	-0.001	-0.003
	(0.042)	(0.049)	(0.075)	(0.077)	(0.017)	(0.018)
Education level attained by the spouse	0.073*	0.009	0.111	0.064	0.009	-0.009
	(0.041)	(0.064)	(0.082)	(0.091)	(0.020)	(0.023)
Household size	-0.137***	-0.155***	-0.008	-0.021	0.011***	0.006
	(0.011)	(0.016)	(0.020)	(0.023)	(0.004)	(0.005)
Dependency ratio	-0.002	0.006	0.064**	0.069**	-0.008	-0.006
	(0.017)	(0.020)	(0.031)	(0.033)	(0.007)	(0.008)
Access to credit (*1=yes*)	-0.133***	-0.181***	0.130**	0.095	-0.030**	-0.044**
	(0.033)	(0.048)	(0.056)	(0.071)	(0.015)	(0.019)
Farmland owned (*hectare*)	0.005	0.008	0.040**	0.042**	0.004	0.004*
	(0.008)	(0.009)	(0.019)	(0.019)	(0.002)	(0.002)
HH has irrigable land (*1=yes*)	0.193**	0.215**	0.160	0.175	0.018	0.024
	(0.078)	(0.084)	(0.121)	(0.125)	(0.027)	(0.028)
Social insurance (1=member in idir/iqub)	0.902***	0.850***	0.294***	0.255***	0.101***	0.086***
	(0.045)	(0.052)	(0.067)	(0.081)	(0.014)	(0.017)
Membership in Agri cooperative (*1=yes*)	-0.024	-0.012	0.038	0.047	0.018	0.022
	(0.037)	(0.043)	(0.054)	(0.055)	(0.015)	(0.016)
HH owns mobile phone (*1=yes*)	0.358***	0.329***	0.006	-0.015	0.093***	0.085***
	(0.036)	(0.042)	(0.058)	(0.061)	(0.016)	(0.016)
Livestock ownership (*TLU*)	0.002	-0.001	0.025**	0.022**	-0.000	-0.001
	(0.002)	(0.003)	(0.012)	(0.010)	(0.001)	(0.002)
Household asset index (PCA)	0.014	0.003	0.110***	0.103***	0.014***	0.011**
	(0.013)	(0.017)	(0.020)	(0.022)	(0.004)	(0.005)
Time to weekly market (*minutes*)	-0.001***	-0.001***	0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Time to Woreda Admin center (*minutes*)	-0.000	-0.000	0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	7.894***		5.845***		0.255***	
	(0.123)		(0.220)		(0.052)	
Number of observations	5,428	5,376	5,428	5,376	5,428	5,376
R2	0.420	0.197	0.059	-0.009	0.102	-0.065
Adjusted R2	0.418	-0.225	0.055	-0.540	0.099	-0.625
Cragg-Donald test		13.48		13.48		13.48
Kleibergen-Paap rk LM statistic		16.56		16.56		16.56
P-value		0.000		0.000		0.000
Hansen J statistic		2.142		1.045		2.525
P-value		0.343		0.593		0.283

Note: Estimation based on three-round balanced panel data. ***p<0.01, **p<0.05 *p<0.1.
Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

4.2 Determinants of rural income diversification

As indicated in section 2.2 we obtain three sets of estimates from Cragg's double-hurdle model. In Table A.7 of the Appendix, we provide estimates of parameters of equation (1), the participation or first hurdle, and equation (2), income share or second-hurdle equation. In Table 5 we provide the third set of estimates: the average partial effects of the explanatory variables on HDI and income shares, obtained using the method described in Burke (2009). Several observations can be made about the results in Table 5.

First, demographic factors play important role in income diversification. Female-headed households have more diversified incomes. This is likely because females often become household heads later in life after being widowed or separated from their husbands. This means female heads are older than their male counterparts, yet have less experience in agriculture, and have smaller farms. Consequently, these factors push them to generate more of their income from diverse – non-farming – activities, which is consistent with our descriptive results as well as the estimates in Table 5. Increase in number of household members is likely to serve as an impetus for greater income diversification not only to provide for the members but also because there likely is ample labor in the household. Larger households have a lower share of remittance income perhaps because fewer members may have migrated out. The results also indicate that households with a higher proportion of females generate a higher share of their income from livestock production and a lower share from crop production and wage income. This may be because female household members, particularly younger girls, are generally discouraged from working as hired labor and spend more time on household chores. Education levels of the household head and/or the spouse are associated positively with the share of income from non-farming (viz. wage and enterprise) activities and negatively with crop and remittance income.

Secondly, interhousehold differences in asset endowment play an important role in income diversification. Households that own a larger, good quality, and irrigable agricultural land are likely to generate a higher share of their income from crop production and a lower share from other activities or less likely to diversify their income, as corroborated by the results. The share of high-value crops in crop output has a similar relationship with income diversification. The obvious positive (negative) relationship of these factors with crop income (income diversification) means that these factors push households out of diversification.

Table 5 Average partial effects of the Double-Hurdle model

Variables	HDI		Crop		Livestock		Wage		Enterprise		Remittance	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Gender of HH head, =1 if female	2.255**	1.006	-4.093***	1.133	0.72	0.832	0.61	0.389	1.024*	0.609	1.362***	0.143
Proportion of females in working age	1.611	1.544	-3.842**	1.717	3.585***	1.249	-4.262***	0.651	0.993	1.005	1.03***	0.200
Age of the head, in years	-0.033	0.026	0.004	0.029	0.053**	0.022	-0.009	0.011	-0.061***	0.017	0.057***	0.005
Education level attained by the head	0.379	0.620	-1.248*	0.686	-0.116	0.522	1.029***	0.229	0.568	0.363	-0.119	0.102
Education level attained by the spouse	0.618	0.775	-1.238	0.869	-0.494	0.661	0.527*	0.283	1.073**	0.439	-0.612***	0.151
Household size	0.352**	0.162	-0.024	0.179	0.552***	0.136	0.096	0.067	-0.049	0.101	-0.289***	0.028
Household had access to credit, yes=1	3.241***	0.718	-2.61***	0.806	-0.116	0.605	1.042***	0.269	1.064**	0.419	0.566***	0.115
Farmland owned (ha)	-0.498***	0.164	0.542***	0.136	-0.028	0.127	-0.581***	0.114	-0.418***	0.140	-0.423***	0.051
Index of land quality	-0.08	0.165	0.531***	0.184	-0.386***	0.140	0.057	0.063	-0.131	0.099	0.041	0.025
Livestock, in tlu	0.414***	0.060	0.014	0.064	0.688***	0.044	-0.711***	0.049	-0.445***	0.065	-0.088***	0.016
Household asset index, PCA	0.396*	0.222	0.785***	0.242	-0.256	0.183	-0.268***	0.092	0.205	0.138	0.186***	0.035
High-value crops in crop output, %	-0.118***	0.012	0.177***	0.013	-0.122***	0.013	-0.032***	0.005	-0.012	0.007	-0.013***	0.002
HH owns mobile phone, yes=1	1.505**	0.726	-3.233***	0.811	-1.124*	0.594	1.343***	0.287	1.789***	0.465	0.955***	0.119
Member of social insurance	3.182***	0.924	-3.976***	1.037	-0.297	0.745	0.402	0.362	3.358***	0.611	-0.367**	0.138
Agri cooperative member	-0.849	0.704	0.341	0.784	0.67	0.576	-0.208	0.285	-0.387	0.424	-0.413***	0.108
HH has irrigable land, yes=1	-2.759**	1.202	12.224	10.990	-4.989***	1.184	-0.146	0.466	-0.269	0.708	-0.876***	0.227
Time to all-weather road, in min	-0.004	0.003	0.003	0.003	0.002	0.002	-0.007***	0.002	0.001	0.002	0.001**	0.000
Population density, persons/sq KM	0.021***	0.006	-0.005	0.006	0.007	0.005	0.003	0.002	-0.001	0.003	-0.001	0.001
Variation of rainfall	0.24	0.159	-1.03***	0.175	0.703***	0.141	0.025	0.065	0.063	0.096	0.0002	0.026
2016 dummy	0.086	1.051	-4.267***	1.187	4.691***	0.886	-0.277	0.408	-0.994	0.632	0.703***	0.160
2019 dummy	3.158***	1.124	0.462	1.247	6.759***	0.959	-2.444***	0.448	-3.493***	0.729	-0.785***	0.176
Number of observations	5,172		5,172		5,172		5,172		5,172		5,172	

Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.
Note: Estimation based on three-round balanced panel data. ***p<0.01, **p<0.05 *p<0.1.

Household access to credits, ownership of mobile phones, and relative measure of household asset/wealth serve as pull factors for household income diversification. These factors are negatively associated with crop and livestock income share (except asset/wealth index) and mostly positively associated with income share of the remaining activities. Similarly, the number of tropical livestock units owned is positively associated with income diversification and livestock income share, although it is negatively associated with wage, enterprise, and remittance income shares. Households that are members in social insurance (i.e., iqqub and/or iddir) have higher income diversification and enterprise income share while membership in such schemes is negatively associated with crop and remittance incomes.

Thirdly, local factors affect income diversification and the importance of different sources in household income. A higher population density leads to higher income diversification perhaps because increased population puts pressure on farming (push) while also increased demand for non-agricultural products may pull households towards diversification. Proximity to all-weather road increases the importance of wage income as availability of wage employment (pull) increases with connectivity and the importance of remittance income. Variation of rainfall reduces the importance of crop income, as most of the crop production in Ethiopia is rainfed (only 8 percent of the households own irrigated land). Rainfall variation is positively associated with livestock income, implying the role of livestock as insurance against crop failure during periods of rain shortfall. This rainfall-crop-livestock nexus is also shown in the 2016 dummy, which is associated negatively with crop income and positively with livestock and remittance incomes.

5. Conclusions and policy implications

Among hallmarks of successfully transformed economies are a reduced share of agriculture in the economy and employment, increases in manufacturing and modern services in GDP, and rapid urbanization. The Ethiopian economy grew rapidly in the last 15 years mostly driven by the rapid growth in crop production. The manufacturing sector contributed little to this economic growth, productivity of high-income elasticity food items was stagnant, the share of agriculture in employment has generally been high, and the rate of urbanization has been low. This leaves open to argument whether the growth observed in Ethiopia is consistent with the stylized facts of economic transformation.

Non-farm economic activities have traditionally been important in the transformation of developing economies of Asia, Latin America, and Africa. Such activities are crucial not only from poverty reduction point of view but also, could lead to accelerated growth in income, output, and employment in rural areas. In this study we use data collected in 2012, 2016, and 2019 by the Agricultural Transformation Agency (ATA) of Ethiopia in its flagship project of Agricultural Commercialization Clusters (ACC) to study income diversification and the importance of non-farm income sources. We use descriptive analyses to elucidate the patterns and trends of income diversification, the importance of different economic activities in total income, and welfare measures of rural households in Ethiopia. We deploy the data on Cragg's (1971) double-hurdle model to study the pull and push factors associated with income diversification and importance of income sources and a fixed-effect and instrumental variable approaches to study the links between income diversification and household welfare.

We find that income diversification changed only marginally over the years. Female headed households have relatively lower and stagnant income diversification. A large majority of households participate in and derive their livelihood from crop production. Although both participation in and share of crop income are slowly declining, these appear to be more than compensated by rising participation in and the share of livestock income. Consequently, the total share of income from farming increased, while non-farm activities declined in importance by both counts over the period considered. Crop production is more important for male-headed households, while a higher proportion of female-headed households participate in and generate a higher share of income from other activities. We also find that participation in and the share of non-farming activities was highest in 2016, when droughts caused by El Niño reduced crop income in most of the country and seemingly pushed households to augment their income with other sources. In addition to stagnancy of household level income diversification, we find little change in community and district level income diversification. This makes the argument that suggests an increase in spatially aggregated income diversification during economic transformation less universal.

Results of the econometric analyses indicate that income diversification has a strong positive effect on consumption expenditure per capita, household dietary diversity, and roof/housing quality. Analyses of push and pull factors associated with income diversification reveal that large

households and female-headed households have more diversified incomes. Income diversification is negatively associated with larger farms, good quality soil, and irrigable land, and with increased production of high-value crops. In contrast, income diversification is positively associated with access to credits, ownership of mobile phones, and relative measure of household asset/wealth, factors which are generally negatively associated with crop and livestock income share. Similarly, the number of tropical livestock units owned, membership in social insurance schemes, and population density are positively associated with income diversification.

These results have important policy implication. First, as is observed in the ACC data, the trend in diversification is stagnant for the period of analysis considered and most of the residents in rural areas depend on agriculture and this is likely to continue into the near future. However, the rapid growth in crop agriculture observed in the last decade and half, whereby almost half of the growth came from expansion in area and labor (Bachewe et al. 2018) is unsustainable. This is due to two related reasons. First, cropland is limited. Landholdings are declining across farmers of all age groups and the decline is rapid among youth farmers (Minten et al. 2020). Secondly, growth in rural population; particularly, growth in working age (15-64 years old) population, is faster relative to growth in cultivated area. Therefore, policymakers, while they need to reemphasize the importance of agriculture, they also need to reimagine agricultural policies to address current and future problems given policies implemented in the last two decades were meant to mainly address food security. In particular, these policies need to relax land markets, increase agricultural intensification (through targeted efforts that can increase land and labor as well as total factor productivity), catalyze commercialization and value-addition activities, and thereby increase rural household income.

Second, agricultural policies need to expand to crops other than cereals, as well as include livestock production. Increases in agricultural income will serve as a catalyst for non-farm employment and income growth as it increases the demand for personal services, health, education, housing, processed non-agricultural products and foods, transport, and communication. This is in addition to employment and incomes generated in the marketing, transportation, and processing of agricultural outputs that serves as a bridge between growing agriculture and growing urban centers. More importantly, firms that provide services (non-tradable goods) face less competition compared to the competition that agro-processing firms can face.

Third, policy makers can improve/expand the rural nonfarm economy by creating incentive systems that encourage large scale agro-processors operate in rural areas and thereby employ locals, enrich up-ward and down-ward linkages, and help in the transfer of technologies to small and medium scale firms in the areas.

Fourth, just as blanket policy recommendations are recently going through a rethink process in other areas, we believe that the issue of non-farm economy development need solutions that fit local conditions. Different areas/communities/agro-ecologies and households within communities differ in their endowments, opportunities, problems, and beliefs. Therefore, policy makers attempting to facilitate non-farm employment and income should first realize the diversity of areas and households and that they could be suited for different non-farm activities. For instance, different areas could be suited for production, processing, and marketing of different agricultural produce. Moreover, in areas where the production and processing of agricultural outputs is infeasible other small and medium enterprises engaged in merchandise trade, services, or other activities could be feasible. Having identified the types of activities that suit the community/people, policy makers need also to choose interventions that are effective to facilitate growth in non-farm employment and income for that particular area.

Fifth, experiences of other developing countries indicate that expansion of roads, communication, electrification, and marketing and transportation infrastructure in rural areas will help in the creation or accelerating growth of rural non-farm economy (Haggblade et al. 2007).

Finally, expansion of employment opportunities in rural areas reduces the ills of urban areas, including urban unemployment and poverty because a majority of the population in major urban areas in Ethiopia are recent migrants from rural areas. Thus, government's efforts to address unemployment in urban areas should expand to rural areas. This includes expanding or tailoring the technical, logistical, and financial support provided for small and medium scale enterprises in urban areas to start or expand non-farm employment and income in the rural environment.

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Appendix: Supplementary Tables and Figures

Table A1 Participation in different income generating activities and contribution of each source of income to overall income, by gender of the household head

Income source	Female headed			Male headed		
	2012	2016	2019	2012	2016	2019
Panel A: Participation in different income generating activities						
Agriculture						
Crop	0.78	0.67	0.70	0.97	0.92	0.94
Livestock	0.69	0.62	0.78	0.80	0.82	0.94
Wage income						
Agricultural	0.09	0.04	0.03	0.08	0.05	0.02
Non-agricultural	0.08	0.10	0.09	0.09	0.13	0.09
Enterprise income	0.29	0.32	0.23	0.31	0.29	0.21
Remittance/transfer	0.22	0.16	0.11	0.07	0.08	0.06
Other income	0.35	0.37	0.27	0.19	0.22	0.14
Panel B: Contribution/share of each income source to overall income						
Agriculture						
Crop	0.48	0.39	0.43	0.66	0.57	0.64
Livestock	0.18	0.18	0.25	0.17	0.22	0.22
Wage income						
Agricultural	0.04	0.02	0.01	0.02	0.01	0.00
Non-agricultural	0.03	0.05	0.04	0.03	0.04	0.03
Enterprise income	0.11	0.14	0.10	0.07	0.08	0.06
Remittance/transfer	0.06	0.08	0.04	0.02	0.02	0.02
Other income	0.11	0.15	0.13	0.04	0.05	0.03
Number of obs.	305	311	321	1,594	1,588	1,578

Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

Table A2 Participation in different income generating activities and contribution of each source of income to overall income, by remoteness

Income source	Remoteness tercile		
	Tercile 1	Tercile 2	Tercile 3
Panel A: Participation in different income generating activities			
Agriculture			
Crop	0.91	0.92	0.90
Livestock	0.82	0.84	0.83
Wage income			
Agricultural	0.06	0.04	0.05
Non-agricultural	0.10	0.11	0.10
Enterprise income	0.29	0.24	0.27
Remittance/transfer	0.09	0.08	0.09
Other income	0.16	0.15	0.27
Panel B: Contribution/share of each income source to overall income			
Agriculture			
Crop	0.60	0.62	0.57
Livestock	0.21	0.20	0.20
Wage income			
Agricultural	0.01	0.01	0.01
Non-agricultural	0.03	0.04	0.03
Enterprise income	0.08	0.06	0.08
Remittance/transfer	0.02	0.02	0.03
Other income	0.04	0.04	0.08
Number of obs.	2,109	1,165	2,359

Note: remoteness is defined based on the distance of the sample household to the closest small city.
Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

Table A3 Participation in different income generating activities and contribution of each source of income to overall income, by farm size category

Income source	Farm size categories				
	<0.5ha	0.5-1ha	1-2ha	2-3ha	>=3ha
Panel A: Participation in different income generating activities					
Agriculture					
Crop	0.85	0.89	0.92	0.92	0.94
Livestock	0.71	0.79	0.84	0.88	0.90
Wage income					
Agricultural	0.11	0.05	0.04	0.03	0.02
Non-agricultural	0.16	0.12	0.09	0.08	0.07
Enterprise income	0.33	0.28	0.27	0.24	0.26
Remittance/transfer	0.11	0.12	0.08	0.08	0.05
Other income	0.29	0.29	0.20	0.13	0.11
Panel B: Contribution/share of each income source to overall income					
Agriculture					
Crop	0.49	0.54	0.62	0.63	0.67
Livestock	0.16	0.20	0.21	0.22	0.23
Wage income					
Agricultural	0.03	0.02	0.01	0.01	0.00
Non-agricultural	0.07	0.04	0.03	0.03	0.02
Enterprise income	0.11	0.09	0.07	0.06	0.05
Remittance/transfer	0.04	0.03	0.02	0.02	0.01
Other income	0.10	0.09	0.05	0.03	0.02
Number of obs.	755	1324	1807	888	853

Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

Table A4 Participation in different income generating activities and contribution of each source of income to overall income, by per capita income quintile

Income source	Per capita income quintile				
	Poorest	Poorer	Middle	Richer	Richest
Panel A: Participation in different income generating activities					
Agriculture					
Crop	0.73	0.92	0.95	0.97	0.99
Livestock	0.66	0.84	0.86	0.89	0.90
Wage income	0.06	0.07	0.05	0.04	0.03
Agricultural	0.07	0.12	0.11	0.12	0.10
Non-agricultural	0.20	0.25	0.28	0.30	0.34
Enterprise income	0.08	0.08	0.09	0.10	0.08
Remittance/transfer	0.33	0.27	0.20	0.15	0.11
Other income	0.73	0.92	0.95	0.97	0.99
Panel B: Contribution/share of each income source to overall income					
Agriculture					
Crop	0.42	0.54	0.61	0.64	0.73
Livestock	0.23	0.23	0.21	0.20	0.15
Wage income	0.02	0.02	0.01	0.01	0.00
Agricultural	0.03	0.04	0.04	0.04	0.02
Non-agricultural	0.09	0.08	0.07	0.07	0.07
Enterprise income	0.03	0.02	0.03	0.03	0.01
Remittance/transfer	0.18	0.06	0.03	0.02	0.01
Other income	0.42	0.54	0.61	0.64	0.73
Number of obs.	1030	1107	1194	1143	1159

Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

Table A5 Participation in different income generating activities and contribution of each source of income to overall income, by region

	Tigray			Amhara			Oromia			SNNP		
	2012	2016	2019	2012	2016	2019	2012	2016	2019	2012	2016	2019
Panel A: Participation in different income generating activities												
Agriculture												
Crop	0.88	0.73	0.85	0.94	0.92	0.87	0.97	0.90	0.92	0.95	0.96	0.95
Livestock	0.86	0.79	0.88	0.80	0.81	0.93	0.78	0.78	0.93	0.95	0.75	0.88
Wage income												
Agricultural	0.05	0.03	0.03	0.10	0.04	0.01	0.07	0.08	0.03	0.95	0.03	0.02
Non-agricultural	0.14	0.17	0.17	0.03	0.08	0.05	0.10	0.11	0.07	0.95	0.15	0.09
Enterprise income	0.23	0.23	0.20	0.25	0.24	0.17	0.38	0.38	0.24	0.95	0.30	0.27
Remittance/transfer	0.13	0.14	0.15	0.03	0.04	0.06	0.09	0.08	0.03	0.95	0.13	0.08
Other income	0.59	0.64	0.47	0.10	0.16	0.12	0.09	0.14	0.05	0.95	0.09	0.05
Panel B: Contribution/share of each income source to overall income												
Agriculture												
Crop	0.44	0.31	0.47	0.72	0.65	0.67	0.69	0.57	0.62	0.63	0.61	0.63
Livestock	0.23	0.28	0.20	0.16	0.21	0.22	0.17	0.22	0.26	0.12	0.15	0.20
Wage income												
Agricultural	0.01	0.01	0.01	0.03	0.01	0.00	0.02	0.03	0.01	0.03	0.01	0.00
Non-agricultural	0.05	0.08	0.06	0.01	0.02	0.01	0.02	0.03	0.03	0.04	0.06	0.04
Enterprise income	0.08	0.09	0.08	0.05	0.06	0.04	0.08	0.10	0.06	0.10	0.11	0.09
Remittance/transfer	0.04	0.04	0.04	0.01	0.02	0.02	0.01	0.02	0.01	0.04	0.04	0.02
Other income	0.15	0.19	0.15	0.03	0.04	0.03	0.01	0.03	0.01	0.05	0.03	0.02
Number of obs.	419	419	419	495	495	495	627	627	627	358	358	358

Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

Table A6 Estimates of Double-Hurdle model (Probit-Truncated models)

Variables	HDI		Crop		Livestock		Wage		Enterprise		Remittance	
	Partic.	Share	Partic.	Share	Partic.	Share	Partic.	Share	Partic.	Share	Partic.	Share
Gender of HH head, =1 if female	0.108	2.053*	-0.125	-4.044***	0.050	2.037	0.021	6.317	0.085	4.900	0.321***	11.266*
	(0.090)	(1.096)	(0.153)	(1.160)	(0.077)	(3.326)	(0.077)	(4.518)	(0.066)	(6.277)	(0.081)	(6.228)
Proportion of females in working age	0.336**	-0.233	0.556**	-5.326***	0.257**	10.042**	-0.479***	-17.425**	0.026	10.368	0.406***	-6.002
	(0.135)	(1.689)	(0.242)	(1.758)	(0.121)	(4.948)	(0.123)	(7.981)	(0.105)	(11.024)	(0.123)	(8.347)
Age of the head, in years	-0.009***	0.018	-0.001	0.007	-0.004**	0.282***	-0.006***	0.352***	-0.012***	0.439**	0.017***	0.154
	(0.002)	(0.028)	(0.004)	(0.029)	(0.002)	(0.086)	(0.002)	(0.135)	(0.002)	(0.182)	(0.002)	(0.189)
Education level attained by the head	0.073	-0.017	-0.032	-1.247*	0.011	-0.639	0.058	8.789***	0.031	4.306	0.021	-5.332
	(0.063)	(0.662)	(0.103)	(0.702)	(0.052)	(2.075)	(0.045)	(2.566)	(0.039)	(3.833)	(0.061)	(5.489)
Education level attained by the spouse	-0.041	1.030	-0.009	-1.289	-0.024	-1.577	0.064	1.809	0.092*	4.856	-0.086	-10.197
	(0.076)	(0.832)	(0.124)	(0.889)	(0.064)	(2.634)	(0.057)	(3.103)	(0.048)	(4.347)	(0.082)	(9.453)
Household size	0.055***	0.068	0.016	-0.062	0.050***	1.370**	0.035***	-1.542*	0.020*	-2.607**	-0.071***	-2.119*
	(0.016)	(0.174)	(0.027)	(0.183)	(0.014)	(0.532)	(0.013)	(0.857)	(0.011)	(1.124)	(0.015)	(1.265)
Household had access to credit, yes=1	0.213***	2.572***	-0.191*	-2.325***	0.135**	-2.704	0.226***	-4.432	0.224***	-8.462*	0.069	10.396*
	(0.069)	(0.774)	(0.110)	(0.826)	(0.058)	(2.414)	(0.052)	(3.137)	(0.045)	(4.344)	(0.070)	(5.683)
Farmland owned (ha)	-0.000	-0.610***	-0.000	0.574***	0.029	-0.594	-0.068***	-2.159	-0.020	-3.443**	-0.051*	-7.825**
	(0.020)	(0.167)	(0.020)	(0.139)	(0.022)	(0.453)	(0.021)	(1.538)	(0.013)	(1.711)	(0.026)	(3.153)
Index of land quality	0.019	-0.224	0.028	0.498***	0.014	-1.764***	0.005	0.365	0.006	-2.285**	0.001	1.130
	(0.016)	(0.179)	(0.026)	(0.189)	(0.014)	(0.555)	(0.012)	(0.733)	(0.011)	(1.034)	(0.016)	(1.189)
Livestock, in tlu	0.061***	0.106**	0.056***	-0.112*	0.137***	0.475***	-0.076***	-3.243***	-0.020***	-3.814***	-0.019**	-0.832
	(0.010)	(0.052)	(0.017)	(0.065)	(0.010)	(0.104)	(0.008)	(0.622)	(0.005)	(0.732)	(0.009)	(0.994)
Household asset index, PCA	0.076***	-0.013	-0.016	0.866***	0.064***	-2.088***	0.008	-4.153***	0.068***	-4.051***	0.068***	-0.568
	(0.025)	(0.232)	(0.038)	(0.248)	(0.021)	(0.714)	(0.018)	(1.168)	(0.014)	(1.560)	(0.020)	(1.811)
Share of high-value crops in crop output, %	-0.003***	-0.124***	0.007***	0.171***	-0.003***	-0.438***	-0.003***	-0.184***	0.000	-0.198***	-0.001	-0.307***
	(0.001)	(0.013)	(0.002)	(0.014)	(0.001)	(0.049)	(0.001)	(0.056)	(0.001)	(0.076)	(0.001)	(0.101)
HH owns mobile phone, yes=1	0.173**	0.710	-0.159	-3.057***	0.091	-5.993**	0.070	11.940***	0.160***	7.393	0.224***	7.990
	(0.070)	(0.782)	(0.121)	(0.830)	(0.061)	(2.351)	(0.056)	(3.441)	(0.047)	(4.794)	(0.069)	(5.485)
Member of social insurance (idir or iqqub)	0.242***	2.312**	0.176	-4.603***	0.005	-1.272	0.160**	-7.520*	0.346***	9.361	-0.123	0.175
	(0.089)	(0.996)	(0.142)	(1.062)	(0.079)	(2.940)	(0.071)	(4.166)	(0.062)	(5.749)	(0.085)	(6.473)

Agri cooperative member	-0.010	-0.972	0.065	0.213	0.029	2.186	-0.008	-2.096	-0.026	-2.472	0.022	-13.958***
	(0.067)	(0.760)	(0.116)	(0.803)	(0.058)	(2.285)	(0.055)	(3.569)	(0.046)	(4.485)	(0.066)	(5.329)
HH has irrigable land, yes=1	-0.139	-2.466*	4.308	3.143**	-0.076	-18.652***	0.058	-6.549	-0.016	-1.922	-0.065	-19.820
	(0.111)	(1.305)	(164.981)	(1.330)	(0.099)	(4.722)	(0.089)	(5.889)	(0.076)	(7.520)	(0.125)	(14.306)
Time to all-weather road, in min	-0.000	-0.004	-0.000	0.004	0.000	0.002	-0.001***	0.013	-0.000	0.017	-0.000	0.043*
	(0.000)	(0.003)	(0.000)	(0.003)	(0.000)	(0.009)	(0.000)	(0.019)	(0.000)	(0.022)	(0.000)	(0.022)
Population density, persons/sq KM	0.001**	0.017***	0.003**	-0.011*	0.001**	0.012	0.001	-0.008	0.000	-0.050	0.001	-0.078
	(0.001)	(0.006)	(0.001)	(0.006)	(0.000)	(0.020)	(0.000)	(0.031)	(0.000)	(0.037)	(0.001)	(0.049)
Variation of rainfall	-0.030**	0.491***	-0.073***	-0.923***	-0.031**	3.314***	-0.001	0.396	0.004	0.473	-0.008	0.745
	(0.015)	(0.172)	(0.028)	(0.180)	(0.013)	(0.557)	(0.012)	(0.806)	(0.010)	(1.014)	(0.016)	(1.430)
2016 dummy	-0.277***	1.925*	-0.628***	-3.086**	-0.046	19.482***	-0.242***	15.642***	-0.319***	18.828***	0.024	18.422**
	(0.097)	(1.141)	(0.158)	(1.215)	(0.086)	(3.478)	(0.080)	(4.788)	(0.069)	(6.625)	(0.096)	(8.094)
2019 dummy	0.485***	0.686	-0.225	1.000	0.913***	11.834***	-0.452***	4.126	-0.526***	6.823	-0.297***	3.455
	(0.114)	(1.200)	(0.185)	(1.277)	(0.102)	(3.652)	(0.087)	(5.157)	(0.074)	(7.207)	(0.105)	(8.597)
Constant	1.178***	48.163***	1.443***	62.690***	0.485*	-39.775***	0.359	46.098***	-0.025	40.136**	-2.218***	11.545
	(0.312)	(3.295)	(0.458)	(3.545)	(0.283)	(10.891)	(0.232)	(13.904)	(0.198)	(18.588)	(0.303)	(28.202)
Zonal dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Log-Likelihood	-22,122		-23,558		-19,716		-5,040		-8,527		-2,910	
Number of observations	5,172		5,172		5,172		5,172		5,172		5,172	

Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.

Table A7. Relevance of instruments (first stage regressions)

	HDI at household level	
	(1)	(2)
HDI at the kebele level	0.407***	0.375***
	(0.062)	(0.060)
ln(Mean rainfall)	-0.029	0.017
	(0.042)	(0.038)
ln(Standard deviation of rainfall)	0.001	0.000
	(0.002)	(0.002)
Gender of HH head (*1=female*)		-0.003
		(0.024)
Proportion of females in working age		0.020
		(0.026)
Age of the HH head		0.001
		(0.001)
Education level attained by the HH head		0.003
		(0.012)
Education level attained by the spouse		0.029**
		(0.013)
Household size		0.008**
		(0.003)
Dependency ratio		-0.003
		(0.005)
Access to credit (*1=yes*)		0.022**
		(0.010)
Farmland owned (*hectare*)		-0.002
		(0.001)
HH has irrigable land (*1=yes*)		-0.012
		(0.016)
Membership in iddir (*1=yes*)		0.020**
		(0.008)
Membership in iqqub (*1=yes*)		-0.006
		(0.009)
HH owns mobile phone (*1=yes*)		0.013
		(0.008)
Livestock ownership (*TLU*)		0.002
		(0.001)
Household asset index (PCA)		0.006*
		(0.003)
Time to weekly market (*minutes*)		0.000
		(0.000)
Time to Woreda Admin center (*minutes*)		0.000
		(0.000)
Constant	0.333***	0.072
	(0.112)	(0.114)
Number of observations	5,589	5,428
R2	0.017	0.032
Adjusted R2	0.016	0.029

Source: Authors' analysis using ACC Surveys of 2012, 2016, and 2019.