The pass-through of international commodity price shocks to producers' welfare: Evidence from Ethiopian coffee farmers*

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Abstract

International commodity price shocks may have large impacts on producers in developing countries. In this paper, I use unique household panel data from Ethiopia to show that a decrease in international coffee price has strong pass-through to the consumption of households that rely on coffee production as a main source of livelihood. It also results in decreases in on-farm labor supply (particularly male labor supply) and induces reallocation of labor towards non-coffee fields, but has negligible effect on off-farm labor supply. The decline in consumption has significant consequences on child malnutrition. I find that children born in coffee-producing households during low coffee price periods have lower weight-to-age and weight-to-height z-scores than their peers born in non-coffee households.

Keywords: Child health, Commodity price shocks, Consumption smoothing, Ethiopia, Income shocks.

JEL Codes: O12, O15, I15, I38

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1 Introduction

What is the effect of frequent booms and busts in international commodity prices on rural households in poor countries who rely on production of these commodities for their livelihood? A number of studies have looked at the effect of such shocks on different outcomes such as child labor and schooling (Kruger, 2007; Cogneau and Jedwab, 2012; Carrillo, 2020); child mortality (Miller and Urdinola, 2010; Haaker, 2018); and long-term adult mental health (Adhvaryu et al., 2019). In most of these papers, the effect of changes in prices of cashcrops is presumed to be mediated through changes in household consumption and labor supply. However, direct empirical evidence of the effects of fluctuations in the prices of cashcrops on the consumption and labor supply decision of households is very limited.[1]

In this paper, I estimate the pass-through of international coffee price shocks on household consumption, labor supply, and welfare in Ethiopia. Ethiopia provides an ideal setting to study this problem compared to most of the settings studied in the literature. About 30% of the households live the below poverty line (World Bank Group, 2015), coffee production is the main source of livelihood for about 20% of the population (Central Statistical Agency, 2016), and there is considerable variation in the share of coffee production in household income due to massive geographic variation in agro-climatic suitability to grow coffee.

I use the Ethiopian Socioeconomic Survey (ESS) data collected by the joint effort of the Ethiopian Central Statistical Agency (CSA) and the World Bank.[2] ESS offers nationally representative panel data (2011, 2013 and 2015 rounds) on about 4000 households and provides information on household production, consumption, labor supply decisions, and child anthropometric measures. A novel feature of this paper is that I use a panel data setting and household level measure of exposure to coffee price change (i.e., the fraction of household farmland allocated to coffee). Existing literature mostly relies on repeated cross-sections and a measure of exposure that is based on geographic locations, so that all households located in a given geographic region are assumed to be equally exposed to price shocks. However, this approach masks massive variation in households' choice of crop portfolio within a narrowly defined geographic unit. In

[1] A number of studies show that informal risk-sharing arrangements among members of relatives or communities insure (perhaps imperfectly) household consumption against income shocks (see, for instance, Townsend, 1995; Jacoby and Skoufias, 1997; Fafchamps and Lund, 2003; and Gertler and Gruber, 2002). However, these studies look at idiosyncratic income shocks, such health shock to household head. The effectiveness of informal risk-sharing against commodity price shocks or weather shocks is likely to be weaker, since these shocks affect most members of the community at the same time.

[2] See https://microdata.worldbank.org/index.php/catalog/2053/download/40408 for details on the sampling procedure and coverage of this data.

Ethiopia's top coffee-producing district, for instance, the fraction of farmland allocated to coffee ranges from less than 10% for some households to 100% for others, averaging about 60%.[3] My approach enables me to capture variation in exposure to coffee price shocks among households within a narrowly defined geographic unit.

The results from empirical exercises show that changes in international coffee prices have significant pass-through to household food and non-food consumption. A 1% decrease in international coffee price results in about an 0.8% decrease in adult equivalent consumption in a household that allocates all its farmland to coffee. Between 2011 and 2013, coffee prices dropped by 50%, implying about 40% decrease in consumption in a household that allocates all its farmland to coffee. Considering an average household among households that allocate at least a quarter of their farmland to coffee, the 50% drop in coffee price results in a 23% decrease in adult equivalent consumption.

Another important result is that household on-farm labor supply responds positively to change in coffee prices. A decrease in coffee price decreases household labor supply on coffee fields, resulting in reallocation of household labor towards non-coffee fields, particularly for male members of the household. While there is no evidence of change in off-farm labor supply and labor income, there is limited evidence that households that already worked in the Productive Safety Net Program (PSNP) decrease the number of days of PSNP work and earn lower PSNP income during low coffee price periods. This is perhaps because coffee farmers increase their PSNP labor supply by cutting on-farm labor supply, which erodes non-coffee farmers' opportunity to work more days in PSNP. While borrowing increases during low coffee price periods, and modestly helps households smooth their consumption, there is no evidence that households' income from aid/transfers changes in response to coffee price changes. The latter could be attributed to the fact that most residents of coffee-producing areas are more or less exposed to coffee price decreases implying less supply of inter-family/friend transfers.

The decrease in household consumption during low coffee price periods has significant consequences on child health. Using child anthropometric measures, I show that cohorts of children who were in utero during low coffee price periods and born in coffee-producing households have significantly lower weight-to-age z-scores (WAZ) and weight-to-height z-scores (WHZ).

This paper is closely related to studies that estimate the effects of commodity price fluctuations

[3] A similar pattern exists in other major coffee districts of the country, and looking at more narrowly defined geography such as *Kebele*, which is the lowest administrative unit, gives a similar conclusion.

on household welfare, including child health and mortality. Miller and Urdinola (2010) show that periods of high coffee prices are associated with higher child mortality in Colombia because higher coffee prices increase the opportunity cost of mothers' time, consequently decreasing mothers' time spent on childcare. In the contrary, in my data, decreases in coffee prices lead to significant decrease in household consumption, but have no effect on labor supply by female household members, consequently leading to poor child health. Perhaps the most closely related to the current paper is the study by Cogneau and Jedwab (2012), who study the effect of a cut in government administered producer price for cocoa on child schooling and health in Côte d'Ivoire. They measure exposure to the price cut using a dummy variable indicating whether a household reported a positive cocoa production. However, they do not have household-level panel that covers pre- and post-shock periods to tightly identify the effect of the shock on household consumption. To the best of my knowledge, the current paper is the first to use a panel data and household-level measure of exposure to commodity price shocks to estimate the effect of such shocks on household consumption.

A number of studies estimate the effect on child health of income volatility due to macroeconomic business cycles or commodity price movements, typically in high- or middle-income settings, including Dehejia and Lleras-Muney, 2004; Neumayer, 2004; Paxson and Schady, 2005; Ferreira and Schady, 2008; Miller and Urdinola, 2010; and Page et al., 2017. These studies mainly seek to address the theoretical ambiguity about the effect of aggregate income shocks on child health. On the one hand, a positive aggregate income shock, e.g., macro economic boom, implies higher *consumption* for families, which improves child outcomes through investments in food and health of children. On the other hand, periods of booms also imply higher *opportunity costs* of mothers' time, which would adversely affect child outcome if mothers spend less time on taking care of the children. These studies find that the *opportunity cost* channel dominates the *consumption* channel, i.e., child health measures are counter-cyclical in high-/middle-income countries. The current paper finds the exact opposite in a low-income country setting. Because most households in my data live on a subsistence income, shocks to income have a first-order effect on spending on child nutrition and health.[4] On the other hand, there is no significant effect of coffee price change on female labor supply.

Few recent papers look at the long-term effects of commodity price shocks. Carrillo (2020)

[4]According to UNICEF (2015), almost half of under-5 mortality is attributable to under-nutrition in poor countries.

studies the effect of coffee price shocks during school-going age on long-run human capital accumulation and earnings in Colombia, and Adhvaryu et al. (2019) use fluctuations in cocoa prices to study the effect of income shocks during childhood on adult mental health. Kruger (2007) looks at the contemporaneous effect of coffee price on child labor and schooling in Brazil. The current paper uses similar source of variation to income, but focuses on the short-term consequences of income shocks.

This paper is also related to studies that use rainfall shocks as a source of variation to address various questions related to household consumption, child health, and human capital accumulation (Paxson, 1992; Townsend, 1995; Morduch, 1995; Jacoby and Skoufias, 1997; and Jensen, 2001).[5] And finally, this paper is related to the literature on the effects of *in utero* exposure to pandemics or drought and famine on child health, notably to Almond (2006) and Almond et al. (2015), as well as to the literature on the effects of transfer programs on child health, such as Hoynes et al. (2016), González (2013), and Lynch et al. (2019).

The rest of the paper is organized as follows. Section 2 briefly describes the datasets and some key summary statistics. Section 3 gives an overview of coffee production and marketing in Ethiopia. Section 4 describes the empirical strategy, while Section 5 presents the results. Section 6 concludes the paper.

2 Data

2.1 Data sources

The main dataset used in this study is the Ethiopian Socioeconomic Survey (ESS) data collected by the Central Statistical Agency (CSA) in collaboration with the World Bank (see Central Statistical Agency and World Bank (2012) for details about this data). This is an exceptionally rich nationally representative panel data of about 4,000 (rural sample) households in 290 villages (enumeration areas). There are three rounds of this survey: 2011, 2013, and 2015. In the rural sample, attrition rate is 5% between 2011 and 2013, and 2% between 2013 and 2015.[6] This attrition is not correlated with the households' 2011 characteristics, such as food and non-food consumption, share of land allocated to coffee, and many other variables, but is slightly negatively correlated with household size and land holding. See table A.1, which reports correlation of attrition between 2011 and 2013 on selected household 2011 characteristics.

[5]More recent ones include: Tiwari et al., 2013; Mendiratta, 2015; and Shah and Steinberg, 2017.

[6]For more information, see https://microdata.worldbank.org/index.php/catalog/2783/download/48264.

This dataset includes information on household production and consumption, disaggregated by crops. In particular, the dataset enables me to calculate the fraction of land and labor a household allocates across crops (or plots), as well as each household member's on-farm and off-farm labor supply. Importantly, the sample locations cover both coffee producing and non-coffee producing districts (see figure 3). A key variable that enables me to construct a measure of households' exposure to coffee price shocks is the share of farmland allocated to coffee production – households' exposure to coffee price shocks is proportional to the fraction of their farmland allocated to coffee production. The dataset also includes information on household demographic characteristics and anthropometric measures for children under five years of age.

There are some shortcomings of the dataset worth mentioning. Its main drawback its relatively small sample size and short panel. The second main drawback is that the child anthropometric measures (height and weight) are poorly measured – height and weight measures reported are biologically implausible for about 3% of the children in the dataset,[7] which I exclude from my analysis.

My international coffee price data comes from the *International Coffee Organization*, which maintains historical statistics on international coffee prices and trade. I use the monthly coffee price index for the variety of coffee known as *Brazilian Naturals*, which is an Arabica species and one of the most widely traded coffee types, with Ethiopia as one of the major suppliers. Figure 1 plots significant swings in the international coffee prices over the study period, 2006-2016.[8] To shed some light on how domestic prices move in response to international prices, figure 2 plots international prices (adjusted by nominal exchange rate) together with domestic prices at major coffee production centers across Ethiopia, obtained from the Retail Price Survey (RPS). The correlations between monthly international price and domestic prices at each of the different coffee producing centers are above 0.9.

2.2 Descriptive statistics

In this subsection, I provide descriptive statistics of key variables from my dataset. Table 1 provides descriptive statistics of most of the variables used in analysis. I provide descriptive statistics for the whole sample and for two different groups of households: households that

[7]While this problem is also prevalent in the Demographic and Health Survey (DHS) dataset, the large sample size of DHS data means that one can still have good variation in the data after dropping these outliers.

[8]The period 2006-2016 is the study period because some of under-5 children in ESS 2011 round data are in utero in 2006, and some of the under-5 children in ESS 2015/16 data are in utero in 2016.

allocate at least 10% of their farmland to coffee and those who allocate less than 10% of their farmland to coffee. While the 10% threshold is arbitrary, it can be argued that farmers who allocate at least 10% of their farmland to coffee are likely to be significantly affected by coffee price fluctuation, and can be considered coffee producers. These households account for 11% of the sample size, and they allocate about 40% of their farmland to coffee, on average (see table 2). There are some notable differences in the summary statistics across the two groups. First, coffee-producing households have lower total adult equivalent consumption than non-coffee farmers, even though this is statistically significant only at 10%. However, looking into the components, food and non-food consumption are not significantly different across the two groups. There are statistically significant differences across the two groups of households in the means of the following variables: household size, female on-farm labor supply, spouse on-farm labor supply, probability of receiving assistance/transfer and the size of assistance/transfer, and rainfall. Besides these differences, the mean of the variables across the two groups are not statistically significantly different.

Panel B of table 1 provides descriptive statistics of child anthropometric measures. It shows an average Ethiopian child has poorer anthropometric measures compared to 2006 WHO child growth standards, as indicated by negative values of weight-for-age z-score (WAZ), weight-for-weight z-score (WHZ) and height-for-age z-score (HAZ).[9][10] Comparing across the two groups of households, we see that children in coffee-producing households have slightly better anthropometric outcomes than those in non-coffee-producing households.

It is worth discussing the distribution of some key variables in detail. First, table 2 provides summary statistics of the share of farmland allocated to coffee for different sub-samples of households. The first row presents the distribution of the share of land allocated to coffee across *all* farmers in the ESS data (rural sample). An average farmer allocates about 5% of its farmland to coffee. However, because the majority of farmers are not coffee producers (the 75th percentile farmer allocates zero fraction of its farmland to coffee), the distribution of the share of land allocated to coffee is highly positively skewed. The second row provides the summary statistics of the share of land allocated to coffee among farmers who allocate at least 5% of their farmland

[9] WAZ, WHZ and HAZ values are computed using the stata program, which is based on 2006 WHO child growth standards.

[10] Ethiopia performs worse than Sub-Saharan African (SSA) countries' average in the proportion of under-5 children stunted, underweight, and wasted. Ethiopia has the highest percent (76%) of children who have not received any of the eight EPI immunizations in SSA countries. See Kanamori and Pullum (2013) for a detailed comparison of child health outcomes across 30 SSA countries using DHS data.

to coffee. This sample accounts for nearly 15% of the total sample. Among these farmers, the average farmer allocates about one-third of its farmland to coffee, while the median and the 75th percentile farmers, respectively, allocate a quarter and half of their farm land to coffee. The third row reports similar summary statistics for sub-sample of farmers who allocate at least 10% of their farmland to coffee. These farmers account for slightly above 10% of the total sample, and they allocate about 40% of their farmland to coffee, on average. Rows 4-6 report similar summary statistics for sub-samples of framers who allocate at least a quarter, one third and half of their farmland to coffee production, respectively. This summary statistics for sub-samples of the households is useful later when we interpret the magnitude of the estimated regression coefficients.

The second important variable is household consumption expenditure. The average adult equivalent consumption in 2011 per day is 14.5 Birr (about 2.75 in current PPP $). The median adult equivalent consumption per day is about 11 ETB (about 2 in current PPP $). The national poverty line for Ethiopia during the same year is 10.35 Birr (World Bank Group, 2015). The average (median) adult equivalent consumption decreases slightly to 1.94 in current PPP $ (1.68 in current PPP $) in 2015. Figure 4 presents the distribution of log total adult equivalent consumption spending.[11] The left panel in this figure shows the distribution of nominal consumption for each survey rounds 2011, 2013, and 2015. It shows a clear rightward shift in the distribution of consumption over time. However, this measure does not account for food price inflation over years. To address this, I purge out zone-year fixed effect to account for changes in prices over years in each zone, and plot the results in the right panel. The result shows that there is no clear rightward shift in the distribution of consumption over time. Household total consumption expenditure is composed of food and non-food expenditures (which mainly includes spending on household goods, clothing, and education). On average, non-food expenditures account for only 18.5% of household total expenditures, with significant variation across households.

3 Coffee production and marketing in Ethiopia

Ethiopia is a top coffee producer in Africa and ranked 5th in the world after Brazil, Vietnam, Colombia, and Indonesia in the year 2015/16. Ethiopia produced about 7 million 60-kg bags of

[11]For details about construction of the consumption variable from survey data, see https://microdata.worldbank.org/index.php/catalog/2053/download/40407.

coffee in 2015/16 , which is about 9% of the world coffee production. About 95% of Ethiopian coffee is produced by smallholder farmers with about a median land size of one hectare, and average coffee yield of 6.34 quintal per hectare. The remaining 5% is produced by government-owned farms and large-scale private farms. Over 5 million farm households engage in some level of coffee production in Ethiopia (Central Statistical Agency, 2016), implying that international coffee price changes might have important implications for poverty. Coffee production in Ethiopia is largely concentrated in the southern and southwestern parts of the country, where there is high rainfall and forest cover, the two essential ingredients of *Arabica* coffee production in Ethiopia.

There are four coffee production systems in Ethiopia, namely: forest, semi-forest, garden, and plantation coffee farms (Tefera and Tefera, 2013). Forest coffee grows under the shades of natural forests with some loose (communal) ownership. Semi-forest coffee is also grown under tree shades maintained by private owners. Garden coffee is grown in the farmers' gardens and plots of land near their homes, whereas plantation coffee is grown by large-scale commercial farms by applying modern production techniques such as irrigation, and modern inputs.

About 60% of coffee production is exported, and coffee export accounts for about a quarter of the country's export revenue. Because of the importance of coffee as source foreign exchange, the Ethiopian government tightly monitors the local and export trade through licensing and regulations. The Derg military regime (1975-1991) required farmers to supply a quota of coffee production at a specified price to the government. After the downfall of Derg, there has been a gradual liberalization of the coffee trade including the removal of entry barriers following Proclamation No. 70/1993, consolidation of taxes related to coffee trade into a single tax family in Proclamation No. 99/1998, and later complete removal of export taxes on coffee in 2002 (Minten et al., 2014). Coffee is exported by cooperatives unions (which are essentially parastatals) or by licensed private exporters. Cooperative unions source their export coffee from (licensed) intermediate suppliers or hulling firms, while private exporters source it from coffee auction markets in Addis Ababa or Dire Dawa. Despite the above liberalization steps, the government still has a heavy hand in the coffee trade. First, following the creation of Ethiopian Commodity Exchange (ECX) in 2008, private traders are required to sell coffee through ECX (Gabre-Madhin, 2012). Other forms of government intervention include allocating licenses. For instance, the government frequently revokes export licenses from traders who hoard excessive amount of coffee (over 500 metric tons) (Tefera and Tefera, 2013), and closely monitors the domestic market to ensure that export-quality coffee is not being sold in local markets. Despite these government interventions, domestic coffee prices are highly correlated with international prices as shown in figure 2.

4 Empirical Strategy

4.1 The pass-through of coffee price shocks to consumption

To estimate the pass-through of international coffee price changes to household consumption, I use ESS data. ESS data allows me to measure household-level exposure to coffee price shocks using the share of household farmland allocated to coffee. The estimation equation is as follows:

$$\text{LogC}_{it} = \beta_0 + \beta_1(\text{LandShareCoffee}_i \times \text{LogPrice}_t) + \gamma_i + \gamma_{zt} + \varepsilon_{it} \tag{1}$$

where i indexes households, γ_i is household fixed effect, and γ_{zt} is zone-year fixed effect included to account for changes in food prices in response to demand changes following movement in coffee prices. C denotes consumption. ESS data reports household level adult-equivalent per capita consumption expenditures disaggregated into food and non-food. *LandShareCoffee* is the share of household land allocated to coffee. *Price* is the average international coffee price in the four quarters before the consumption survey month.[12]

Identification comes from large variations in the fraction of farmland allocated to coffee across households and massive swings in the international coffee prices over time. The identification assumptions are: (i) households cannot endogenously adjust the fraction of their farmland allocated to coffee in response to coffee price (at least in the short run); (ii) international coffee price change is exogenous to Ethiopia; and (iii) coffee price movement does not have any significant effect on non-coffee producers.

To rule out any concern about households endogenously adjusting the fraction of land allocated to coffee in response to coffee price change, I use the share of land allocated to coffee at the beginning of the panel, i.e., the year 2011.[13] Moreover, variation in the fraction of farmland allocated to coffee is largely attributed to geographic variation in agro-climatic suitability to grow coffee (see figure 3 and table A.2). Table A.2 decomposes the variation in consumption,

[12] Using average prices over one, two, or three quarters before the consumption survey month has no significant effect on the estimates.

[13] The lumpy nature of coffee production by itself rules out any endogenous adjustment of coffee production in the short run. Coffee plants take about 5 years to grow into trees and bear fruit. Hence, it is unlikely that farmers would adjust the share of their land allocated to coffee following fluctuations in coffee prices.

landholding, and the share of land allocated to coffee. It shows that about 72% of the variation in landholding is within a village, but only 32% of variation in the share of land allocated to coffee is within a village.[14] The remaining 68% of variation in the share of land allocated to coffee is across villages, implying the importance of agro-climatic condition to grow coffee.

The international movement in coffee price is exogenous to Ethiopia, which has low (below 10%) international market share. For instance, the coffee price hike in 2011 (which is crucial in my identification) is attributed to poor harvests in Colombia, Indonesia, Mexico and Vietnam, mainly, and to growing demands in emerging economies such as Brazil, China, and India.[15]

Movement in coffee price might have local spillovers to non-coffee producers in the form of general equilibrium effects. Booms in coffee prices might increase local demand and lead to local food price inflation, which would affect non-coffee producers living in largely coffee-growing regions. Similarly, higher coffee prices may also affect local labor demand and wages. While it is impossible to completely address these potential spillover effects, one can minimize the bias due to these spillovers by including time varying location specific fixed effects. I include zone-year fixed effects in equation 3 to address this issue.

4.2 On-farm and off-farm labor supply responses

On-farm labor supply: To explore the effect of coffee price shocks on household on-farm labor supply, I estimate the following regression:

$$\mathrm{L}_{it}^{\mathrm{onf}} = \beta_0 + \beta_1(\mathrm{LandShareCoffee}_i \times \mathrm{LogPrice}_t) + \gamma_i + \gamma_{zt} + \varepsilon_{it} \tag{2}$$

where i indexes households, γ_i is household fixed effect, and γ_{zt} is zone-year fixed effect included to account for changes in local labor demand in response to movement in coffee prices. L^{onf} is hours of on-farm labor supply (which is obtained by adding on-farm labor supply across all crop fields cultivated by the household). I estimate this equation for men, women, spouses, and children separately to investigate potential heterogeneity in response across gender and age groups. I also estimate similar regression replacing L^{onf} by L^{coffee} (hours of labor supply on coffee fields) and $\frac{L^{\mathrm{coffee}}}{L^{\mathrm{onf}}}$ (the share of labor allocated to coffee fields).

[14] While the 32% within-village variation is surprisingly high (given that there is little agro-climatic variation within a village – the average village size about 25km square), there are a number of potential factors that might explain this variations including risk attitude (risk averse farmers might like to diversify their crop portfolio), variation in forest coverage, family labor supply constraints, size of farmland, etc.

[15] See https://www.theguardian.com/business/2011/apr/21/commodities-coffee-shortage-price-rise-expected.

Off-farm labor supply: Households might also look for off-farm employment opportunities to smooth consumption during low coffee price periods. I consider two off-farm employment options: daily labor and employment in the Productive Safety Net Program (PSNP).

$$\mathrm{L}_{it}^{\mathrm{off}} = \beta_0 + \beta_1(\mathrm{LandShareCoffee}_i \times \mathrm{LogPrice}_t) + \gamma_i + \gamma_{zt} + \varepsilon_{it} \quad (3)$$

where i indexes households, γ_i is household fixed effect, and γ_{zt} is zone-year fixed effect included to account for changes in local labor demand in response to movement in coffee prices. L^{off} is hours of off-farm labor supply per season. I estimate this equation separately for employment as a daily laborer (market labor) and employment in PSNP program.

4.3 Credit and transfers as consumption smoothing options

Households might use credits and transfers (from government, NGOs, and relatives) to smooth consumption during crises. To see whether borrowing or receipt of aid responds to coffee price shocks, I estimate the following regression:

$$Y_{it} = \beta_0 + \beta_1(\mathrm{LandShareCoffee}_i \times \mathrm{LogPrice}_t) + \gamma_i + \gamma_{zt} + \varepsilon_{it} \quad (4)$$

where Y_{it} is the amount of credit or transfers received by the household. Credit includes loans from formal financial sectors and informal money lenders. Likewise, transfer includes assistance received from relatives, NGOs, and the government.

4.4 Coffee price shocks and child malnutrition

The pass-through of coffee prices to household consumption may have consequences on child malnutrition and health. To investigate this, I compare anthropometric outcomes of cohorts of children born during high and low coffee price periods in households that allocate different fractions of their farmland to coffee. The regression equation estimated is the following:

$$H_{cit} = \beta_0 + \beta_1(\mathrm{LandShareCoffee}_i \times \mathrm{LogPriceUtero}_c) + X\delta + \gamma_v + \gamma_t + \gamma_m + \varepsilon_{cit} \quad (5)$$

where H_{cit} is a measure of health outcome for a child c in household i born in year t. $PriceUtero_c$ is the average coffee price in the months when the child was in utero. I also include exposure to coffee price shock after birth as a control to see the sensitivity of the result. X includes a vector of child and household characteristics including child's age and gender, and mother's education and land size. I also include time-varying village characteristics such as rainfall. γ_t is cohort fixed effects (included to account for nationwide shocks and trends in child health) and γ_m is month of birth fixed effects (included to account for the possibility that children who are in utero during harvest seasons might be better off compared to those in utero during slack season), and ε_{cit} is the error term. In my preferred specification, I include village fixed effects γ_v. I also see how results are sensitive to using zone fixed effect and household fixed effect (between-sibling comparison). However, because most of the variation in exposure to coffee price comes from across-household variation in the share of farmland allocated to coffee, between-sibling comparison too restrictive. Also, due to the short panel, most households have only one child under five years of age.

I consider three standard child anthropometric measures: weight-for-age z-score (WAZ), weight-for-height z-score (WHZ), and height-for-age z-score (HAZ). These measures are recommended by WHO as reliable measures of malnutrition for children less than 60 months old World Food Program (2013). WAZ is considered a reliable measure of child acute and chronic malnutrition, whereas WHZ is considered a measure acute malnutrition and ill-health. Low HAZ is an indicator of chronic malnutrition.

5 Results

5.1 The pass-through of coffee price shocks to consumption

Figure 5 presents a visualization of how the correlation between household consumption and the share of farmland allocated to coffee changes over time following booms and busts in international coffee prices. The figure shows that during the 2011 coffee price boom, households with higher fraction of their farmland allocated to coffee have significantly higher adult equivalent consumption. This fact is completely reversed in the years 2013 and 2015, when coffee prices were 50% lower than their 2011 values – in 2013 and 2015, household consumption significantly decreases with the fraction of their farmland allocated to coffee.

Table 3 presents formal estimations of the relationship depicted in figure 5. The standard errors are clustered at zone level. Panel A reports the estimation results, while Panel B presents the implied changes in consumption following a 50% decrease in coffee prices between 2011 and 2013. The first column presents the effect on *total* household adult equivalent consumption, whereas the second and third columns report the effect on food and non-food consumption.[16] Across all three columns, we see that change in coffee price has significant effects on total consumption and its components (food and non-food consumption). However, the effect on food expenditure is stronger than the effect on non-food expenditure.

The coefficient estimates in panel A can be interpreted as percentage change in consumption following a 1% change in coffee price for a household that allocates all its farm land to coffee (for the most exposed household). In equation 3, the effect of a percentage change in coffee price is given by $\beta_1 \times \text{LandShareCoffee}_i$, which varies across households depending on the fraction of farmland allocated to coffee. For a household that allocates all its farmland to coffee, $\text{LandShareCoffee}_i = 1$, the effect of a percentage change in coffee price is given by β_1. For a household that does not produce any coffee, the effect of the price change is zero. Accordingly, for a household that allocates all its farmland to coffee, a 50% decrease in coffee price results in about a 40% decrease in household adult equivalent food consumption and about a 30% decrease in non-food consumption.

Panel B reports the implied changes in household total, food, and non-food expenditures following a 50% price drop between 2011 and 2013 for households at different points in the distribution of the share of land allocated to coffee. The first row in Panel B reports the implied decrease in consumption of an average farmer in ESS data (rural sample). An average farmer in the ESS data allocates only 5% of its farmland to coffee production (see table 2), and as a result, consumption decreases by only 2.5% following a 50% decrease in coffee price. However, because the share of land allocated to coffee is highly positively skewed (slightly more than three quarters of households do not produce coffee at all), it is important to quantify the loss in consumption among farmers who produce coffee. The second row of panel B of table 3 shows that among households that allocate at least 5% of their farmland to coffee, the consumption of an average farmer decreases by about 13% following 50% decrease in coffee prices. Rows 3-6 report estimates of consumption loss for an average household among households that allocate at least 10%, 25%, 33%, and 50% of their farmland to coffee, respectively. Clearly, the consumption losses are significantly higher for households that allocate significant fraction of their farmland to coffee. For households that allocate over one-third of their farmland to coffee, coffee production can be considered as their main source of livelihood, and an average household among these

[16]Non-food expenditure mainly includes expenditure on health and education. Non-food expenditure accounts for only 18.5% of total consumption expenditure, on average.

group of households experiences about a 25% decrease in consumption following a 50% decrease in coffee prices. This level of consumption loss is likely to have a significant effect on the poverty level of the households, given the fact that the average household is very close to the national poverty line (see section 2).

5.2 On-farm and off-farm labor supply responses

In this subsection, I present results on how the labor allocation of household members responds to changes in coffee prices. Figure 6 gives a visualization of how household *on-farm* labor supply changes in response to change in coffee prices. It shows that household on-farm labor supply (on all fields) increases with the share of land allocated to coffee in 2011, when coffee price is high, but this correlation becomes almost zero when coffee price is low in 2013. Table 4 reports the formal estimation result. Panel A reports how household labor supply on *all fields* changes in response to coffee price changes. The first column shows that household labor supply on all fields significantly decreases following decreases in coffee prices, and column 2 shows that this is driven by labor supply by male members of the household. The magnitude of this effect is large. For an average household among those that allocate at least 5% of their farmland to coffee, a 10% decrease in coffee price leads to a 6.5% decrease in on-farm labor supply. Columns 3-5 show that female, spouse, and child labor supplies on all fields do not respond to changes in coffee prices.

Panel B reports the effect of coffee price change on labor supply on *coffee fields*. We see that household labor supply on coffee fields significantly decreases in response to decreases in coffee prices. Moreover, the decrease in household labor supply on coffee fields is driven by decreases in labor supply by male members and the spouse (see columns 2 and 4 of panel B). To interpret the estimated coefficients, an average household among those that allocate at least 5% of their farmland to coffee experiences a 7.2% decrease in labor supply on coffee fields following a 10% decrease in coffee prices.

One can infer that the decrease in labor supply on all fields reported in Panel A is driven by the decrease in labor supply on coffee fields reported in Panel B. This is formally estimated in Panel C, which demonstrates how the share of labor allocated to coffee farm changes in response to coffee price change. Column 1 shows that the fraction of household on-farm labor supply allocated to coffee fields significantly decreases following decreases in coffee prices. Using the estimated coefficient and the summary statistics in the land share of coffee in table 2, I conclude that, among households that allocate at least 5% of their farmland to coffee, a 1% decrease in coffee price leads to decrease in the share of labor allocated to coffee by 0.06 on average. This is significant compared to the average share of labor allocated to coffee of 0.27 among households that allocate at least 5% of their farmland to coffee. Column 2 shows that the fraction of male on-farm labor allocated to coffee decreases significantly, while columns 3-5 show no significant change in the share of labor allocated to coffee for female, spouse, and child labor.

Table 5 reports how households' off-farm labor supply responds to coffee price changes. I consider two off-farm employment options: employment in the Productive Safety Net Program (PSNP) and employment in labor market at market wage. The results in table 5 show that while employment in PSNP does not respond on the extensive margin, there is significant change on the intensive margin, i.e., those who already worked in PSNP work fewer days and earn less income in PSNP following decreases in coffee prices. Given that households that supply labor to the PSNP are likely to be those with limited on-farm employment opportunities, as coffee price decreases and on-farm labor supply on coffee fields decrease for some households, competition increases for households that work in the PSNP, and they work fewer days and earn less income in the program. Table 5 also shows that off-farm employment in the labor market does not respond to coffee price changes, either in the extensive or intensive margin.

5.3 Credit and transfers as consumption smoothing options

My measure of credit includes loan received from formal and informal money lenders. Aid includes transfers from families, friends, and government and non-government sources. Table 6 presents results on how changes in coffee price affect households' borrowings and aid receipts. The first column shows that households are less likely to receive credit when coffee prices are higher, and the second column shows that the amount of credit received is lower when coffee prices are higher. Among households that allocate at least 5% of their farmland to coffee, an average household is more likely to receive credit by 0.8 following a 10% decrease in coffee prices. Columns 3-4 show that household's aid receipt is not responsive to change in coffee prices, both in the extensive and intensive margins.

Table 7 explores whether credit and aid help households to smooth consumption during low coffee price periods. The results in the first two columns suggest that borrowing seems to help households smooth food consumption. However, the estimated coefficients are economically small, implying that consumption smoothing is minimal even for households that receive credit.[17] The last two columns show that aid has no meaningful role in consumption smoothing during low coffee price periods.

Finally, I explore whether households use migration of some household members to smooth consumption in response to coffee price drops. Table A.3 reports the correlation between reasons for member of a household leaving the household between 2011 and 2013, and the share of household land allocated to coffee in 2011. The first column regresses migration for work (to any place, including other villages) on the share of household land allocated to coffee. The estimates coefficient is positive, but borderline statistically insignificant. Columns 2-5 explore whether other most commonly cited reasons for leaving households, including migration for education, mortality, divorce, and marriage, are correlated with the share of land allocated to coffee. None of these variables are significantly correlated with the coffee intensity of the households.

5.4 Income shocks and child malnutrition

The previous subsection has shown that coffee price shocks have significant effects on household consumption. What is the consequence of this on child health? Figure 7 shows the visualization of the data. It shows that, for children who are in utero during the coffee boom period (2010-2012), the anthropometric measures of the children are positively related to the share of household land allocated to coffee. For children who are in utero during low coffee price period 2007-2009, child anthrompometric measure is negatively related to the share of household land allocated to coffee. Table 8 reports the results for the effect of coffee price shocks on anthropometric measures of children. I estimate different specifications to explore sensitivity of the estimates. I include different fixed effects and control for the effect of income shock after birth.

Panel A estimates a specification with zone fixed effects. The result shows that children who are in utero during higher coffee price periods have significantly higher levels of WAZ and WHZ measures the higher is the fraction of land allocated to coffee in their households. These results hold with and without controling for exposure to coffee price shock after birth. The effect on HAZ is positive, but not statistically significant. Panel B estimates a specification with village fixed effects, i.e., this specification utilizes only within-village/kebele variation in the measure of exposure. The result shows that the effect of coffee price shock on WAZ and

[17] A potential explanation is that households may not have the flexibility to use loans for consumption smoothing and loans for direct consumption is rare.

WHZ is still statistically significant. Again, inclusion of exposure to coffee price shock after birth has no significant effect. Lastly, Panel C estimates the most conservative specification with household fixed effects. That is, this panel utilizes variation in exposure to coffee price shock among siblings in a household. The effect on WHZ remains statistically significant, while the effect on WAZ becomes statistically insignificant.

It is worth commenting on the size of these estimates, focusing on the specification with village fixed effects (preferred specification) that does not include the effect of exposure after birth. This specification is preferred because it utilizes variation in exposure among cohorts of children born in a village, and households within a village are reasonably comparable. The estimates indicate that a 10% higher coffee price during the period when a child is in utero would increase a child's WAZ by about 4.3 units (and WHZ by about 5 units) for a child who is born in an average household that allocates at least 5% of its farmland to coffee. Overall, these estimates are large, but not implausible, given that: (i) households that are reliant on coffee have no meaningful mechanism to smooth their consumption during low price periods; (ii) these households already live close to the poverty line, and significant consumption loss is likely to push them into deep poverty; and (iii) children are the most vulnerable members of a household.

The pro-cyclical nature of child health observed in this paper is in contrast to several studies that report the counter-cyclicality of child health in other contexts, including those by Dehejia and Lleras-Muney, 2004; Neumayer, 2004; Paxson and Schady, 2005; Ferreira and Schady, 2008; Miller and Urdinola, 2010; and Page et al., 2017. In particular, it is worth comparing the current result with Miller and Urdinola (2010), who utilize a similar source of variation to income (coffee price movements) in a developing country context (Colombia). Miller and Urdinola (2010) find a stark counter-cyclicality of cohort size in Colombia, mainly due to pro-cyclical under-5 mortality. They attribute this to increases in the opportunity cost of mothers' time during high coffee price periods, which leads to reductions in the amount of time spent on childcare, such as time spent on fetching clean water, taking children to distant health stations for preventive and primary health care, and practicing good hygiene. Unfortunately, their paper does not separately identify the effect of price change on consumption (the *consumption channel*), which operates in the opposite direction to the above-mentioned *opportunity cost channel*. However, the fact that they find a positive effect of coffee price change on mortality implies that the opportunity cost channel dominates the consumption channel in their context. The results in this paper show the exact opposite – the *consumption channel* dominates the *opportunity cost* *channel*, so that child health is pro-cyclical. As documented in section 5.1, coffee price shocks have strong pass-through on household consumption. However, the results in section 5.2 show that female labor supply, particularly spouse's labor supply, does not respond to coffee price changes, implying the opportunity cost channel is insignificant.

6 Conclusions

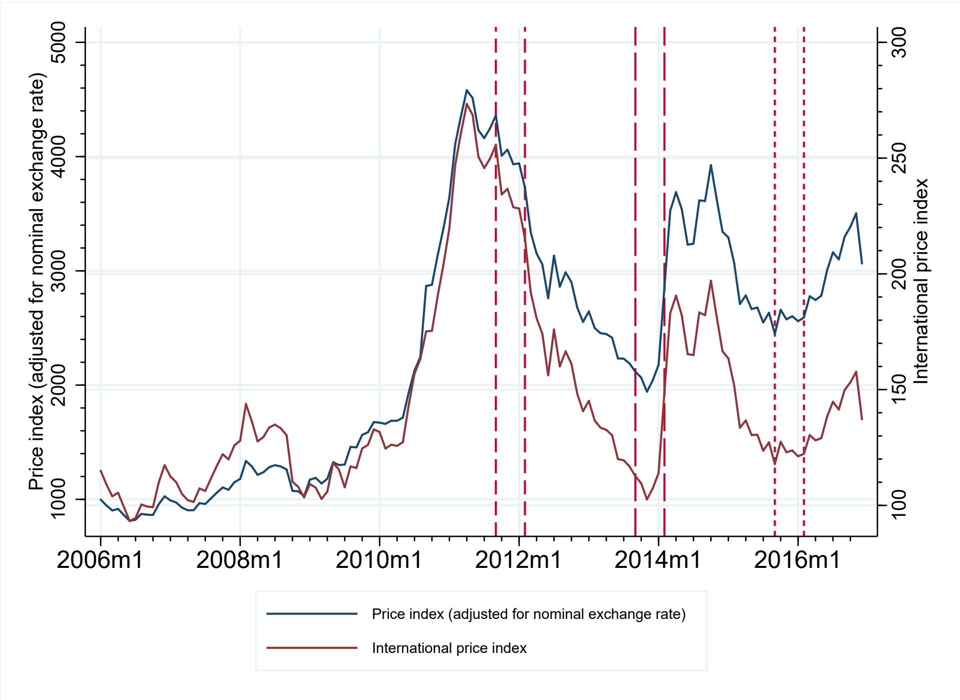
In this paper, I use household-level panel data from Ethiopia to provide strong evidence that exogenous shocks to international coffee prices have significant effect on household consumption. I find that a low coffee price induces borrowing, but borrowing has limited effect on household consumption smoothing. Moreover, I show that households (particularly male members) adjust their on-farm labor supply in response to coffee price changes. Households reallocate more fraction of their on-farm labor supply to non-coffee fields when coffee prices drop. However, the effect of coffee price change on off-farm labor supply is negligible.

I then explore the consequences of consumption losses due to low coffee prices on child anthropometric measures, and show that children who are born in coffee producing households during low coffee price periods have lower measures of weight-to-age and weight-to-height z-scores. In view of evidence that childhood malnourishment and poor health have lasting effects on the children, this result implies significant welfare cost of coffee price fluctuations.

Innovative insurance schemes, such as commodity price indexed insurances (similar to weather indexed insurance schemes), may have a positive effect on welfare. Future studies that seek experimental evidence of the feasibility and effectiveness of these insurance schemes would be a step forward towards solution to this problem.

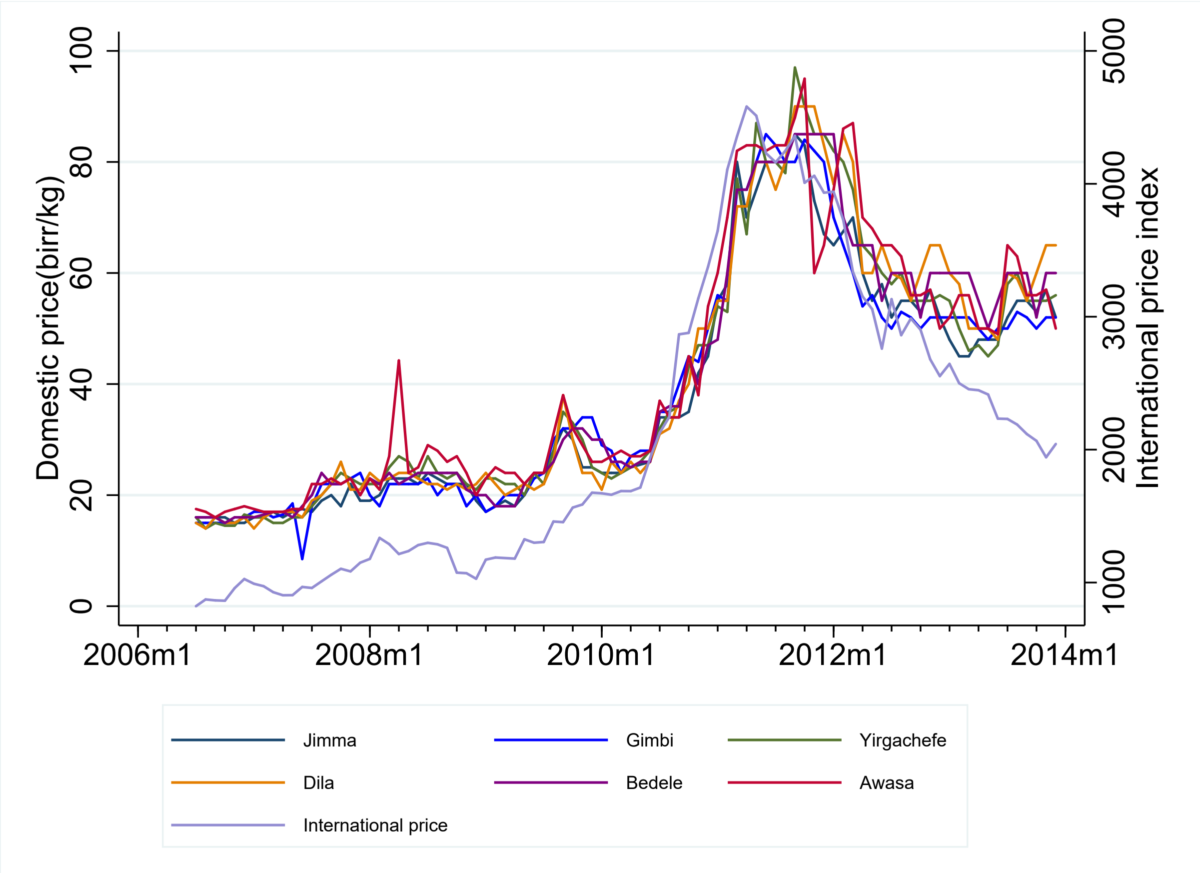
Another potentially useful intervention is the Fair Trade certification, which is found to be effective in improving smallholder farmers' welfare by increasing the value of their product and guaranteeing a minimum price in many other countries (for instance, see (Dragusanu and Nunn, 2020) for the case of Costa Rica). In Ethiopia, coffee certification is not only insignificant (less than 2% of coffee transaction is done under Fair Trade scheme between 2006 and 2013 (Minten et al., 2014)), but is also found to be ineffective in providing farmers with better prices, perhaps because the rents from certification are appropriated by cooperative unions (Jena et al., 2012). More efforts to certify coffee to add value and improving the the services of cooperative unions by allowing more control by the coffee farmers are likely to improve welfare.

Figure 1: Monthly international coffee price index



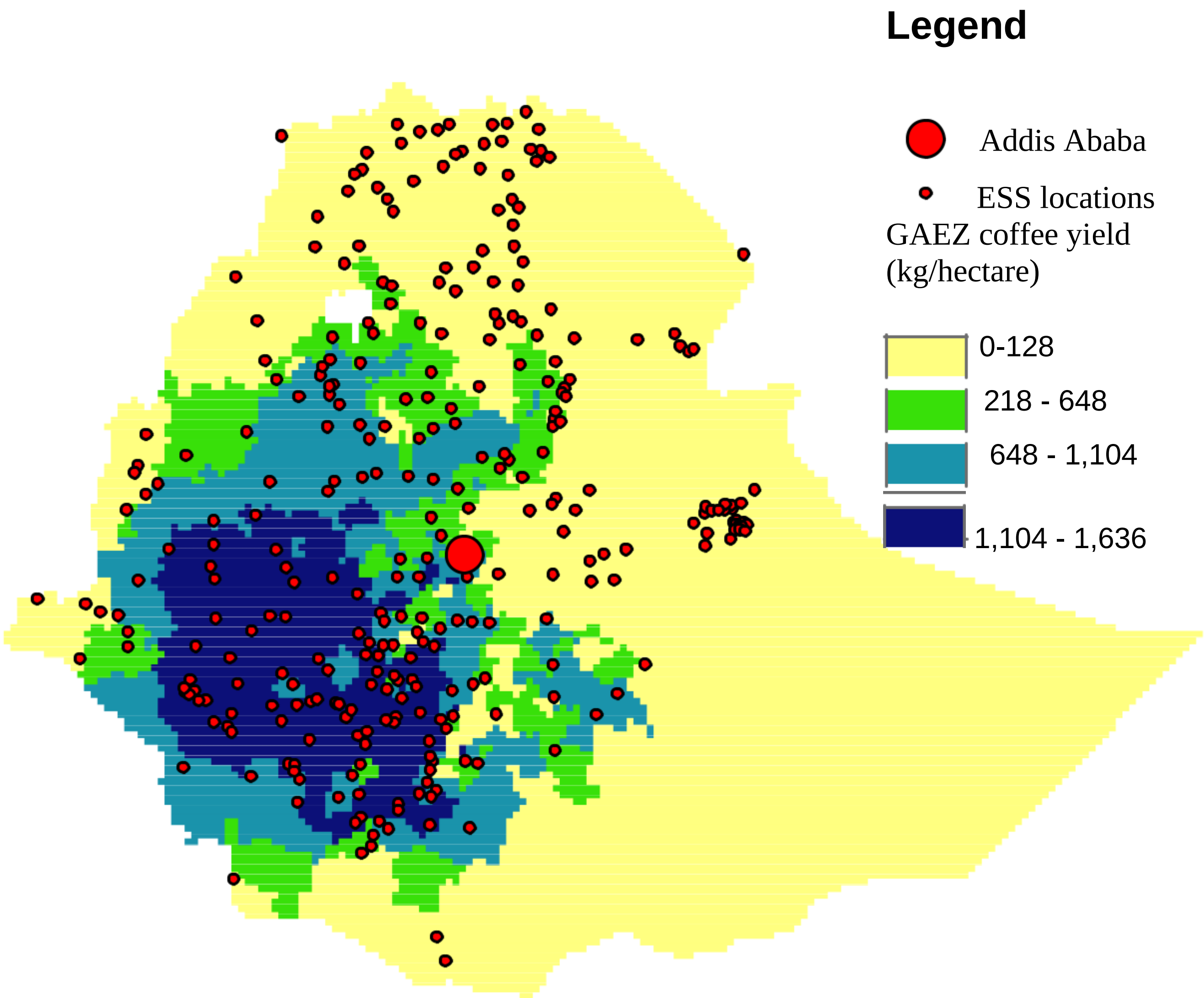
Note: This figure plots coffee price index for the variety of coffee known as *Brazilian Naturals*, which is Arabica species that is dried inside the fruit rather than after the fruit has been removed. It is one of the most widely traded coffee type, with Ethiopia as one of the major suppliers. In addition to the international price index, I also plot the index adjusted for nominal exchange rate of Birr/USD to facilitate comparison with domestic coffee prices below. The gap between the international price index and the index adjusted for nominal exchange rate is expanding after 2012 due to depreciation of Birr against USD. The vertical red lines indicate the survey windows. Data Source: International Coffee Organization.

Figure 2: Co-movement of international and domestic coffee prices



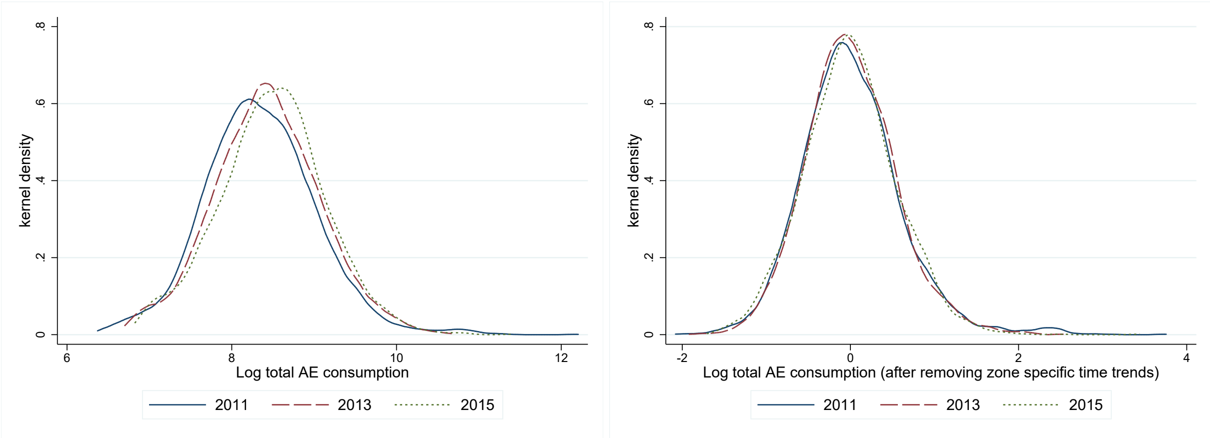
Note: This figure plots international coffee price index (adjusted for nominal exchange rate depreciation) alongwith domestic coffee price at major coffee production centers. Data Source: International Coffee Organization (for international coffee price index) and Retail Price Survey (for domestic coffee prices). Our retail price data covers only until 2014.

Figure 3: ESS sample locations and GAEZ yield (kg/hectare)



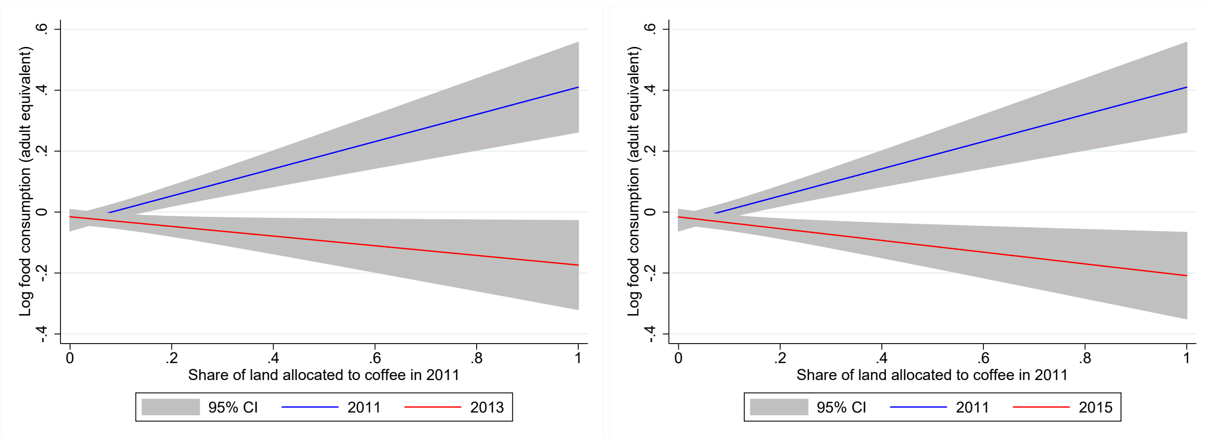
Notes: This figure shows GAEZ estimated yield for coffee based on rain-fed and intermediate input usage farming techniques. *Data Source: FAO/GAEZ.*

Figure 4: The distribution of log total adult equivalent consumption across years



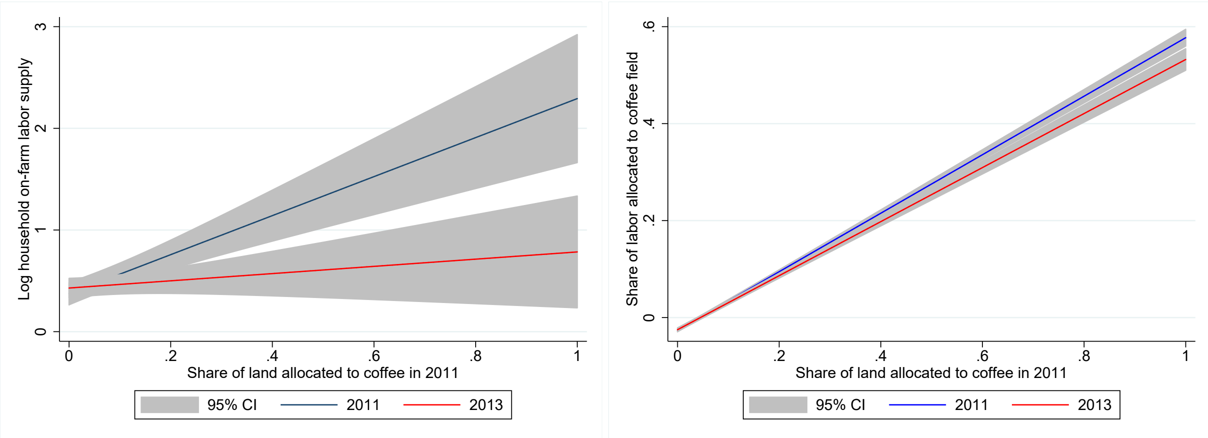
Note: This figure shows the distribution of log total AE consumption. The left panel shows the distribution of nominal values of log total AE consumption for each rounds of survey. The right panel removes zone specific trends to account for inflation at local level.

Figure 5: Correlation between household consumption and the share of land allocated to coffee



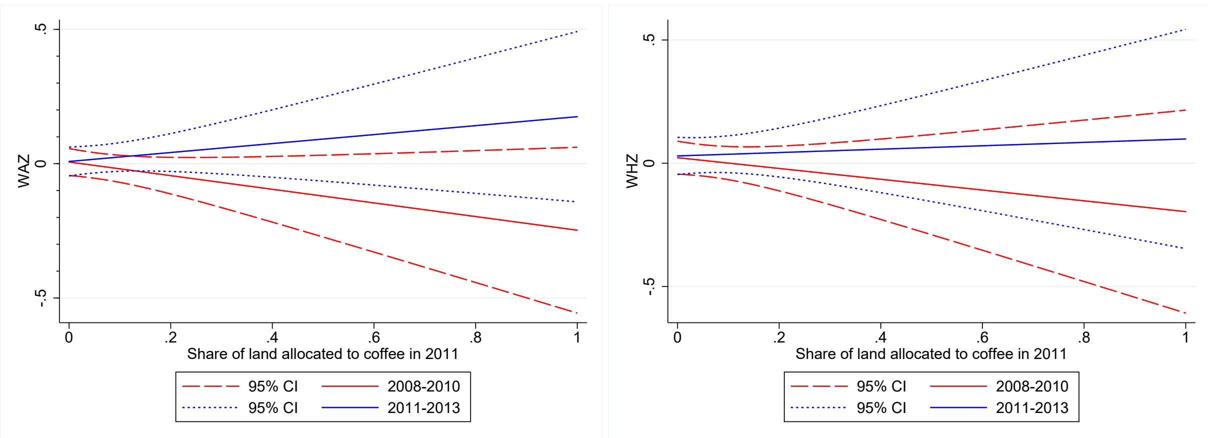
Note: This figure shows the correlation between log household adult equivalent consumption and the share of land allocated to coffee in 2011. The effect of rainfall and price inflation (year fixed effects) are removed before plotting. The figure shows that in 2011, when coffee price boomed, there is a significant positive correlation between household consumption and the fraction of household land allocated to coffee. This fact is totally reversed in the years 2013 and 2015, when international coffee price is about 50% less than its 2011 level (see figure 1).

Figure 6: Correlation between household on-farm labor supply and the share of land allocated to coffee



Note: The left panel plots log household on-farm labor supply (after removing the effects of rainfall and year fixed effects) against the share of land allocated to coffee in 2011. The figure shows that in 2011, when coffee price boomed, there is a significant positive correlation between household on-farm labor supply and the fraction of household land allocated to coffee. This positive correlation is significantly weaker in the year 2013, when international coffee price is about 50% less than its 2011 level (see figure 1). The right panel shows the correlation between the share of household labor allocated to coffee field (after removing the effect of rainfall and year fixed effects) and the share of land allocated to coffee field for the years 2011 and 2013. It shows that the fraction of labor allocated to coffee decreases between 2011 and 2013, given the fraction of land allocated to coffee. This implies reallocation of labor towards other crops following decrease in coffee price.

Figure 7: Correlation between child anthropometric measure and land share of coffee across years



Note: This figure shows the correlation between child anthropometric measures and the share of land allocated to coffee in 2011, for cohorts born during low and high coffee price periods. The effects of rainfall, cohort-fixed effect, month of birth fixed-effect, gender and age were purged out before plotting. The left panel shows the correlation between weight-to-age z-score (WAZ) and the share of household land allocated to coffee for cohorts born between 2008-2010 (who are exposed to low coffee price in utero) and cohorts born between 2011-2013 (who are exposed to high coffee price in utero). It shows that for cohorts born during low coffee price period, WAZ is negatively correlated with the share of land allocated to coffee. In the contrary, for cohorts born during high coffee price period WAZ is positively correlated with the fraction of household land allocated to coffee. The right panel shows similar pattern using weight-to-height z-score (WHZ)

Tables

Table 1: Summary statistics

	All Households		Households with land share of coffee ≥ 10%		Households with land share of coffee <10%	
Variable	Mean	SD	Mean	SD	Mean	SD
	Panel A: Household outcomes					
Number of observations	9967		1147		8820	
Household size size	5.01	2.37	5.34	2.37	4.96	2.36
Total consumption AEq (Birr)	5459.87	5023.29	5206.51	4820.59	5491.74	5047.58
Food consumption AEq (Birr)	4413.71	4117.02	4262.43	4523.97	4432.74	4062.84
Non-food consumption AEq (Birr)	994.31	2279.72	889.05	1096.29	1007.55	2387.11
Received credit	0.25	0.43	0.24	0.43	0.25	0.43
Total credit (Birr)	747.72	8644.08	427.02	1457.95	789.03	9168.24
Received assistance	0.20	0.40	0.08	0.27	0.21	0.41
Total assistance (Birr)	245.65	1072.01	54.75	322.47	270.29	1130.87
Land holding (hectare)	0.87	4.84	0.84	2.96	0.88	5.03
Rainfall (mm/year)	1132.77	428.64	1486.65	374.86	1087.18	413.65
Household on-farm labor (hrs)	1133.93	2072.87	1205.97	1595.08	1124.56	2127.02
Male on-farm labor (hrs)	769.63	1730.16	777.66	1146.99	768.59	1792.16
Female on-farm labor (hrs)	309.25	578.76	374.72	619.19	300.73	572.78
Spouse on-farm labor (hrs)	225.42	430.22	280.09	513.76	218.31	417.64
Child on-farm labor (hrs)	55.05	271.10	53.58	166.45	55.24	281.88
Number of PSNP days worked	10.05	41.82	6.21	36.09	10.56	42.48
PSNP income	231.39	3228.04	83.52	410.75	250.62	3427.88
Number of days worked as laborer	12.69	44.34	14.00	47.95	12.52	43.85
Labor income	405.96	4347.76	330.66	1465.98	415.75	4591.45
	Panel B: Child outcomes					
Number of children	3994		3512		482	
Weight-for-age z-score	-1.08	1.30	-0.93	1.37	-1.10	1.29
Weight-for-height z-score	-0.39	1.48	-0.30	1.47	-0.40	1.48
Height-for-age z-score	-1.43	1.89	-1.24	1.93	-1.46	1.88

Notes: This statistics is calculated from ESS data by restricting to rural samples only. For child outcomes, biologically implausible height and weight records that lead to implausible values of any of WAZ, WHZ or HAZ (i.e above 5 or below -5) are dropped in the calculation of this statistics and in all the regressions below. Consumption spending are in Adult Equivalent (AEq) terms.

Table 2: The distribution of the share of land allocated to coffee in 2011

Sample	Mean	Median	75%	90%	95%	SD	N
All farmers	0.05	0.00	0.00	0.13	0.37	0.16	3466
Land share of coffee >5%	0.34	0.25	0.50	0.79	0.93	0.27	492
Land share of coffee>10%	0.41	0.32	0.59	0.85	0.94	0.27	389
Land share of coffee>25%	0.56	0.51	0.75	0.93	1.00	0.24	244
Land share of coffee>33%	0.63	0.60	0.79	0.95	1.00	0.21	190
Land share of coffee>50%	0.75	0.75	0.89	1.00	1.00	0.16	125

Notes: This table provides the distributive statistics of the share of household land allocated to coffee production in the year 2011 for different sub-samples of farmers defined based on the farmers' intensity of coffee farm.

Table 3: Pass-through of coffee price shock to household consumption

	Total AEC	Food AEC	Non-food AEC
	Panel A: Regression results		
Land share of coffee * LogPrice	0.822***	0.834***	0.580*
	(0.205)	(0.207)	(0.300)
	Panel B: Implied effects of 50% price decrease between 2011 and 2013 for average farmer		
all sample	-2.06%	-2.09%	-1.45%
$\geq$ 5% land share of coffee	-13.49%	-14.18%	-9.84%
$\geq$ 10% land share of coffee	-16.85%	-17.1%	-11.89%
$\geq$ 25% land share of coffee	-23.02%	-23.35%	-16.24%
$\geq$ 33% land share of coffee	-25.89%	-26.27%	-18.27%
$\geq$ 50% land share of coffee	-30.83%	-31.28%	-21.75%
N	9525	9525	9525
R^2	0.650	0.608	0.710

Notes: This table is based on three rounds (2011, 2013, and 2015) of ESS survey. Standard errors are clustered at zone level. All regressions include household and zone-year fixed effects, and log rainfall. EAC stands for adult-equivalent consumption. All dependent variables are in log units of monetary value adjusted for variation in living expense across regions. *Land share of coffee* is the fraction of household land allocated to coffee in 2011. *LogPrice* is the log of average coffee price over the four quarters before the survey month.

Table 4: On-farm labor supply response to coffee price shocks

	Household	Male	Female	Spouse	Child
	Panel A: On-farm labor supply on all fields				
Land share of coffee * LogPrice	2.119***	1.876***	-0.804	-0.532	-0.124
	(0.556)	(0.647)	(0.794)	(0.812)	(0.785)
N	9870	9870	9870	9870	9870
R^2	0.754	0.770	0.691	0.688	0.544
	Panel B: On-farm labor supply on coffee field				
Land share of coffee * LogPrice	2.508***	1.902***	0.967	1.335*	-0.066
	(0.657)	(0.627)	(0.702)	(0.681)	(0.637)
N	9870	9870	9870	9870	9870
R^2	0.892	0.869	0.803	0.778	0.557
	Panel C: The share of labor allocated to coffee				
Land share of coffee * LogPrice	0.183***	0.144*	0.084	0.112	0.083
	(0.069)	(0.079)	(0.087)	(0.083)	(0.098)
N	9870	9870	9870	9870	9870
R^2	0.818	0.803	0.679	0.657	0.529

Notes: This table is based on three rounds (2011, 2013, and 2015) of ESS survey. Robust standard errors in parenthesis. All regressions include household and zone-year fixed effects, and log rainfall. All dependent variables are measured as inverse hyperbolic sine (IHS) transformation of hours per year to deal with zero values. The share of labor allocated to coffee is defined as the ratio of labor supply on coffee fields to one *plus* labor supply on all fields, to account for zero values. Male labor supply includes labor supply by all male members above 13 years of age (including the husband if any). Female labor supply includes labor supply by all female household members above 13 years of age (including the spouse if any). Children are defined as household members who are $\leq$ 13 years of age. The labor supply measure includes the sum of planting and harvesting labor applied on a field. *Land share of coffee* is the fraction of household land allocated to coffee in 2011. *LogPrice* is the log of average coffee price over the four quarters before the survey month.

Table 5: Off-farm labor supply and income

	Worked in PSNP	Number of PSNP days	PSNP income	Worked as laborer	Number of laborer days	Laborer income
Land share of coffee	0.037	21.640**	372.586**	0.106	6.459	-263.042
* LogPrice	(0.078)	(8.994)	(184.920)	(0.153)	(16.145)	(413.961)
N	9750	9750	9757	9779	9779	9765
R^2	0.668	0.608	0.597	0.572	0.518	0.458

Notes: This table is based on three rounds (2011, 2013, and 2015) of ESS survey. Standard errors are clustered at zone level. All regressions include household and zone-year fixed effects, and log rainfall. *Worked in PSNP* and *Worked as laborer* are dummy variables indicating whether any member of the household worked in PSNP or as daily laborer. *Land share of coffee* is the fraction of household land allocated to coffee in 2011. *LogPrice* is the log of average coffee price over the four quarters before the survey month.

Table 6: Coffee price shock, borrowing, and assistance

	Received Credit	Total Credit	Received Assist	Total Assist
Land share of coffee	-0.240	-982.719**	0.068	-162.086
* LogPrice	(0.179)	(459.695)	(0.079)	(242.118)
N	9968	9968	9968	9933
R^2	0.530	0.369	0.617	0.512

Notes: This table is based on three rounds (2011, 2013, and 2015) of ESS survey. Standard errors are clustered at zone level. All regressions include household and zone-year fixed effects, and log rainfall. *Received Credit* and *Received Assistance* are dummy variables indicating whether the household has received loan or transfers from formal or informal sources. *Land share of coffee* is the fraction of household land allocated to coffee in 2011. *LogPrice* is the log of average coffee price over the four quarters before the survey month.

Table 7: Credit, assistance and consumption smoothing

	Credit		Assistance	
	Total AEC	Food AEC	Total AEC	Food AEC
Land share of coffee * LogPrice	0.817***	0.827***	0.821***	0.822***
	(0.197)	(0.202)	(0.212)	(0.215)
Land share of coffee * LogPrice * Credit	-0.042*	-0.056*		
	(0.023)	(0.033)		
Land share of coffee * LogPrice * Assistance			0.003	0.024
			(0.029)	(0.030)
N	9525	9525	9525	9525
R^2	0.651	0.609	0.650	0.608

Notes: This table is based on three rounds (2011, 2013, and 2015) of ESS survey. Standard errors are clustered at zone level. All regressions include household and zone-year fixed effects, and log rainfall. *Land share of coffee* is the fraction of household land allocated to coffee in 2011. *LogPrice* is the log of average coffee price over the four quarters before the survey month.

Table 8: Coffee price shocks and child malnutrition

	WAZ		WHZ		HAZ	
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Zone fixed effects					
Land share of coffee	0.973**	0.980*	1.147*	1.253*	0.337	0.203
* Log price in utero	(0.480)	(0.539)	(0.637)	(0.709)	(0.496)	(0.564)
Land share of coffee		0.017		0.248		-0.314
* Log price post birth		(0.435)		(0.625)		(0.676)
N	3994	3994	3994	3994	3994	3994
R^2	0.096	0.096	0.071	0.071	0.087	0.087
	Panel B: Village/Kebele fixed effects					
Land share of coffee	1.216*	1.340*	1.438**	1.673**	0.402	0.326
* Log price in utero	(0.657)	(0.730)	(0.702)	(0.746)	(0.616)	(0.735)
Land share of coffee		0.286		0.538		-0.169
* Log price post birth		(0.490)		(0.583)		(0.746)
N	3994	3994	3994	3994	3994	3994
R^2	0.209	0.209	0.165	0.165	0.178	0.178
	Panel C: Household fixed effects					
Land share of coffee	0.888	0.793	1.760*	1.847*	-0.643	-0.942
* Log price in utero	(0.974)	(1.139)	(0.977)	(0.955)	(1.483)	(1.505)
Land share of coffee		-0.272		0.177		-0.761
* Log price post birth		(1.136)		(1.297)		(1.554)
N	3994	3994	3994	3994	3994	3994
R^2	0.695	0.695	0.646	0.646	0.636	0.636

Notes: This table is based on children in three rounds (2011, 2013, and 2015) of ESS survey. Standard errors are clustered at zone level. This table is based on anthropometric measures of children under 5 years of age in ESS data, after removing biologically implausible extreme values (WAZ, WHZ and HAZ values of > 5 or < -5). All regressions include, month of birth, and year of birth fixed effects, and log rainfall. *Land share of coffee* is the fraction of household land allocated to coffee in 2011. *LogPrice* is log of the average coffee price when the child was in utero.

Appendices

A Appendix Tables

Table A.1: Attrition of sampled households between 2011 and 2013

	Attrition (1 if household dropped out)
Household size	-0.018340***
	(0.001886)
Food consumption	-0.000004
	(0.000004)
Non-food consumption	-0.000004
	(0.000004)
Total consumption	0.000004
	(0.000004)
Share of land allocated to coffee	-0.027836
	(0.023480)
Land holding	-0.000001***
	(0.000000)
N	3768
R^2	0.049

Notes: All the regressors are 2011 values. The number of observation is smaller than the sample size in 2011 due to missing values in some of the variables.

Table A.2: Decomposition of variation in selected variables

	Region FEs	Zone FEs	Village/Kebele FEs
Log adult equivalent consumption	0.058	0.183	0.408
Land holding	0.038	0.087	0.281
Share of land allocated to coffee	0.134	0.389	0.681

Notes: This table reports R-squares from regression of the variables listed on region fixed effects (column 1), zone fixed effects (column 2), and village/kebele fixed effects (column 3) . In ESS rural sample, there are 10 regions, 69 zones and 290 villages/kebeles.

Table A.3: Migration of household member between 2011 and 2013

	Migration for work	Migration for education	Mortality	Divorce	Marriage
Land share of coffee	0.031	-0.010	0.004	0.007	0.016
	(0.022)	(0.007)	(0.006)	(0.009)	(0.032)
Male	0.011***	0.000	0.002	-0.013***	-0.032***
	(0.003)	(0.003)	(0.002)	(0.004)	(0.005)
Age in 2011	0.001***	0.001***	-0.001***	-0.002***	0.007***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Age in 2011 Sqr	-0.000***	-0.000***	0.000***	0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Marital Status	-0.003	-0.008***	0.000		
	(0.002)	(0.001)	(0.003)		
N	16017	16017	16017	4975	9942
R^2	0.048	0.045	0.045	0.083	0.092

Notes: Standard errors clustered at household level in parenthesis. All regressions include village fixed effects. The dependent variables indicate why household member left the household between 2011 and 2013 surveys.

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