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Cash Crops and Food Security: Evidence from Ethiopian Smallholder Coffee Producers

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ABSTRACT *One of the central questions in food policy debates 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 data collected by the authors on about 1600 coffee farmers in the country, we find that coffee income is associated with improved food security, even after controlling for total income and other factors. Further analysis suggests that one possible pathway is linked to being better able to smooth consumption across agricultural seasons.*

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 key 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, Staatz, Holtzman, Crawford, & Bernsten, 1988). There are a number of channels through which cash crop production could contribute to food security. First, specialisation in a commodity which provides a higher return allows farm households to buy food as well as non-food consumption goods, and thereby achieve a higher level of welfare, including food security (Timmer, 1988). Second, the benefits arising from cash cropping also accrue to non-cash crop producers through increases in labour opportunities, since their production is often labour-intensive (Poulton, Al-Hassan, Cadisch, Reddy, & Smith, 2001). Third, cash income relaxes liquidity constraints thus facilitating the purchase of improved inputs (Govereh & Jayne, 2003). This cash income ultimately offers opportunities for farmers to invest and improve the management of their farms, thus stimulating agricultural innovation and increasing yields. However, as pointed out 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 specialising in

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the production of a single commodity, farm households often prefer to diversify their production portfolio and therefore smooth their consumption over time (Fafchamps, 1992).

The empirical evidence on this topic remains inconclusive. For instance, Pierre-Louis, Sanjur, Nesheim, Bowman, and Mohammed (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, Dewalt, Uquillas, & Dewalt, 1994), cacao and sugarcane production in Mexico (Dewey, 1981), and cold-weather vegetable production in Guatemala (Immink & Alarcon, 1993). DeWalt (1993) and Kennedy and Bouis (1993) also highlight mostly mixed evidence.

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 per cent of the world's coffee supply (Eakin, Winkels, & Sendzimir, 2009).[3] Despite the central role of coffee in the Ethiopian economy (it is Ethiopia's biggest export crop and it is grown by over four million smallholders) and high levels of food insecurity in the country, there is a lack of knowledge about how coffee production shapes the food security of smallholder coffee farming households. We contribute to this knowledge gap using data collected by the authors on about 1600 coffee farming households in Ethiopia. Apart from the usual household characteristics, the survey instrument contained detailed questions about household food security and coffee production. Section 2 of this paper describes the context and data and provides some descriptive statistics while Section 3 presents the econometric strategy used in this paper.

In Section 4 we find that households with larger shares of coffee income in their total income portfolio report significantly less food insecurity than other households. This finding is remarkably robust to a wide range of robustness checks that we present in Sections 5 and 6. Further analysis in Section 7 suggests that the coffee income pathway to food security is linked to seasonality. Although coffee is mainly harvested at the same time as 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. We discuss policy options in the concluding section.

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 per cent on average of Ethiopia's gross domestic product (GDP), 10 per cent of agricultural production, and about 37 per cent 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 per cent 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 (Worako, Van Schalkwyk, Alemu, & Ayele, 2008).

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 groundwork 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 10 coffee production areas that made up 77 per cent of all coffee production in 2012/13 were selected based on production data obtained from the Central Statistical Agency (CSA) of Ethiopia. These 10 areas – all located either in Oromia or Southern Nations, Nationalities, and Peoples' (SNNP) regions – were stratified based on the coffee variety produced in that area, 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.[4] 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 (that is, four woredas from each coffee production area). 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.

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), totalling 1598 coffee farming households overall in 20 woredas and 80 kebeles (Table 1).

It is generally acknowledged that food security is dependent on three core elements: adequate food availability, adequate access to food by all people, and appropriate food utilisation (FAO, 2009). Given the multi-dimensional and complex nature of food security, it is not possible to easily measure these different components at once and the proper measurement of food security in different dimensions has therefore been the subject of a large literature (for an overview, see Carletto, Zezza, and Banerjee 2013; Bertelli and Macours 2014; Coates 2013). In this study, we focus on the food access element. To do so, we measure food (in)security using the Household Food Insecurity Access Scale (HFIAS) developed by (Coates, Swindale, & 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 (Deitchler, Ballard, Swindale, & Coates, 2010; Knueppel, Demment, & Kaiser, 2010; Melgar-Quinonez et al., 2006), including Ethiopia (Gebreyesus, Lunde, Mariam, Woldehanna, & Lindtjørn, 2015; Maes, Hadley, Tesfaye, Shifferaw, & Tesfaye, 2009).[5]

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. Table S1 in the Supplementary Materials provides the full list of these questions. For the

Table 1. Distribution of sample households by coffee variety and by major production areas

	Coffee variety	Production area	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.

computation of HFIAS, a household received zero points if it reported that the event did not happen during the last 12 months, one if it rarely occurred (1 or 2 times), two if it sometimes (3–10 times) occurred, and three 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 1 shows how the food insecurity score is distributed within our sample. Nearly 40 per cent of the households reported being fully food secure, since they reported zero incidences of these nine food insecurity measures in the previous 12 months. The remaining 60 per cent 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.[6]

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 summarises household total incomes and income sources. The average household in our sample earned about 22,000 birr in the calendar year, corresponding to about 1100 USD at the time of the survey.[7] These average incomes remain relatively similar across the different coffee production areas with the exception of Nekempt where the mean

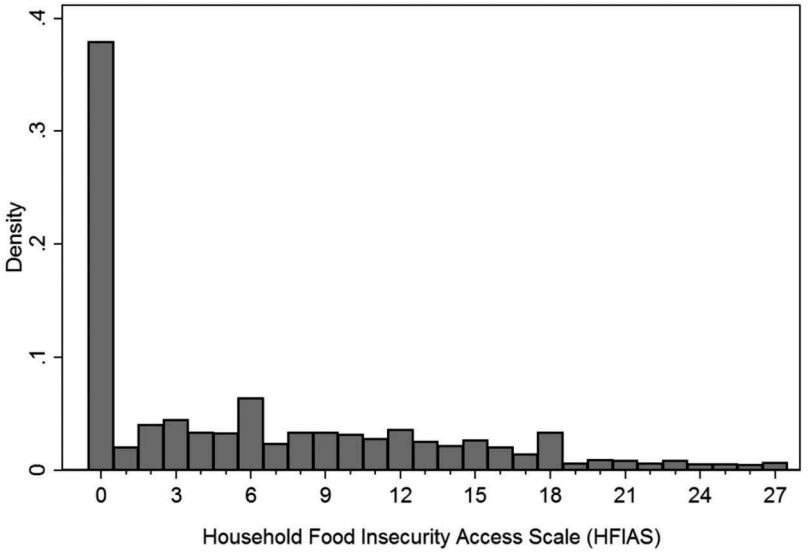

Figure 1. Distribution of the household food insecurity access scale (HFIAS) score.
Source: Authors' calculations based on ESSP's coffee survey, 2014

Table 2. Household income sources by coffee production area

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).

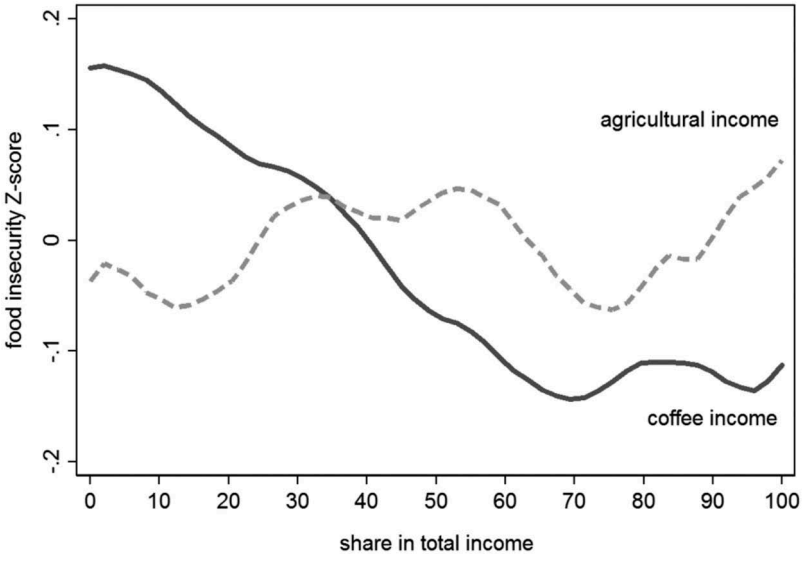

Figure 2. Relationship between food security and income sources.
Source: Authors' calculations based on ESSP's coffee survey, 2014.
Notes: Local polynomial regression. Agricultural income refers to income from food crops and livestock (see Table 2).

income is considerably lower at 14,700 birr (760 USD). On average, 42 per cent of total income comes from coffee cultivation, while food crops contribute on average 34 per cent. Livestock and livestock products account for 10 per cent of the total income, on average. However, these averages mask considerable heterogeneity across the different coffee production areas. In Sidama and Yirgacheffe regions, the share of coffee income constitutes more than 50 per cent of total income, on average. In Harar, where many farmers engage in khat[8] cultivation, the corresponding figure is 29 per cent.

Figure 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 levels of food insecurity (as indicated by a 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).

Next, we test whether this strong association between food (in)security and coffee income observed in Figure 2 holds if we control for various household characteristics that may be driving this relationship. Table 3 provides the summary statistics for all the variables used in the analysis. The final sample used in the analysis is based on 1597 households.[9]

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}):

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

where β captures the relationship of interest; the impact of the coffee-income share on household food insecurity.[10] 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

Table 3. Summary statistics for variables used in analysis (N = 1597 households)

Variable category	Variable	Mean (std. dev.)
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[a]	0.946 (0.226)
	Age of the household head[a]	44.82 (14.36)
Highest education level in household	Less than primary education (reference category)[a]	0.051 (0.221)
	Primary education[a]	0.703 (0.457)
	Secondary education & above[a]	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)
	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 in high altitude)	0.353 (0.365)

Source: Authors' calculations based on ESSP's coffee survey, 2014.
Notes: [a]Indicates a dummy (binary) variable.

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}. The computed standard errors are clustered at the kebele level.

Figure 2 suggests a non-linear relationship between food insecurity and coffee income. More specifically, the share of coffee income decreases food insecurity (that is improves food security) until 70 per cent of the income comes from coffee.[11] After this threshold, the relationship between food insecurity and coffee income is relatively flat. To account for this non-linear relationship, we replace C_{hw} in Equation (1) with a spline function (see Suits, Mason, & Chan, 1978) consisting of two linear segments and a threshold value (or knot) at 0.7.

Finally, in Sections 5 and 6 we consider an array of robustness checks, including an attempt to address the endogeneity of the coffee income variable using an instrumental variable approach.

4. Results

Column 1 of Table 4 provides the results based on estimation of Equation (1). Focusing first on the control variables, 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 report 0.23 units of standard deviation lower food insecurity. As expected, higher household income levels are associated with lower food insecurity scores, though the magnitude of the association is small.

The coefficient on the share of coffee income in total income appears with a negative sign and is statistically highly significant ($p < 0.01$). Keeping the total income level fixed and increasing the share of coffee in the total income portfolio by 25 per cent (that is one standard deviation) is associated with 0.10 unit of standard deviation decrease in food insecurity, on average. Column 2 shows the estimation results based on the spline function. We see that the coefficient on the first segment (0–0.7) is statistically significant ($p < 0.01$) whereas the coefficient on the second segment is not ($p = 0.98$). Moreover, the estimated association in the first segment is of similar magnitude as in column 1: 25 per cent in coffee income share is associated with a 0.12 unit of standard deviation decrease in food insecurity, on average.

5. Robustness (1): instrumenting coffee income share variable

Estimating Equation (1) using the ordinary least squares (OLS) regression raises some concerns about the unbiasedness of β for two reasons. The first is endogenous selection: more food secure households may be more willing to take risks and more likely to engage in coffee cultivation. Measurement error poses another endogeneity concern: measuring income in low-income settings like Ethiopia is notoriously difficult (Deaton, 1997). Both endogenous selection and measurement error would mean that the estimated parameter of interest (β) would be biased.

Mindful of these endogeneity concerns, we explore the robustness of our results using instrumental variable (IV) techniques.[12] Our IV-approach builds on Ethiopia's land allocation system where all land in principle is owned by the state. More specifically, individual farmers enjoy all the rights of the owner, but cannot officially sell the land (Ambaye, 2012; Deininger, Ali, Holden, & Zevenbergen, 2008).[13] As a result, land in Ethiopia is mostly acquired either through inheritance from parents or by community allocation (Ghebru, Koru, & Taffesse, 2016).[14] Therefore, the amount of coffee land that was owned by their parents should be a good predictor of the income derived from coffee by the households in our sample.[15] Below we show that this is indeed the case. Furthermore, the amount of inherited coffee land should not directly affect households' current food security status, other than through the coffee income channel (this is the so-called exclusion restriction). Using these insights, we use the share of inherited coffee land in total land

Table 4. Association between household food insecurity and coffee income

Dependent variable: Food insecurity Z-score	(1)	(2)
Share of coffee income	−0.412***	n/a
	(0.119)	
Share of coffee income < 0.7 (spline function)	n/a	−0.480***
		(0.135)
Share of coffee income ≥ 0.7 (spline function)	n/a	0.015
		(0.527)
(log) Total household income	−0.114***	−0.114***
	(0.038)	(0.038)
Male head	−0.006	−0.009
	(0.084)	(0.083)
Age of the household head	0.002	0.002
	(0.002)	(0.002)
Primary education	−0.062	−0.062
	(0.111)	(0.112)
Secondary education & above	−0.229**	−0.227*
	(0.116)	(0.117)
Number of male members less than 5 years	0.068**	0.065**
	(0.029)	(0.029)
Number of male members between 6 and 15	0.008	0.007
	(0.020)	(0.020)
Number of male members between 16 and 60	0.072***	0.071***
	(0.025)	(0.025)
Number of male members older than 60	0.007	0.005
	(0.096)	(0.096)
Number of female members less than 5 years	0.066**	0.066**
	(0.030)	(0.030)
Number of female members between 6 and 15	−0.011	−0.011
	(0.020)	(0.020)
Number of female members between 16 and 60	−0.001	−0.002
	(0.032)	(0.032)
Number of female members older than 60	0.000	0.000
	(0.080)	(0.080)
(log) Value of livestock owned by HH per capita	−0.045***	−0.044***
	(0.013)	(0.013)
(log) Value of durable assets owned by HH per capita	−0.111***	−0.113***
	(0.030)	(0.030)
(log) Total land owned by HH	−0.202***	−0.201***
	(0.069)	(0.069)
Woreda dummies?[a]	yes	yes
R^2	0.332	0.333
R^2-adjusted	0.317	0.317
Observations	1,597	1,597

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

as an instrument for contemporaneous coffee incomes.[16] 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).[17]

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 1200 and 2200 meters above sea level (masl) at the equator, although the optimal altitude in higher latitudes, such as Ethiopia, is considerably less (Pohlan & Janssens, 2010). It is therefore likely that coffee land in lower altitudes is more productive than in higher altitudes. We set the

threshold to 1700 masl and hypothesise that coffee land above this altitude is less productive.[18] 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 1700 masl, and zero otherwise) into X_{hw} in the main equation.

Table A1 in the Appendix shows the first-stage regression results. The two excluded instruments appear with a priori correct signs and are significant at the 5 per cent level at least. The share of inherited coffee land in the total land portfolio is associated with a 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, that is, 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.

Table 5 presents the results. Column 1 shows the OLS result when we add the altitude variable to the model and column 2 reports the results based on the IV-estimator. First, including the altitude variable to the model yields identical coffee-income coefficient as observed in column 1 of Table 4. However, the estimated coefficient is considerably larger when we apply the IV-estimator. According to the IV-estimator (column 2), increasing the share of coffee in a household's income portfolio by 25 per cent decreases the household food insecurity score on average by 0.35 units of standard deviation ($p = 0.039$) after controlling for total income, household size, and assets. However, the 95 per cent confidence interval for the IV-point estimate is large (−2.731, −0.074) and includes the OLS estimate (−0.412). Moreover, according to a Durbin–Wu–Hausman test, we cannot reject the null that the OLS estimator is consistent ($p = 0.205$).

Table 5. Replicating Column 1 of Table 4 using an IV-approach

	(1)	(2)
Dependent variable: Food insecurity Z-score	OLS	IV
Share of coffee income	−0.412***	−1.402**
	(0.119)	(0.678)
(log) Total household income	−0.114***	−0.130***
	(0.038)	(0.038)
Kebele is located in high altitude (>1,700 masl)	−0.003	−0.001
	(0.052)	(0.064)
Other control variables?[a]	yes	yes
Woreda dummies?[a]	yes	yes
R^2	0.332	-
R^2-adjusted	0.316	-
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.
Notes: 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.

6. Robustness (2): other checks

We conducted an array of further robustness checks. The results of these sensitivity analyses are reported and discussed in the Supplementary Materials. First, our results are robust to excluding the total income variable from the model (Table S2 in the Supplementary Materials) or using a coffee income variable instead of the share (Table S3 in the Supplementary Materials). Second, the IV-results are robust to an alternative way of defining inheritance (Table S4 in the Supplementary Materials). Third, both OLS and IV results are robust to using count data models (Table S5 in the Supplementary Materials). Fifth, appending our model with variables that relative remoteness does not change our results (Table S6 in the Supplementary Materials).

7. 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 on how coffee income shapes households' food security.

As discussed in the introduction, previous literature highlights two different pathways in which cash cropping may improve food security of the cash cropping households. First is the pure income effect; cash cropping increases incomes and richer households typically report lower food insecurity. Second is access to cash income that facilitates various investments to increase future incomes. However, since we control for income levels in the regressions, the positive association between coffee income and food security is over and above the income channel. As such, there must be an additional pathway through which coffee income shapes food security.

One such non-income pathway is seasonality. In Ethiopia, as in other African countries, only a small portion of the cultivated land is irrigated (Faurès & Santini, 2008), making agriculture heavily dependent on rainfall. This results in considerable seasonal fluctuations in household incomes, food availability and prices (Dercon & Krishnan, 1998; Gilbert, Christiaensen, & Kaminski, 2017; Hirvonen, Taffesse, & Worku, 2016; Kaminski, Christiaensen, & Gilbert, 2014). One 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 field work.

We examined this hypothesis using the 2013/14 Ethiopia Socioeconomic Survey (ESS)[19] 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 3 shows the harvest times for the five main food crops (barley, maize, sorghum, teff, and wheat). We see that most farmers in these regions harvest their produce between November and February. About 24 per cent of the farmers reported to have sold part of their harvest. Figure 4 shows that most of the sales occur between December and February, that is, immediately after the harvest. The ESS data also provides information about the timing of food shortages.[20] Figure 5 reports the per cent 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 6 provides the timing of the coffee harvests and sales based on our own survey of coffee farmers. We see that while the main harvest time for coffee follows the timing of the main food crops (Figure 4), coffee sales are more evenly scattered across the calendar year compared to the main food crops (Figure 5).[21] 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.[22] For example, only 4 per cent 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 presented here suggests that one potential reason why coffee production leads to lower food insecurity

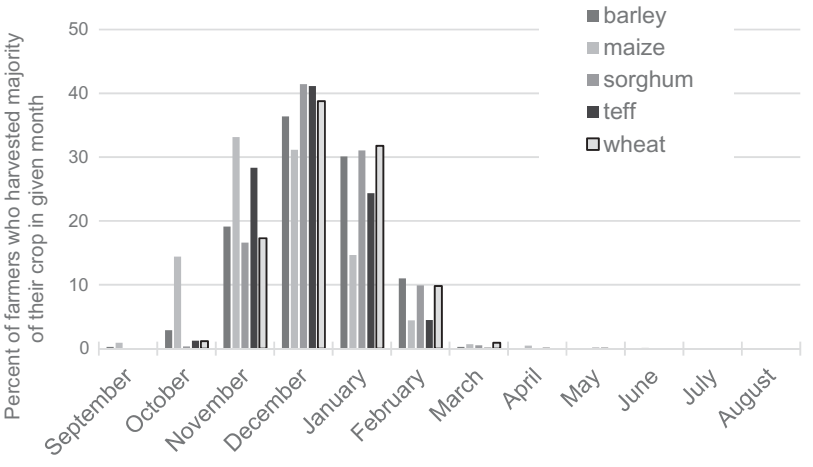

Figure 3. Harvest times of the main food crops in the study regions.
Source: Authors' calculations based on Ethiopia Socioeconomic Survey, 2013/14.
Notes: Each bar gives the per cent of farmers who harvested most of the crop in the given month. Bars for each crop sum up to 100.

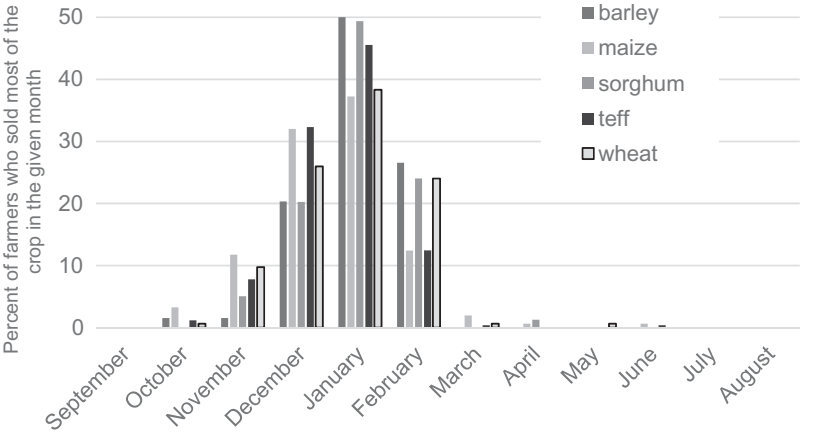

Figure 4. Sales times of the main food crops in the study regions.
Source: Authors' calculations based on Ethiopia Socioeconomic Survey, 2013/14.
Notes: Each bar gives the per cent of farmers who sold most of the crop in the given month. Bars for each crop sum up to 100.

is linked to the availability of cash income from coffee sales during the lean season. However, this finding should not be taken to imply that other income or non-income related pathways are not important.

8. Conclusions

The transformation of subsistence agrarian economies towards higher agricultural commercialisation 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

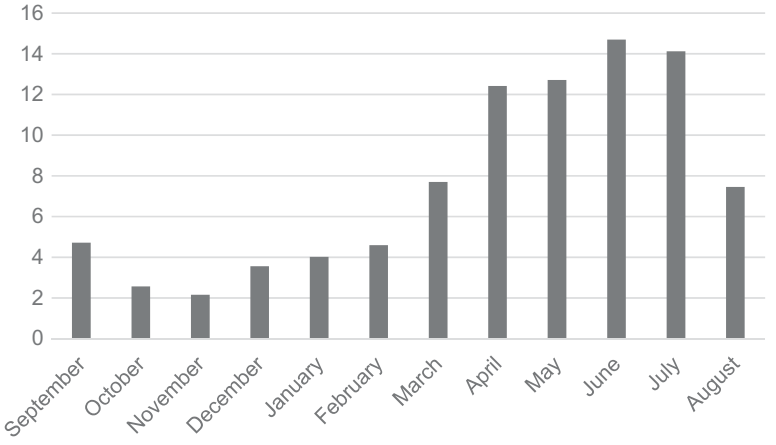

Figure 5. Food shortages in the study regions, per cent of households reporting food shortage by month.
Source: Authors' calculations based on Ethiopia Socioeconomic Survey, 2013/14.

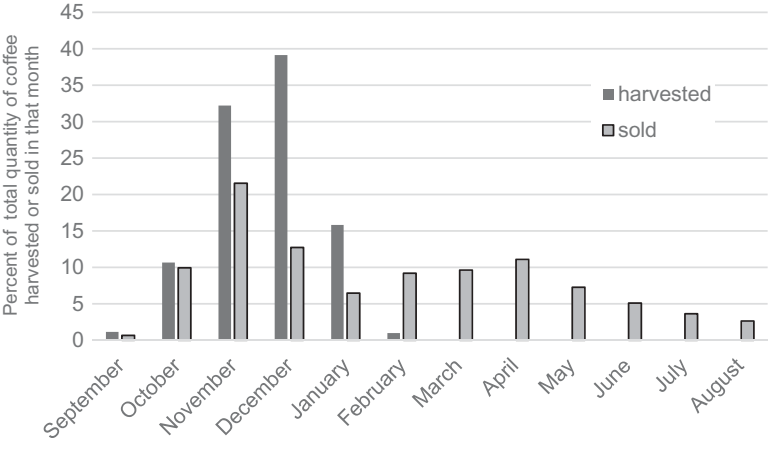

Figure 6. Harvest and sales times of coffee.
Source: Authors' calculations based on ESSP's coffee survey, 2014.
Notes: Each bar gives the per cent of the total quantity harvested or sold in that month. 'Harvested' and 'sold' bars each add up to 100.

been a long-standing debate on the role of income from cash crops on household income, welfare, and food security (Maxwell & Fernando, 1989; Von Braun, 1995; Von Braun & Kennedy, 1986).

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 1600 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, we find that coffee income considerably alleviates household food insecurity. This finding is robust to a wide variety of robustness checks, including an attempt to address the endogeneity of coffee income using an instrumental variable approach. 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 commercialised agriculture does not jeopardise 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 organisations tend to underinvest in commodities and value chains that are not directly linked to increased food supply in a country.[23] 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, & Robinson, 2011). Therefore, further understanding is needed of these issues and how to address them, for example, through improved access to savings institutions.

This study 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 (Adhvaryu, Kala, & Nyshadham, 2013; Kruger, 2007; Lederman & Porto, 2016; Singhal, Tarp, & 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 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, Tamru, Kuma, & Nyarko, 2014). Therefore, an important extension of this paper would be to conduct a similar analysis in both less and more favourable years. Second, an emerging body of literature shows how men and women spend income differently (Duflo, 2012; Duflo & Udry, 2004; Hoddinott & Haddad, 1995; Meinzen-Dick, Behrman, Menon, & Quisumbing, 2012). As coffee marketing is mostly managed by men in Ethiopia,[24] a fruitful avenue for future research would be to study how women's empowerment shapes food security in coffee growing households.

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Notes

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 (that is 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. 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).
4. Ethiopia is a federal state divided into 11 administrative regions. Each region is divided into zones that form the second highest administrative unit. Zones are formed of multiple woredas – the third highest administrative unit in Ethiopia. Finally, each woreda is formed of multiple kebeles – the lowest administrative unit.
5. While widely adopted, some authors have highlighted some measurement issues, including low accuracy in measuring temporal trends (Desiere, D'Haese, & Niragira, 2015), low predictive power for household targeting (Becquey et al., 2010), and lack of causal explanations, respondent bias, and possible issues with cross-cultural comparability (Bertelli & Macours, 2014).
6. 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.
7. The exchange rate at the time of the survey stood at 19.40 birr per USD.
8. Khat is a mild stimulant plant grown in many areas of the country, most prominently in Harar.
9. One household with implausible income values was dropped from the final sample.
10. 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.
11. Nearly 14 per cent of the households in the sample had a coffee-income share above this 70 per cent threshold.
12. 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 & Trivedi, 2005, pp. 187–188). 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 normality) yields 831.2, exceeding all the conventional critical values. Second, the number of instruments (two) exceeds the number of endogenous regressors (one).
13. Recent studies show that some households have acquired land through purchases, especially in south Ethiopia. Ghebru et al. (2016), report that 8.4 per cent of the parcels obtained in SNNP were through purchases while this was considerably less common (less than 3%) in other regions (Amhara, Oromia and Tigray). In our data, about 10 per cent of the land was obtained through purchases. Similar to the evidence provided in Ghebru et al. (2016), this is mostly occurring in the coffee regions located in SNNP (Sidama & Yirgachefe). While 90 per cent of the coffee land is acquired either through inheritance or through community (government) allocation, the finding that some households have acquired their land through purchases is surprising. As we write above, according to Ethiopian law, farmers have the user-rights to their land but cannot officially sell the land. More research is needed to understand this.
14. Even in the case of community allocation, often the allocated land was previously owned by the parents of the recipients (Fafchamps & Quisumbing, 2005). Typically the sons inherit their parents' land while daughters move to live with their husbands (Fafchamps & Quisumbing, 2002; Rahmato & 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 & Gurmu, 2011).
15. Information was collected in the survey on the mode of acquisition of land. Results show that cultivation of owned plots is the prevalent tenure situation. Of the 5643 cultivated plots in our datasets, 92 per cent was reported to be owned by the household. Land was also acquired through share-cropping in (7%), renting in (0.9%) or borrowing in at no cost (0.1%). For coffee plots in particular, 93.1 per cent were reported to be owned by the household, 6.5 per cent sharecropped in, 0.3 per cent rented in and 0.1 per cent borrowed at no cost.
16. As inheritance, we consider land transfer from the parents either when they are alive or after their death. In Section 6, we show that our results are robust to only considering cases after parental death. 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.
17. Farm sizes are small and declining in Ethiopia. Unfortunately, the Central Statistical Agency does not provide statistics on the average farm size. However, it publishes information on land area and the number of landholdings. When we divide those numbers in the case of grain crops (which made up almost 90% of cultivated area in 2016/17), we see that the farm sizes have been declining over the last decade (from 0.94 hectares in 2004/05 to 0.72 hectares in 2016/17).
18. Unfortunately, we could not find an optimal growing altitude range for Ethiopia (or for another country in a similar latitude range) from the literature. Instead, we estimated a coffee 'yields–altitude' relationship using a locally weighted regression

approach on our data. This method shows that yields are considerably higher in lower altitudes until 1700 masl after which the relationship between yields and altitude stabilise. Finally, we measure altitude through GPS coordinates collected at the household level. In order to minimise 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.

19. 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).
20. 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?'.
21. When we compare the coffee income per hectare with income from other crops per hectare, a difference of about 10 per cent is noted between coffee income (mean: 11,580 birr; median: 8000 birr) and other crop income (mean: 10,603 birr; median: 7200 birr). While most food crops in Ethiopia are characterised by significant seasonality, this is not the case for coffee where price movements over the year are mostly dictated by international price movements. This means that the terms of the trade of coffee versus other crops change over the season and relatively less food can typically be bought with coffee in the lean versus the harvest period, that is if there are no important international changes in coffee prices.
22. 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%). 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 per cent, indicating that the bulk of sales is made after they have been dried by the households.
23. For illustrations in the case of coffee in Ethiopia, see Agrer (2014).
24. Our survey shows that more than 70 per cent of coffee transactions are done by men.

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References

Adhvaryu, A., Kala, N., & Nyshadham, A. (2013). *Booms, busts, and household enterprise: Evidence from coffee farmers in Tanzania*. Ann Arbor, MI: University of Michigan.

Agrer. (2014). *Formulation of coffee development strategy for Ethiopia*. Mimeo.

Ambaye, D. (2012, May 6–10). *Land Rights in Ethiopia: Ownership, equity, and liberty in land use rights*. International Federation of Surveyors Working Week 2012: Knowing to manage the territory, protect the environment, evaluate the cultural heritage, Rome, Italy.

Angrist, J. D., & Pischke, J.-S. (2009). *Mostly harmless econometrics: An empiricist's companion*. Princeton: Princeton University Press.

Becquey, E., Martin-Prevel, Y., Traissac, P., Dembélé, B., Bambara, A., & Delpeuch, F. (2010). The household food insecurity access scale and an index-member dietary diversity score contribute valid and complementary information on household food insecurity in an urban West-African setting. *The Journal of Nutrition*, *140*(12), 2233–2240. doi:10.3945/jn.110.125716

Bertelli, O., & Macours, K. (2014). *Food security and agriculture in developing countries: Measurement and hypotheses for impact evaluations*. Brussels: LEI Wageningen UR.

Cameron, A. C., & Trivedi, P. K. (2005). *Microeconometrics: Methods and applications*. New York, NY: Cambridge University Press.

Carletto, C., Zezza, A., & Banerjee, R. (2013). Towards better measurement of household food security: Harmonizing indicators and the role of household surveys. *Global Food Security*, *2*(1), 30–40. doi:10.1016/j.gfs.2012.11.006

Coates, J. (2013). Build it back better: Deconstructing food security for improved measurement and action. *Global Food Security*, *2*(3), 188–194. doi:10.1016/j.gfs.2013.05.002

Coates, J., Swindale, A., & Bilinsky, P. (2007, August). *Household food insecurity access scale (HFIAS) for measurement of food access: Indicator guide* (v. 3). Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

CSA, and the World Bank. (2015). *Ethiopia socioeconomic survey (ESS) - wave two (2013/2014)*. Washington, DC: The World Bank.

Deaton, A. (1997). *The analysis of household surveys: A microeconometric approach to development policy*. Baltimore, MD: Published for the World Bank by Johns Hopkins University Press.

Deininger, K., Ali, D. A., Holden, S., & Zevenbergen, J. (2008). Rural land certification in Ethiopia: Process, initial impact, and implications for other African countries. *World Development*, *36*(10), 1786–1812. doi:10.1016/j.worlddev.2007.09.012

Deitchler, M., Ballard, T., Swindale, A., & Coates, J. (2010). *Validation of a measure of household hunger for cross-cultural use*. Washington, DC: Food and Nutrition Technical Assistance II Project (FANTA-2), FHI 360, 2010.

Dercon, S., & Krishnan, P. (1998). *Changes in poverty in rural Ethiopia 1989-1995: Measurement, robustness tests and decomposition*. Oxford: Centre for the Study of African Economies, Institute of Economics and Statistics, University of Oxford.

Desiere, S., D'Haese, M., & Niragira, S. (2015). Assessing the cross-sectional and inter-temporal validity of the household food insecurity access scale (HFIAS) in Burundi. *Public Health Nutrition*, *18*(15), 2775–2785. doi:10.1017/S1368980015000403

DeWalt, K. M. (1993). Nutrition and the commercialization of agriculture: Ten years later. *Social Science & Medicine*, *36*(11), 1407–1416. doi:10.1016/0277-9536(93)90383-F

Dewey, K. G. (1981). Nutritional consequences of the transformation from subsistence to commercial agriculture in Tabasco, Mexico. *Human Ecology*, *9*(2), 151–187. doi:10.1007/BF00889132

Duflo, E. (2012). Women empowerment and economic development. *Journal of Economic Literature*, *50*(4), 1051–1079. doi:10.1257/jel.50.4.1051

Duflo, E., Kremer, M., & Robinson, J. (2011). Nudging farmers to use fertilizer: Theory and experimental evidence from Kenya. *The American Economic Review*, *101*(6), 2350–2390. doi:10.1257/aer.101.6.2350

Duflo, E., & Udry, C. (2004). *Intrahousehold resource allocation in Cote d'Ivoire: Social norms, separate accounts and consumption choices*. Cambridge, MA: National Bureau of Economic Research.

Eakin, H., Winkels, A., & Sendzimir, J. (2009). Nested vulnerability: Exploring cross-scale linkages and vulnerability teleconnections in Mexican and Vietnamese coffee systems. *Environmental Science & Policy*, *12*(4), 398–412. doi:10.1016/j.envsci.2008.09.003

Fafchamps, M. (1992). Cash crop production, food price volatility, and rural market integration in the third world. *American Journal of Agricultural Economics*, *74*(1), 90–99. doi:10.2307/1242993

Fafchamps, M., & Quisumbing, A. R. (2005). Marriage, bequest, and assortative matching in rural Ethiopia. *Economic Development and Cultural Change*, *53*(2), 347–380. doi:10.1086/425373

Fafchamps, M., & Quisumbing, A. R. (2002). Control and ownership of assets within rural Ethiopian households. *Journal of Development Studies*, *38*(6), 47–82. doi:10.1080/00220380412331322581

FAO (Food and Agriculture Organization of the United Nations). (2009). *The state of food insecurity in the World 2009: Economic crises-impacts and lessons learned*. Rome: FAO.

FAO, IFAD, and WFP. (2015). The state of food insecurity in the world. The state of food insecurity in the world 2015. In *Meeting the 2015 international hunger targets: Taking stock of uneven progress*. Rome: Food and Agriculture Organization (FAO), International Fund for Agricultural Development (IFAD) and World Food Programme (WFP).

Faurès, J.-M., & Santini, G. (2008). *Water and the rural poor: Interventions for improving livelihoods in sub-Saharan Africa*. Rome, Italy: Food and Agriculture Organization (FAO).

Gebreyesus, S. H., Lunde, T., Mariam, D. H., Woldehanna, T., & Lindtjørn, B. (2015). Is the adapted household food insecurity access scale (HFIAS) developed internationally to measure food insecurity valid in urban and rural households of Ethiopia? *BMC Nutrition*, *1*(1), 2. doi:10.1186/2055-0928-1-2

Ghebru, H., Koru, B., & Taffesse, A. S. (2016). *Household perception and demand for better protection of land rights in Ethiopia* (ESSP Working paper 83). Addis Ababa: International Food Policy Resesarch Institute.

Gibson, M. A., & Gurmu, E. (2011). Land inheritance establishes sibling competition for marriage and reproduction in rural Ethiopia. *Proceedings of the National Academy of Sciences*, *108*(6), 2200–2204. doi:10.1073/pnas.1010241108

Gilbert, C. L., Christiaensen, L., & Kaminski, J. (2017). Food price seasonality in Africa: Measurement and extent. *Food Policy*, *67*, 119–132. doi:10.1016/j.foodpol.2016.09.016

Govereh, J., & Jayne, T. S. (2003). Cash cropping and food crop productivity: Synergies or trade-offs? *Agricultural Economics*, *28*(1), 39–50. doi:10.1111/agec.2003.28.issue-1

Hicks, A. (2002). Post-harvest processing and quality assurance for speciality/organic coffee products. *AU Journal of Technology*, *5*, 3.

Hirvonen, K., Taffesse, A. S., & Worku, I. (2016). Seasonality and household diets in Ethiopia. *Public Health Nutrition*, *19*(10), 1723–1730. doi:10.1017/S1368980015003237

Hoddinott, J., & Haddad, L. (1995). Does female income share influence household expenditures? Evidence from Côte d'Ivoire. *Oxford Bulletin of Economics and Statistics*, *57*(1), 77–96. doi:10.1111/obes.1995.57.issue-1

Immink, M. D. C., & Alarcon, J. A. (1993). Household income, food availability, and commercial crop production by smallholder farmers in the western highlands of Guatemala. *Economic Development and Cultural Change*, *41*(2), 319–342.

Jha, S., Bacon, C. M., Philpott, S. M., Rice, R. A., Méndez, V. E., & Läderach, P. (2011). A review of ecosystem services, farmer livelihoods, and value chains in shade coffee agroecosystems. In W. B. Campbell, and S. L. Ortíz (Eds.), *Integrating agriculture, conservation and ecotourism: Examples from the field* (vol. 1, pp. 141–208). Springer Science & Business Media.

Kaminski, J., Christiaensen, L., & Gilbert, C. L. (2014). *The end of seasonality? New insights from Sub-Saharan Africa* (World Bank Policy Research Working Paper 6907). Washington, DC: The World Bank.

Kennedy, E., & Peters, P. (1992). Household food security and child nutrition: The interaction of income and gender of household head. *World Development*, *20*(8), 1077–1085. doi:10.1016/0305-750X(92)90001-C

Kennedy, E. T., & Bouis, H. E. (1993). Linkages between agriculture and nutrition: Implications for policy and research. *International Food Policy Research Institute,*1–22.

Knueppel, D., Demment, M., & Kaiser, L. (2010). Validation of the household food insecurity access scale in rural Tanzania. *Public Health Nutrition*, *13*(3), 360–367. doi:10.1017/S1368980009991121

Kruger, D. I. (2007). Coffee production effects on child labor and schooling in rural Brazil. *Journal of Development Economics*, *82*(2), 448–463. doi:10.1016/j.jdeveco.2006.04.003

Lederman, D., & Porto, G. (2016). The price is not always right: On the impacts of commodity prices on households (and countries). *The World Bank Research Observer*, *31*(1), 168–197.

Leonard, W. R., Dewalt, K. M., Uquillas, J. E., & Dewalt, B. R. (1994). Diet and nutritional status among cassava producing agriculturalists of coastal Ecuador. *Ecology of Food and Nutrition*, *32*(3–4), 113–127. doi:10.1080/03670244.1994.9991393

Maes, K. C., Hadley, C., Tesfaye, F., Shifferaw, S., & Tesfaye, Y. A. (2009). Food insecurity among volunteer AIDS caregivers in Addis Ababa, Ethiopia was highly prevalent but buffered from the 2008 food crisis. *The Journal of Nutrition*, *139*(9), 1758–1764. doi:10.3945/jn.109.108548

Maxwell, S., & Fernando, A. (1989). Cash crops in developing countries: The issues, the facts, the policies. *World Development*, *17*(11), 1677–1708. doi:10.1016/0305-750X(89)90193-9

Meinzen-Dick, R., Behrman, J., Menon, P., & Quisumbing, A. (2012). Gender: A key dimension linking agricultural programs to improved nutrition and health. In Chapter 8, S. Fan and R. Pandya-Lorch (Eds.), *Reshaping Agriculture for Nutrition and Health*, 135–144. Washington, DC: International Food Policy Research Institute.

Melgar-Quinonez, H. R., Zubieta, A. C., MkNelly, B., Nteziyaremye, A., Maria Filipinas D, G., & Dunford, C. (2006). Household food insecurity and food expenditure in Bolivia, Burkina Faso, and the Philippines. *The Journal of Nutrition*, *136*(5), 1431S–1437S.

Minten, B., Tamru, S., Kuma, T., & Nyarko, Y. (2014). *Structure and performance of Ethiopia s coffee export sector* (Vol. 66). Washington, DC: International Food Policy Research Institute (IFPRI).

MOA. (2014). *Growth and transformation plan II (GTP TP II) coffee sector plan. Amharic version (Draft)*. Addis Ababa: Ministry of Agriculture (MOA), Government of Ethiopia.

Negash, M., & Swinnen, J. F. M. (2013). Biofuels and food security: Micro-evidence from Ethiopia. *Energy Policy*, *61*, 963–976. doi:10.1016/j.enpol.2013.06.031

Pierre-Louis, J. N., Sanjur, D., Nesheim, M. C., Bowman, D. D., & Mohammed, H. O. (2007). Maternal income-generating activities, child care, and child nutrition in Mali. *Food and Nutrition Bulletin*, *28*(1), 67–75. doi:10.1177/156482650702800108

Pohlan, H. A. J., & Janssens, M. J. J. (2010). Growth and production of coffee. *Soils, Plant Growth and Crop Production*, *III*, 101.

Poulton, C., Al-Hassan, R., Cadisch, G., Reddy, C., & Smith, L. (2001). *The cash crop versus food crop debate* (Issues Paper 3). London: Department for International Development.

Rahmato, D., & Assefa, T. (2006). *Land and the challenge of sustainable development in Ethiopia, Conference Proceedings*. Addis Ababa: African Books Collective.

Reardon, T., Delgado, C., & Matlon, P. (1992). Determinants and effects of income diversification amongst farm households in Burkina Faso. *The Journal of Development Studies*, *28*(2), 264–296. doi:10.1080/00220389208422232

Singhal, S., Tarp, F., & Beck, U. (2016). *Coffee price volatility and intra-household labour supply evidence from Viet Nam*. Helsinki: World Institute for Development Economic Research (UNU-WIDER).

Suits, D. B., Mason, A., & Chan, L. (1978). Spline functions fitted by standard regression methods. *The Review of Economics and Statistics*, *60*, 132–139. doi:10.2307/1924341

Timmer, C. P. (1988). The agricultural transformation. *Handbook of Development Economics*, *1*(Part II), 276–331.

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development* (United Nations Resolution A/RES/70/1). New York: United Nations.

Von Braun, J. (1995). Agricultural commercialization: Impacts on income and nutrition and implications for policy. *Food Policy*, *20*(3), 187–202. doi:10.1016/0306-9192(95)00013-5

Von Braun, J., & Kennedy, E. (1986). *Commercialization of subsistence agriculture: Income and nutritional effects in developing countries* (Working Papers on Commercialization of Agriculture and Nutrition 1). Washington, DC: International Food Policy Research Institute.

Weber, M. T., Staatz, J. M., Holtzman, J. S., Crawford, E. W., & Bernsten, A. R. H. (1988). Informing food security decisions in Africa: Empirical analysis and policy dialogue. *American Journal of Agricultural Economics*, *70*(5), 1044–1052. doi:10.2307/1241733

White, H. (1980). A heteroskedasticity-consistent covariance-matrix estimator and a direct test for heteroskedasticity. *Econometrica*, *48*(4), 817–838. doi:10.2307/1912934

Worako, T. K., Van Schalkwyk, H. D., Alemu, Z. G., & Ayele, G. (2008). Producer price and price transmission in a deregulated Ethiopian coffee market. *Agrekon*, *47*(4), 492–508. doi:10.1080/03031853.2008.9523812

Zorya, S., Morgan, N., Rios, L. D., Hodges, R., Bennett, B., Stathers, T., … Lamb, J. (2011). *Missing food: The case of postharvest grain losses in sub-Saharan Africa* (Technical Report). Washington, DC: The World Bank.

Appendix

Table A1. First stage regression results of Column 2 of Table 5

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 (that is **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 (that is 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.
Notes: 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.