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Cash crops and food security: Evidence from Ethiopian smallholder coffee producers

Tadesse Kuma, Mekdim Dereje, Kalle Hirvonen, and Bart Minten

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ABSTRACT

One of the key questions in food policy debates in the last decades has been the role of cash cropping for achieving food security in low income countries. We revisit this question in the context of smallholder coffee production in Ethiopia. Using unique data collected by the authors on about 1,600 coffee farmers in the country, we find that coffee income improves food security, even after controlling for total income and other factors and after addressing the endogeneity of coffee income. Further analysis suggests that the pathway for achieving this improved food security is linked to being better able to smooth consumption across agricultural seasons. In contrast with food crops, coffee sales take place almost throughout the whole year, providing farmers with cash income also during the lean season.

JEL-codes: O13, Q18, O12

Key words: Agriculture, food policy, sub-Saharan Africa, seasonality

1. INTRODUCTION

Despite dramatic improvements in global crop yields over the past half-century, chronic food insecurity, hunger, and undernourishment persist in many parts of world. Nearly 800 million people do not have enough to eat and, alarmingly, in Africa, despite recent economic growth, this number is on the rise (FAO, IFAD, and WFP 2015). This issue will remain one of the central development challenges for national governments and their development partners for some time to come.[1]

One of the central ongoing topics in food policy debates has been the role of growing cash crops[2] for achieving food security in low income countries (Weber et al. 1988). There are a number of channels through which cash crop production could contribute to food security. First, specialization in cash crop production allows farm households to increase their overall income by producing a commodity which provides a higher return to their productive resources; they can then use the cash income obtained from cash crop sales to buy food as well as non-food consumption goods, and achieve a higher level of welfare, including food security (Timmer 1988). Second, cash crop production contributes to rural poverty alleviation through livelihoods diversification and by increasing the average earning potential of a household, which in turn increases the household's spending potential on food and non-food items. Third, the benefits arising from cash cropping also accrue to non-cash crop producers through the effect of cash crop production on employment, since their production is often labor-intensive (Poulton et al. 2001). Fourth, the introduction of cash cropping opportunities means that households are less cash constrained to purchase improved inputs for their food crops (Govereh and Jayne 2003). This cash income ultimately offers opportunities for farmers to invest and improve the management of their farms, and thus stimulating agricultural innovation and increasing the yields. In general, proponents believe that cash crop production paves the way for agricultural transformation.

Still, despite continued efforts to promote cash crop agriculture as a means of reducing rural poverty and food insecurity, it is unclear to what extent and under which conditions cash crop production achieves these outcomes at the household level (Masanjala 2006; Jones and Gibbon 2011). The international literature suggests that the impact of cash crop production on food and nutrition security is context specific, depending on geographical conditions, crop choice, local and global social structures, market situation, and the policy environment (Branca et al. 1993; DeWalt 1993; Sharma 1999).[3] Its effect also varies with the demographic and socio-economic status of the household, such as landholding and family size,

[1] Food security is also high on the global agenda: United Nations' Sustainable Development Goal #2 aims to end hunger and ensure access for all to safe, nutritious and sufficient food all year around by 2030 (United Nations 2015).

[2] A cash crop is defined as a crop grown for direct sale or for market sales rather than for subsistence food or for household consumption. Cash crops could be classified into two categories: first, crops that are exclusively grown for sale (i.e. non-food), which include crops such as cotton, coffee, cocoa or tea, and second, food crops that may be consumed by the household or sold at markets, such as rice or maize, and also certain fruits and vegetables. In this study, we focus on the first category.

[3] In general, the empirical evidence remains inconclusive. For instance, Pierre-Louis et al. (2007) show positive correlations between the production of peanuts in Mali and food security and dietary diversity. Von Braun (1995) and Kennedy and Peters (1992) also document a positive contribution of cardamom production in Papua New Guinea, rice in the Gambia, maize in Zambia, and potatoes in Rwanda. Negash and Swinnen (2013) found positive correlations of food caloric intake with the participation of the household in the production of castor beans used for biofuel in Ethiopia. On the other hand, negative correlations were found with cash crop production of cassava in Ecuador (Leonard et al. 1994), cacao and sugarcane production in Mexico (Dewey 1981), and cold-weather vegetable production in Guatemala (Immink and Alarcon 1993).

gender of household head, women's empowerment, education levels, and other factors (Gauchan 1997; Kiriti and Tisdell 2004; Komarek 2010). As stated by Reardon, Delgado, and Matlon (1992), producing cash crops is also more susceptible to risks related to production, markets, and prices than is the case for food crops. Hence, rather than fully specialize in the production of a single commodity, farm households prefer to diversify their production portfolio and therefore smooth their consumption over time (Fafchamps 1992).

We revisit this question in the context of coffee production in Ethiopia. Coffee is one of the most important cash crops produced and marketed, not only in Ethiopia, but also in more than 50 developing countries. Small-scale farmers are estimated to contribute 70 percent of the world's coffee supply (Eakin, Winkels, and Sendzimir 2009).[4] Despite the central role of coffee in the Ethiopian economy (it is Ethiopia's biggest export crop and as it is grown by over 4 million smallholders), and high levels of food insecurity in the country, there is a lack of knowledge about the importance of coffee income in household food security and the pathways through which coffee production may contribute to food security.

This study aims to understand the extent to which coffee production and the income it provides contributes to the food security of smallholder coffee farming households in the country. Using data collected by the authors on about 1,600 coffee farmers in Ethiopia, we find that households with larger shares of coffee income in their total income portfolio report significantly less food insecurity than other households. This result is robust even after controlling for a variety of household characteristics, including total income and other household characteristics, and addressing the endogeneity of coffee income through a plausible Instrumental Variable approach. Further analysis suggests that the coffee income pathway to food security is linked to seasonality. Although coffee is mainly harvested at the same time as the main food crops, it is sold throughout the year, which consequently provides coffee farming households cash income during the lean season when food stocks in coffee growing areas are generally low.

2. CONTEXT, DATA AND DESCRIPTIVE ANALYSIS

In Ethiopia, coffee is seen as green gold for the nation; it has been and remains the leading cash crop and export commodity, accounting for about 4 percent on average of Ethiopia's gross domestic product (GDP), 10 percent of agricultural production, and about 37 percent of total export earnings over the past decade. It is further estimated that coffee production is mostly in the hands of smallholders and that about 4.2 million smallholder farming households contribute between 93 and 95 percent of national coffee production (MOA 2014). These smallholder coffee producers are heavily dependent on coffee income as their main source of livelihood. Moreover, the coffee sector in Ethiopia directly and indirectly affects the livelihood of a quarter of Ethiopia's total population, providing jobs for farmers, local traders, processors, transporters, exporters and different service providers.

Before conducting a formal survey of Ethiopia's coffee producers and processors in early 2014, a rapid rural appraisal of some coffee communities was conducted. Focus group discussions were held with key informants including processors, extension agents, government officials, and leaders and members of growers' associations and coffee cooperatives in order to find out about farmers' production systems, technology adoption, sales, consumption, income, and related challenges that impact food and nutrition security in relation to coffee production. This initial ground work greatly assisted in the preparation of the survey instrument used for the collection of quantitative data.

Our survey focused on areas with the highest coffee production in the country. The ten zones that made up 77 percent of all coffee production in 2012/13 were selected based on production data obtained from the Central Statistical Agency (CSA) of Ethiopia. These ten zones – all located either in Oromia or Southern Nations, Nationalities, and Peoples' (SNNP) regions – were stratified based on the coffee variety produced in that zone, as defined within the classifications for export markets by the Ethiopia Commodity Exchange (ECX). Woredas (districts) within each strata were ranked from the highest to the lowest based on their history of production levels. They were then divided into two groups – of less productive woredas and of more productive woredas. Four woredas, two from each category, were randomly selected (i.e., four woredas from each coffee zone). A list of kebeles (sub-districts) of the selected woredas was then obtained from the Woreda Administrative Offices. We ranked all kebeles by their level of coffee production and randomly selected two kebeles from the bottom half of the list of kebeles and two kebeles from the top half of the list.

[4] Worldwide, the industry supports about 25 million coffee producers. When we consider participants in the coffee value chain including coffee harvesters, processors, transporters, casual and regular workers, closer to 100 million people are engaged in the sector and their livelihoods depend on the crop in some way (Jha et al. 2011).

Finally, we obtained a list of all households in the selected kebeles from the kebele administration. These households were ranked by the coffee area they cultivated in the year before the survey. A total of 20 farmers was then selected: 10 from the bottom half of the list and 10 from the top part of the list. We interviewed a total of 16 kebeles times 20 farmers (320 farmers) per stratum (Sidama, Jimma, Nekempt, Harar, Yirgacheffe), overall totaling 1,598 coffee farming households in 20 woredas and 80 kebeles (Table 2.1).

Table 2.1: Distribution of sample households by coffee variety and by major zones

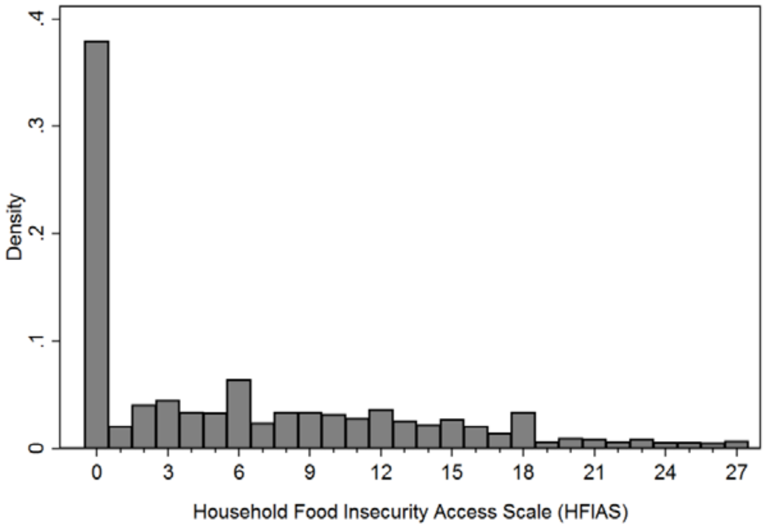
	Coffee variety	Zones	Woredas	Total households
1	Sidama	Sidama	Dale, Dara, & Chere	320
		Borena	Bule Hora	
2	Jimma	Jimma	Gomma & Chora Botar	318
		Illu Aba Bora	Mattuu & Ale	
3	Nekempt	West Wollega	Haroo, Lalo Asabi & Ganji	320
		Qelem Wollega	Sayo	
4	Harar	West Hararge	Boke, Daro Labu & Habroo	320
		East Hararge	Badeno	
5	Yirgacheffe	Gedio	Dilla Zuria, Yirgacheffe	320
		Guji	Adola Rede & Qerecha	
	Total			**1,598**

Source: Authors' calculations based on ESSP's coffee survey, 2014

We measure food (in)security using the Household Food Insecurity Access Scale (HFIAS) developed by (Coates, Swindale, and Bilinsky 2007). Using nine different questions to explore households' perceptions on food security and their individual coping mechanisms, HFIAS was found to provide a reliable measure of food security in different countries (Melgar-Quinonez et al. 2006; Knueppel, Demment, and Kaiser 2010), including Ethiopia (Maes et al. 2009). In the food security module of the survey, the respondents were first asked whether they had experienced a food security issue in the previous 12 months, such as a concern that their household would not have enough food. If the response was positive, then the frequency of this occurrence was ascertained. Appendix A provides the full list of these questions. For the computation of HFIAS, a household received zero points if it reported that the event did not happen during the last 12 months, 1 if it rarely occurred (1 or 2 times), 2 if it sometimes (3 to 10 times) occurred, and 3 if it occurred often (more than 10 times). The sum of these frequency scores for the nine questions then yields a *food insecurity score* ranging between 0 and 27. Figure 2.1 shows how the food insecurity score is distributed within our sample. Nearly 40 percent of the households reported to be fully food secure, since they reported zero incidences of these nine food insecurity measures in the previous 12 months. The remaining 60 percent of the sample reported some food insecurity of varying degree. To facilitate the interpretation of food security/insecurity, we express our food insecurity score in terms of z-scores in the remainder of the paper.[5]

[5] The Z-scores are computed by subtracting the household specific food security value from the sample mean and then dividing this with the standard deviation of the sample. The end-product is a variable with a zero mean and standard deviation of one.

Figure 2.1: Distribution of the Household Food Insecurity Access Scale (HFIAS) score



Source: Authors' calculations based on ESSP's coffee survey, 2014

During the survey, we collected detailed information about households' income from food and cash crops, including coffee, as well as non-crop income. The non-crop income includes rental income, wage income and income from non-farm enterprises and remittances. We captured all income information over a period of 12 months. Table 2.2 summarizes household total incomes and income sources. The average household in our sample earned about 22,000 birr in the calendar year, corresponding to about 1,100 USD at the time of the survey. [6] These average incomes remain relatively similar across the different coffee zones with the exception of Nekempt where the mean income is considerably lower at 14,700 birr (760 USD). On average, 42 percent of total income comes from coffee cultivation, while food crops contribute on average 34 percent. Livestock and livestock products account for 10 percent of the total income, on average. However, these averages mask considerable heterogeneity across the different coffee zones. In Sidama and Yirgacheffe regions, the share of coffee income constitutes more than 50 percent of total income, on average. In Harar, where many farmers engage in khat[7] cultivation, the corresponding figure is 29 percent.

Table 2.2: Household income sources by coffee zone

Source of income	Full sample	Sidama	Yirga-cheffe	Jimma	Nekempt	Harar
Total income (birr)	22,335	24,449	26,728	23,612	14,730	22,161
From coffee (%)	41.6	50.2	52.0	37.1	39.2	29.4
From khat (%)	5.6	1.5	1.9	2.6	0.2	22.0
From food crops (%)	34.2	30.9	27.4	37.4	42.8	32.5
From livestock (%)	10.0	8.5	9.7	11.7	8.8	11.5
From other sources (%)	8.6	9.0	9.0	11.2	9.1	4.7
Total (%)	100	100	100	100	100	100

Source: Authors' calculations based on ESSP's coffee survey, 2014.

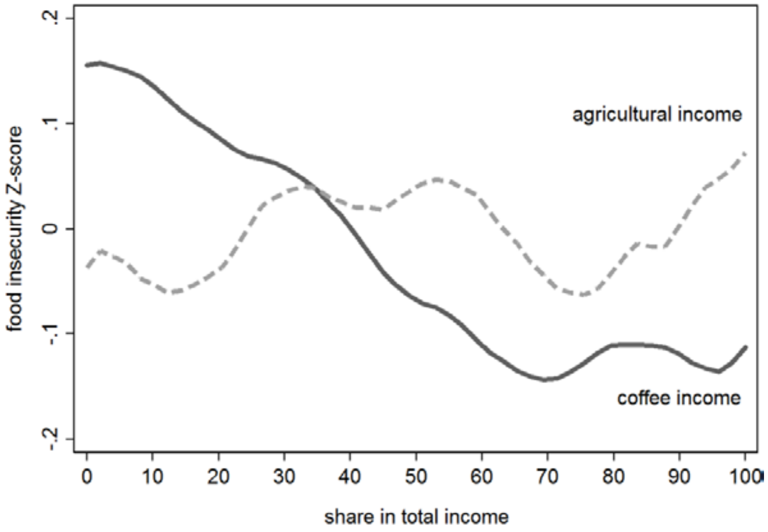
Note: Other income sources include income from non-agricultural related activities (rental income, income from non-farm enterprises, wage employment, and remittances).

Figure 2.2 shows a locally weighted regression between household food security and different income sources. We focus on contrasting coffee income (solid line) with income from food crops or livestock related activities (dashed line). We see that households that have a higher share of coffee income in their total income portfolio report lower level of food insecurity (as indicated by lower Z-score value). Interestingly, we do not observe a similar relationship for the income coming from food crops or livestock related activities (denoted as 'agricultural income' in Figure 2.2).

[6] The exchange rate at the time of the survey stood at 19.40 birr per USD.

[7] Khat is a mild stimulant plan grown in many areas of the country, most prominently in Harar.

Figure 2.2: Relationship between food security and income sources



Source: Authors' calculations based on ESSP's coffee survey, 2014.

Note: Local polynomial regression. Agricultural income refers to income from food crops and livestock (see Table 2.2).

Next, we test whether this strong association between food (in)security and coffee income holds if we control for various household characteristics that may be driving this relationship. We also address the potential endogeneity of coffee income. Table 2.3 provides the summary statistics for all the variables used in the analysis. The final sample used in the analysis is based on 1,597 households.[8]

Table 2.3: Summary statistics for variables used in analysis of relationship between food (in)security and coffee income

Variable category	Variable	Mean (standard deviation)
Dependent variables	Food insecurity Z-score	0.000
		(1.000)
	Food insecurity count (Poisson models)	6.279
		(7.027)
Income variables	Share of coffee income in total household income	0.416
		(0.243)
	(log) total household income (in birr)	9.597
		(0.922)
Household head's characteristics	Male head (*)	0.946
		(0.226)
	Age of the household head (*)	44.82
		(14.36)
Highest education level in household	Less than primary education (reference category) (*)	0.051
		(0.221)
	Primary education (*)	0.703
		(0.457)
	Secondary education & above (*)	0.246
		(0.431)
Household demographics	Number of male members 0-5 years of age	0.535
		(0.752)
	Number of male members 6-15 years of age	1.212
		(1.162)
	Number of males 16-60 years	1.447
		(0.921)
	Number of males 61+ years	0.145
		(0.355)

[8] One household with implausible income values was dropped from the final sample.

Variable category	Variable	Mean (standard deviation)
	Number of female members 0-5 years of age	0.515
		(0.728)
	Number of female members 6-15 years of age	1.146
		(1.129)
	Number of females 16-60 years	1.383
		(0.783)
	Number of females 61+ years	0.0689
		(0.265)
Household wealth	(log) Value of livestock owned by HH per capita (in birr)	6.464
		(2.426)
	(log) Value of durable assets owned by HH per capita (in birr)	5.292
		(1.447)
	(log) Total land owned by HH (in hectares)	0.885
		(0.465)
Community characteristics	Kebele is located in high altitude (>1,700 masl)	0.779
		(0.415)
Excluded instruments	Share of inherited coffee land in total HH land	0.439
		(0.350)
	(Share of inherited coffee land in total HH land) * (kebele is located in high altitude)	0.353
		(0.365)
	Observations	**1,597**

Source: Authors' calculations based on ESSP's coffee survey, 2014. (*) indicates a dummy (binary) variable.

3. ECONOMETRIC APPROACH

We model the level of food insecurity reported by household *h* residing in woreda *w* (F_{hw}) as a function of share of income coming from coffee (C_{hw}):

(1) $$F_{hw} = \beta C_{hw} + \gamma T_{hw} + X_{hw}{}'\delta + \omega + \varepsilon_{hw},$$

where β captures the relationship of interest; the impact of the coffee-income share on household food insecurity.[9] Of note is that coffee-income is a function of household total income. This raises a concern that β is (partially) also reflecting changes in household total incomes. In order to isolate such general income effects, we include household total income (T_{hw}) in the model so that β will not capture the general income effect on household food insecurity. We further control for various household characteristics, including household size and demographics, characteristics of the household head (age and sex), highest level of education in the household, as well as household wealth (durable assets, livestock ownership, and land size). All these household and community characteristics are captured by vector X_{hw} in Equation (1). We also include dummies for each woreda (ω) to control for the coffee geography and other things associated with the woreda. The last term in the equation marks the error term, ε_{hw}. Finally, the computed standard errors are clustered at the kebele level.

Estimating equation (1) using the simple Ordinary Least Squares (OLS) regression would be unlikely to yield an unbiased estimate of β for two reasons. More food secure households may be more willing to take risks and more likely to engage in coffee cultivation. This raises a concern about reverse causality. Measurement error poses another endogeneity concern: measuring income in low-income settings like Ethiopia is notoriously difficult (Deaton 1997). Both reverse causality and measurement error would mean that the estimated parameter of interest (β) would be biased.

We use Instrumental Variable (IV) techniques to solve these endogeneity concerns.[10] Our IV-approach exploits the land allocation system in Ethiopia where all land in principle is owned by the state. More specifically, individual farmers enjoy

[9] The share of income coming from coffee (C_{hw}) is constructed by dividing the household's total reported coffee income by the household's total income.

[10] The IV-estimation is based on a two-step linear IV-GMM estimator. This estimator is more efficient than the conventional two-stage least squares estimator when the equation is over-identified and the standard errors display heteroskedasticity (Cameron and Trivedi 2005, p. 187-8). These two conditions are met in our application. First, the null of homoskedasticity is rejected in our application: the White (1980) test (less sensitive to departures from

all the rights of the owner, but cannot officially sell the land (Deininger et al. 2008; Ambaye 2012). As a result, land in Ethiopia is mostly acquired either through inheritance from parents or by community allocation (Ghebru, Koru, and Taffesse 2016).[11] Therefore, the amount of coffee land owned by households is, at least partially, dependent on the amount of coffee land that was owned by their parents. This creates plausible exogenous variation to household's contemporaneous coffee incomes, but should not directly affect the household's current food security status (other than through the coffee income channel). Using this insight, we use the share of inherited coffee land in total land as an instrument for contemporaneous coffee incomes.[12] We further control for total land size to ensure that this instrument is not picking up any land size effect (which would then violate the exclusion restriction).

Our second instrument is an interaction between the first instrument, the share of inherited coffee land, and altitude. The optimal altitude for growing Arabica coffee is between 1,200 and 2,200 meters above sea level (masl) at the equator, although the optimal altitude in higher latitudes, such as Ethiopia, is considerably less (Pohlan and Janssens 2010). It is therefore likely that coffee land in lower altitudes is more productive than in higher altitudes. We set the threshold to 1,700 masl and hypothesize that coffee land above this altitude is less productive.[13] Finally, since altitude could be correlated with a number of unobserved variables that are also correlated with food security, we include the level term (a binary variable obtaining a value of one if the kebele is located above 1,700 masl, and zero otherwise) into X_{hw} in the main equation.

Table 3.1: First stage regression results

Dependent variable: share of coffee income in total income	**(1)**
Excluded instruments:	
Share of inherited coffee land in total land	0.165***
	(0.032)
(Share of inherited coffee land in total HH land) * (kebele is located in high altitude (>1,700 masl))	-0.097**
	(0.038)
Included instruments (i.e. control variables)	
kebele is located in high altitude (>1,700 masl)	0.043
	(0.040)
(log) total land size	0.092***
	(0.024)
Other included instruments (i.e. control variables)? [a)]	Yes
R^2	0.245
Weak-identification tests:	
Cragg-Donald F-statistic	14.34
Kleibergen-Paap rk Wald F statistic (or Angrist-Pischke F-test of excluded instruments)	20.22
p-value of Angrist-Pischke F-test	0.000***
Over-identification test:	
Hansen-J	0.204
--- p-value	0.652
Observations	**1,597**

Source: Authors' calculations based on ESSP's coffee survey, 2014.

Note: Standard errors clustered at the *kebele* level in parentheses. Statistical significance noted at *** p<0.01, ** p<0.05, * p<0.1. [a)] Coefficients omitted to preserve space.

Table 3.1 shows the first-stage regression results. The two excluded instruments appear with *a priori* correct signs and are significant at least at the 5 percent level. The share of inherited coffee land in the total land portfolio is associated with a

normality) yields 831.2, exceeding all the conventional critical values. Second, the number of instruments (2) exceeds the number of endogenous regressors (1).

[11] Even in the case of community allocation, often the allocated land was previously owned by the parents of the recipients (Fafchamps and Quisumbing 2005). Typically the sons inherit their parents' land while daughters move to live with their husbands (Fafchamps and Quisumbing 2002; Rahmato and Assefa 2006). Finally, age plays an important role in the land allocation within families, with eldest sons more likely to inherit more productive land than younger ones (Gibson and Gurmu 2011)

[12] The share of inherited coffee land in total land is constructed by taking the total amount of coffee land that the household has inherited and dividing by the total amount of land owned by the household.

[13] We measure altitude through GPS coordinates collected at the household level. In order to minimize the role of measurement error in the altitude variable, we applied the mean altitude in the community for each household. The lowest altitude in our sample is at 1530 masl and highest at 2160 masl. We therefore only use an upper threshold to determine the optimal coffee growing altitude.

higher share of coffee income in the total income (after controlling for total land size). The coefficient on the interaction term is negative, confirming our prior that land inherited in higher altitude ranges is less productive (after including a dummy for households located in higher altitudes). The IV-diagnostics tests further show that the instruments are collectively relevant, i.e., good predictors of the share of coffee income; the Kleibergen-Paap rk Wald F-test value is 20.2 and the Angrist and Pischke (2009) test rejects the null hypothesis that the endogenous regressor is weakly identified (p<0.001). Finally, based on the Hansen-Sargan test, we cannot reject the null of zero correlation between the instruments and the error term.

4. RESULTS

Table 4.1 provides the results based on estimation of Equation (1). Column 1 shows the OLS estimates and Column 2 the IV-estimates. Focusing first on the control variables in the OLS model, we see that the coefficients on all wealth categories (durable asset and livestock ownership levels and land size) appear highly significant and negative, implying that wealthier households report lower food insecurity. Similarly, education is associated with lower levels of food insecurity: households with members that have completed secondary school have lower food insecurity scores. As expected, higher household income levels are associated with lower food insecurity scores.

The coefficient on the share of coffee income in total income appears with a negative sign and is statistically highly significant (p<0.01) in the OLS model. However, the magnitude of the effect is small: keeping the total income level fixed and increasing the share of coffee in the total income portfolio by 10 percent decreases food insecurity on average by 0.04 units of standard deviation. In contrast, the estimated effect is considerably larger when we apply the IV-estimator. According to the IV-estimator, increasing the share of coffee in a household's income portfolio by 10 percent, decreases the household food insecurity score on average by 0.14 units of standard deviation, after controlling for total income, household size, and assets. Moreover, the point estimate is statistically significant at the five percent level (p=0.039). This means that a household's engagement in cash crops leads to significant and considerable improvements in food security.

We assess the robustness of this finding in a number of ways. First, the total coffee income variable can also be endogenous for the same reasons as our coffee income share variable. This would then bias the estimate that measures the impact of the total income on food security, but it may also affect other estimated coefficients, especially if they are correlated with the total income variable. We explored the sensitivity of our estimates in two ways. First, we excluded the total income variable from the model. Second, we used (logged) coffee income instead of the share variable. The estimation results are presented in Appendix B and C. We see that by excluding the total income variable from the model yields nearly an identical estimate on the coffee-income share variable (Appendix B). Similarly, using a coffee income variable instead of the share also gives a negative and significant coefficient in both the OLS and IV-models (Appendix C).

Second, our outcome variable is essentially a count (see Figure 2.1), and therefore the validity of using a linear model is questionable. The advantage of using the linear model is that it provides a host of specification tests that we can use to assess the validity of our IV-approach. Still, we assess the robustness of our findings using the Poisson model. For this exercise we replace the z-score version of the dependent variable with the original count. This variable has a mean of 6.28 and standard deviation of 7.03 (see Table 2.3). Appendix D shows that the estimated coefficients (marginal effects) are comparable to the ones obtained using the linear models in Table 4.1. The simple Poisson yields a coefficient of -1.96 which corresponds to -0.28 unit of standard deviations in the food insecurity score. This is slightly lower than the corresponding OLS estimate in column 1 of Table 4.1. The IV-Poisson estimates range between -7.63 and -13.04, corresponding to -1.09 and -1.86 units of standard deviations in the food insecurity score. The linear-IV estimate reported in column 2 of Table 4.1, -1.40, lies in the middle of this range.

Finally, relative remoteness could be correlated with reported food insecurity (Stifel and Minten 2015), but it may also be a factor in a household's decision to engage in cash crop cultivation (Fafchamps 1992). To check that this is not driving our results, we appended our model with variables that measure the distance of communities in which sample households reside to the nearest all-weather road and to the district capital. The results, reported in Appendix E, are robust to including these variables in the model.

Table 4.1: The impact of coffee income on household food insecurity

Dependent variable: Food insecurity Z-score	(1) OLS	(2) IV
Share of coffee income	-0.413***	-1.402**
	(0.119)	(0.678)
(log) Total household income	-0.114***	-0.130***
	(0.038)	(0.038)
Kebele is above 1700 meter altitude	-0.003	-0.001
	(0.052)	(0.064)
Male head	-0.006	-0.033
	(0.084)	(0.084)
Age of the household head	0.002	0.003
	(0.002)	(0.002)
Primary education	-0.062	-0.076
	(0.111)	(0.113)
Secondary education & above	-0.229**	-0.240**
	(0.117)	(0.117)
Number of male members less than 5 years	0.068**	0.058*
	(0.029)	(0.030)
Number of male members between 6 and 15	0.008	0.010
	(0.020)	(0.019)
Number of male members between 16 and 60	0.072***	0.059**
	(0.026)	(0.028)
Number of male members older than 60	0.006	-0.001
	(0.096)	(0.098)
Number of female members less than 5 years	0.066**	0.057*
	(0.030)	(0.031)
Number of female members between 6 and 15	-0.011	-0.017
	(0.020)	(0.020)
Number of female members between 16 and 60	-0.001	-0.011
	(0.032)	(0.030)
Number of female members older than 60	0.000	-0.047
	(0.080)	(0.085)
(log) Value of livestock owned by HH per capita	-0.045***	-0.050***
	(0.013)	(0.013)
(log) Value of durable assets owned by HH per capita	-0.111***	-0.105***
	(0.030)	(0.031)
(log) Total land owned by HH	-0.202***	-0.122
	(0.069)	(0.076)
Woreda dummies? [a)]	yes	yes
R^2	0.332	-
Weak-identification tests:		
Cragg-Donald F-statistic	-	14.34
Kleibergen-Paap rk Wald F statistic (or Angrist-Pischke F-test of excluded instruments)	-	20.22
p-value of Angrist-Pischke F-test	-	0.000***
Over-identification test:		
Hansen-J	-	0.204
--- p-value	-	0.652
Observations	**1,597**	**1,597**

Source: Authors' calculations based on ESSP's coffee survey, 2014.

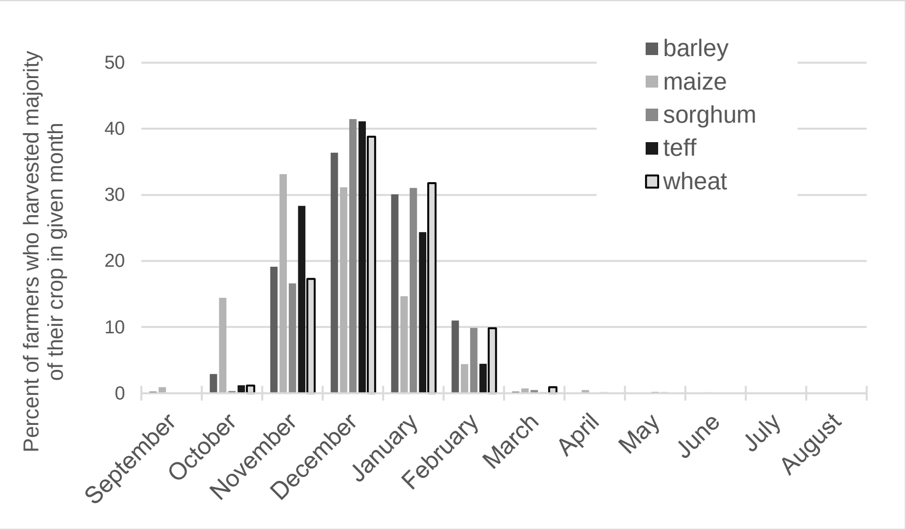
Note: Standard errors clustered at *kebele* level in parentheses. Statistical significance at *** p<0.01, ** p<0.05, * p<0.1. [a)] Coefficients omitted to preserve space.

5. WHY IS COFFEE INCOME GOOD FOR FOOD SECURITY?

The foregoing econometric analysis has established that households with a larger share of coffee income in their total income portfolio report less food insecurity than other households, after controlling for a variety of household characteristics including total income, wealth, education and the endogeneity of coffee income. But the econometric analysis does not shed light on the mechanism between food security and coffee income. One potential pathway in which coffee income improves food security is linked to seasonality. In Ethiopia, as in other African countries, only a small portion of the cultivated land is irrigated (Faurès and Santini 2008), making agriculture heavily dependent on rainfall, resulting in considerable seasonal fluctuations in household incomes, food availability and prices (Dercon and Krishnan 1998; Kaminski, Christiaensen, and Gilbert 2014; Gilbert, Christiaensen, and Kaminski 2015; Hirvonen, Taffesse, and Worku 2016). The advantage of producing coffee over other crops is that it provides income almost throughout the whole year, including during the lean season when food stocks are generally low and food prices high. This is also something that emerged from our discussions with the farmers during the field work.

We examined this hypothesis using the 2013/14 Ethiopia Socioeconomic Survey (ESS)[14] together with our coffee survey. Focusing on agricultural production, the ESS data provides information about the harvests and sales of main food crops in the study regions (Oromia and SNNP). Figure 5.1 shows the harvest times for the five main food crops (barley, maize, sorghum, teff, and wheat). We see that most farmers in these region harvest their produce between November and February. About 24 percent of the farmers reported to have sold part of their harvest. Figure 5.2 shows that most of the sales occur between December and February, i.e., immediately after the harvest. The ESS data also provides information about the timing of food shortages.[15] Figure 5.3 reports the percent of households that reported food shortages by month. Unsurprisingly, the share of households reporting food shortages is lowest just after the harvests, and highest four to six months after the main harvest period.

Figure 5.1: Harvest times of the main food crops in the study regions



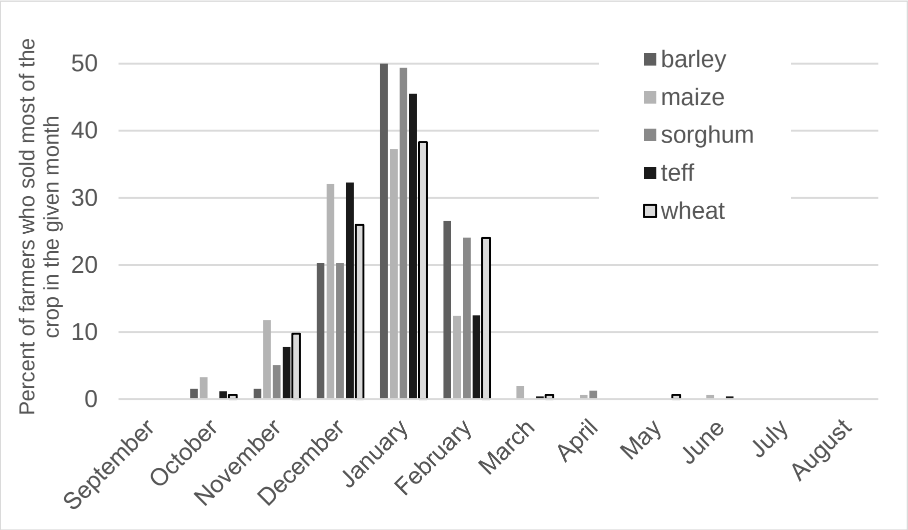
Source: Authors' calculations based on Ethiopia Socioeconomic Survey, 2013/14.

Note: Each bar gives the percent of farmers who harvested most of the crop in the given month. Bars for each crop sum up to 100.

[14] The Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA), led by the World Bank, collects nationally representative panel data in eight African countries. In Ethiopia, the LSMS-ISA survey is called the Ethiopia Socioeconomic Survey and at the time of writing, contains two rounds of data, 2011-2012 and 2013-2014. We use the later one to shed light on the timing of harvest and sales of the main crops cultivated in Oromia and SNNP regions. For more information about the surveys, see CSA and the World Bank (2015).

[15] More specifically, the questionnaire asks "In the last 12 months, have you been faced with a situation when you did not have enough food to feed the household?", if the response was 'yes', then "In which months of the last 12 months did you experience this incident?".

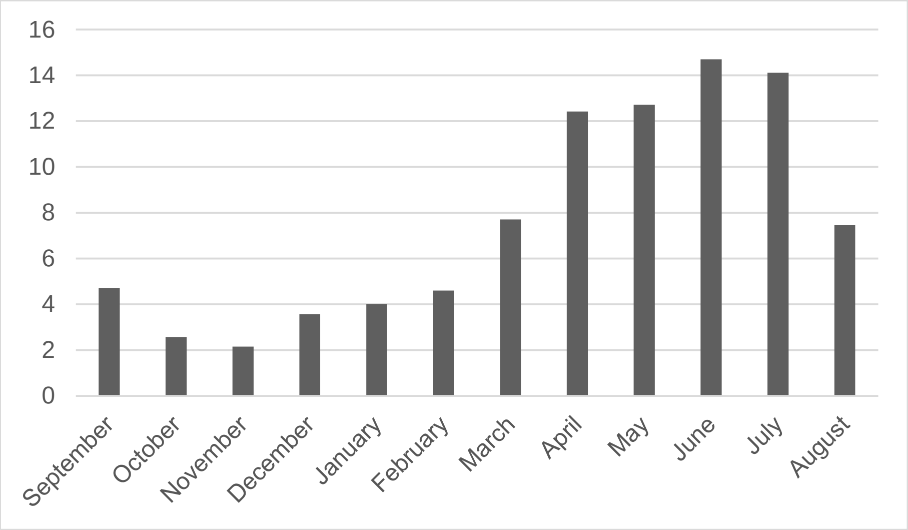
Figure 5.2: Sales times of the main food crops in the study regions



Source: Authors' calculations based on Ethiopia Socioeconomic Survey, 2013/14.

Note: Each bar gives the percent of farmers who sold most of the crop in the given month. Bars for each crop sum up to 100.

Figure 5.3: Food shortages in the study regions, percent of households reporting food shortage by month

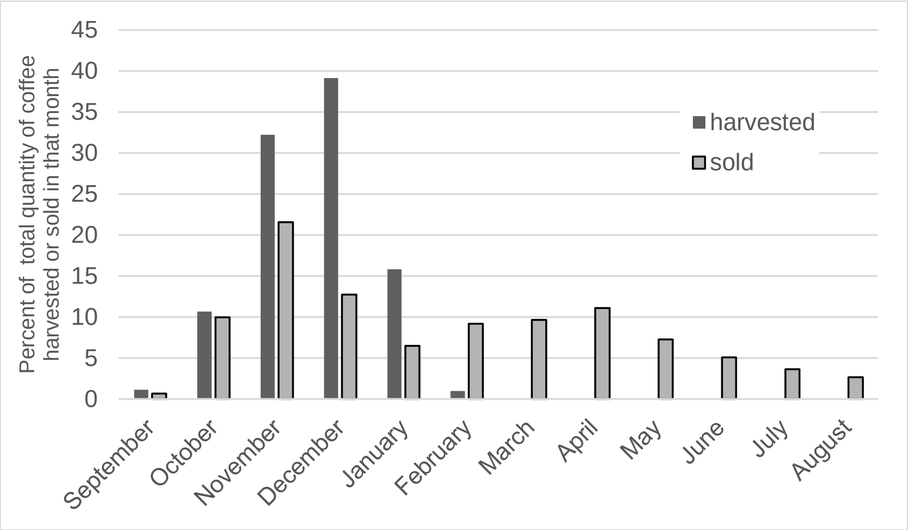


Source: Authors' calculations based on Ethiopia Socioeconomic Survey, 2013/14.

Figure 5.4 provides the timing of the coffee harvests and sales based on our own survey on coffee farmers. We see that while the main harvest time for coffee follows the timing of the main food crops (Figure 5.2), coffee sales are more evenly scattered across the calendar year compared to the main food crops (Figure 5.3). There is the possibility that the prevalence of sales of food crops immediately after harvest, in contrast with coffee sales, is driven by the difficulty of storing some types of food crops, due to their moisture content, bulkiness, and required storage infrastructure. Such storage problems are less of an issue with coffee. [16] For example, only 4 percent of the coffee farmers in our survey reported losses during storage, significantly lower than the level of storage losses usually observed with food crops in sub-Saharan Africa (Zorya et al. 2011). The descriptive analysis above suggests that the reason why coffee production leads to lower food insecurity is linked to the availability of cash income from coffee sales during the lean season.

[16] Coffee can be harvested either in the form of red or dried cherry. Of note is that red cherries have to be sold immediately after the harvest, whereas dry cherries can be kept for longer. Dried coffee can be stored for several months, even years if stored well (Hicks 2002) and can therefore be considered as a form of savings. Most households in our sample harvest their coffee when it is red (85 percent). The rest of the sample harvest their coffee when it has dried on the tree. However, the share of red cherry sales in total sales stands at only 23 percent, indicating that the bulk of sales is made after they have been dried by the households.

Figure 5.4: Harvest and sales times of coffee



Source: Authors' calculations based on ESSP's coffee survey, 2014.

Note: Each bar gives the percent of the total quantity harvested or sold in that month. 'Harvested' and 'sold' bars each add up to 100.

6. CONCLUSIONS

The transformation of subsistence agrarian economies towards higher agricultural commercialization and towards a greater reliance on non-farm incomes generally is viewed as part of the growth process of developing economies. Yet, there is still an important debate on what impact this transformation may have on the welfare and food security of rural and agricultural populations. In particular, there has been a long-standing debate on the role of income from cash crops on household income, welfare, and food security (Von Braun and Kennedy 1986; Maxwell and Fernando 1989; Von Braun 1995).

We revisit this question in the context of Ethiopia and coffee – the most important export product of the country. Using a large-scale survey of approximately 1,600 Ethiopian coffee growing households, we explore the linkage between coffee sales and food security. Using simple associations and multivariate regression models that control for a host of household characteristics, as well as using instruments to address the potential endogeneity of coffee income, we find that coffee income considerably alleviates household food insecurity. Further analysis suggests that this could be linked to a relaxation of seasonal liquidity constraints. In particular, we find that coffee is sold throughout the year providing coffee farming households with cash income during the lean season, when food stocks are generally low and prices high.

Our findings have a number of important implications for policy and future research. First, our research suggests that participation in commercialized agriculture does not jeopardize households' food security. In contrast, we find the opposite: engaging in cash crop farming, such as coffee, is linked with better food security. Still, governments and international organizations tend to underinvest in commodities and value chains that are not directly linked to increased food supply in a country.[17] For example, the Consortium of International Agricultural Research Centers (CGIAR) focuses its research exclusively on crops and products that are directly linked to improved food intakes. However, investments that facilitate cash cropping and improve marketing systems could prove important vehicles for poverty alleviation and improved food security. Second, seasonality considerations are often important for preferences and choices made by rural households, as has been shown by other studies (Duflo, Kremer, and Robinson 2011). Therefore, further understanding is needed of these issues and how to address them, e.g., through improved access to savings institutions.

This paper has limitations. First, due to the volatile nature of coffee production and prices, smallholder coffee producers remain exposed to international market related shocks which, in turn, would affect the food consumption and overall food security of coffee growers (Kruger 2007; Adhvaryu, Kala, and Nyshadham 2013; Lederman and Porto 2016; Singhal, Tarp, and Beck 2016). As the purchasing power from coffee sales is affected by the price level of staple food grain, the price of coffee relative to that of food grains has obvious implications for the food security of coffee farming households. During years in which coffee prices are high, farmers are able to pay their agricultural credit, government taxes, and other

[17] For illustrations in the case of coffee in Ethiopia, see Agrer (2014).

obligations from coffee sales, and are also able to purchase adequate food for family consumption. Conversely, when income from coffee fails to cover cash requirements, this situation negatively affects the food security and welfare of coffee producing households. A caveat in the current study is that it was fielded during a year in which the international coffee prices were relatively normal (Minten et al. 2014). Therefore, an important extension of this paper would be to conduct a similar analysis in both less and more favorable years. Second, an emerging body of literature shows how men and women spend income differently (Hoddinott and Haddad 1995; Duflo and Udry 2004; Duflo 2012; Meinzen-Dick et al. 2012). As coffee marketing is mostly managed by men in Ethiopia [18], a fruitful avenue for future research would be to study how women's empowerment shapes food security in coffee growing households.

[18] Our survey shows that more than 70 percent of coffee transactions are done by men.

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APPENDICES

Appendix A: Questions in the food security module of the survey

1a. In the past 12 months, did you worry that your household would not have enough food?

1b. How often did you worry in the past 12 months?

2a. In the past 12 months, were you or any household members not able to eat the kinds of foods you preferred because of lack of resources?

2b. How often did this happen in the past 12 months?

3a. In the past 12 months, did you or any household members have to eat a limited variety of foods because of lack of resources?

3b. How often did this happen in the past 12 months?

4a. In the past 12 months, did you or any household members

4b. How often did this happen in the past 12 months?

5a. In the past 12 months, did you or any household members have to eat a smaller meal than you felt you needed because there wasn't enough food?

5b. How often did this happen in the past 12 months?

6a. In the past 12 months, did you or any household member have to eat fewer meals in a day because there was not enough food?

6b. How often did this happen in the past 12 months?

7a. In the past 12 months, was there ever no food to eat at all in your household because there were no resources to get any food?

7b. How often did this happen in the past 12 months?

8a. In the past 12 months, did you or any household member go to sleep at night hungry because there was not enough food?

8b. How often did this happen in the past 12 months?

9a. In the past 12 months, did you or any household member go a whole day without eating anything because there was not enough food?

9b. How often did this happen in the past 12 months?

The response options for a-questions were 'yes or no'.
The response options for b-questions were 'Rarely (1-2 times)', Sometimes (3-10 times)' or 'Often (more than 10 times)'.

Appendix B: Replicating Table 4.1 but dropping total HH income from the model

Dependent variable: Food insecurity Z-score	(1) OLS	(2) IV
Share of coffee income	-0.396***	-1.491**
	(0.121)	(0.693)
Controls? [a)]	yes	yes
Woreda dummies? [a)]	yes	yes
R^2	0.327	-
Weak-identification tests:		
Cragg-Donald F-statistic	-	14.06
Kleibergen-Paap rk Wald F statistic (or Angrist-Pischke F-test of excluded instruments)	-	20.12
p-value of Angrist-Pischke F-test	-	0.000***
Over-identification test:		
Hansen-J	-	0.196
--- p-value	-	0.658
Observations	**1,597**	**1,597**

Source: Authors' calculations based on ESSP's coffee survey, 2014.

Note: Standard errors clustered at the *kebele* level in parentheses. Statistical significance noted at *** p<0.01, ** p<0.05, * p<0.1. [a)] Coefficients omitted to preserve space.

Appendix C: Replicating Table 4.1 but replacing coffee income share with (log) coffee income

Dependent variable: Food insecurity Z-score	(1) OLS	(2) IV
(log) coffee income	-0.100***	-0.427**
	(0.025)	(0.212)
(log) Total household income	-0.010	0.309
	(0.046)	(0.209)
Controls? [a)]	yes	yes
Woreda dummies? [a)]	yes	yes
R^2	0.333	-
Weak-identification tests:		
Cragg-Donald F-statistic	-	8.41
Kleibergen-Paap rk Wald F statistic (or Angrist-Pischke F-test of excluded instruments)	-	8.35
p-value of Angrist-Pischke F-test	-	0.001***
Over-identification test:		
Hansen-J	-	0.223
--- p-value	-	0.637
Observations	**1,597**	**1,597**

Source: Authors' calculations based on ESSP's coffee survey, 2014.

Note: Standard errors clustered at the *kebele* level in parentheses. Statistical significance noted at *** p<0.01, ** p<0.05, * p<0.1. [a)] Coefficients omitted to preserve space.

Appendix D: Replicating Table 4.1 using Poisson models

Dependent variable: Food insecurity (count)	(1)	(2)	(3)	(4)
estimator:	Poisson	Poisson IV-GMM	Poisson IV-GMM	Poisson IV control function
error structure:	-	additive	multiplicative	-
Share of coffee income in total household income	-1.955***	-7.642**	-12.466*	-13.042***
	(0.681)	(3.625)	(6.905)	(5.051)
Controls? a)	yes	yes	yes	yes
Woreda dummies? a)	yes	yes	yes	yes
Pearson goodness-of-fit test	9623.0	-	-	-
--- p-value	0.000***	-	-	-
Over-identification test:	-			
Hansen-J χ^2-test	-	0.020	0.645	-
--- p-value	-	0.887	0.421	-
Observations	**1,597**	**1,597**	**1,597**	**1,597**

Source: Authors' calculations based on ESSP's coffee survey, 2014.

Note: Standard errors clustered at the *kebele* level in parentheses. The standard errors for the marginal effects at the means are computed using the delta-method. Statistical significance noted at *** p<0.01, ** p<0.05, * p<0.1. a) Coefficients omitted to preserve space.

Appendix E: Replicating Table 4.1 but adding remoteness measures to the model

Dependent variable: Food insecurity Z-score	(1) OLS	(2) IV
(log) coffee income	-0.419***	-1.464**
	(0.118)	(0.684)
(log) distance to all season road	-0.044	-0.053
	(0.035)	(0.037)
(log) distance to the woreda admin office	0.078	0.126*
	(0.054)	(0.070)
Controls? a)	yes	yes
Woreda dummies? a)	yes	yes
R^2	0.333	-
Weak-identification tests:		
Cragg-Donald F-statistic	-	14.10
Kleibergen-Paap rk Wald F statistic (or Angrist-Pischke F-test of excluded instruments)	-	20.64
p-value of Angrist-Pischke F-test	-	0.000***
Over-identification test:		
Hansen-J	-	0.250
--- p-value	-	0.617
Observations	**1,597**	**1,597**

Source: Authors' calculations based on ESSP's coffee survey, 2014.

Note: Standard errors clustered at the *kebele* level in parentheses. Statistical significance noted at *** p<0.01, ** p<0.05, * p<0.1. a) Coefficients omitted to preserve space.

About the Authors

Tadesse Kuma is a Senior Researcher in agriculture and rural development at the Ethiopian Development Research Institute (EDRI)**; Mekdim Dereje** is a Research Officer in the Ethiopia Strategy Support Program (ESSP) of the International Food Policy Research Institute and the Ethiopian Development Research Institute (EDRI), Addis Ababa, Ethiopia**; Kalle Hirvonen** is a Research Fellow at the Ethiopia Strategy Support Program in the Development Strategy and Governance Division of IFPRI, based in Addis Ababa**;** and **Bart Minten** is the Program Leader for the Ethiopia Strategy Support Program and a Senior Research Fellow in the Development Strategy and Governance Division of IFPRI, based in Addis Ababa.

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
2033 K Street, NW | Washington, DC 20006-1002 USA
T: +1.202.862.5600 | F: +1.202.457.4439
Skype: ifprihomeoffice | ifpri@cgiar.org | www.ifpri.org

ETHIOPIAN DEVELOPMENT RESEARCH INSTITUTE
P.O. Box 2479, Addis Ababa, Ethiopia
T: +251.11.550.6066; +251.11.553.8633 | F: +251.11.550.5588
info@edri-eth.org | www.edri-eth.org

IFPRI–ESSP ADDIS ABABA
P.O. Box 5689, Addis Ababa, Ethiopia
T: +251.11.617.2000 | F: +251.11.646.2318
mahlet.mekuria@cgiar.org | http://essp.ifpri.info

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