An Analysis of Coffee Production, Food Security, and Child Nutrition in Ethiopia

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Introduction: Child Malnutrition and Commercial Agriculture

Arguably one of the most enduring legacies of COVID-19 will be the pandemic's impact on global nutrition and food security. A recent report estimated that an additional 9.3 million children will become wasted, 2.6 million will become stunted, and 168,000 will die by 2022 as a result of the COVID-19 pandemic and associated economic shock (Carducci et al., 2021). These statistics underscore a global problem that preceded the events of 2020. Malnutrition had been increasing gradually around the world for years so that 690 million people were already undernourished by 2019 (Pretorius et al., 2019) (Carducci et al., 2021). This trend has major implications for global poverty and well-being. Malnourished individuals have lower energy levels and are more likely to become sick. This can impede economic activity while also increasing healthcare costs for families (Schaible & Kaufmann, 2007) (Vorster, 2010). Furthermore, these effects can also lead to mental health issues and social isolation (Pretorius et al.,2019) (Huang et al., 2013). Malnutrition has even greater consequences for young children who may suffer impediments to their physical and mental development, which limit their future earning potential and shorten their life span (Martinez et al., 2018).

Historically, policy makers and many researchers have promoted agricultural commercialization policies as a solution to malnutrition and food insecurity. This is the process of transforming farming practices so that farmers grow crops for sale in local and global markets rather than for their own consumption. Some evidence suggests that these strategies can improve food security and nutrition by raising the income of farmers and lowering food prices (Shenggen et al., 2019). However, there is also a large body of research that suggests commercialization can lead farmers to become over dependent on international crop markets and change their consumption habits to include more processed foods (Hamilton & Fischer, 2003). Therefore, these researchers argue that commercialization can actually worsen problems of food insecurity and malnutrition.

In light of current nutrition challenges amplified by the pandemic, a greater understanding of the relationship between child nutrition and agricultural commercialization is needed to inform international development policies. In this paper, I explored this area of inquiry using household-level data from

Ethiopia. Specifically, I sought to examine the relationship between coffee production and acute malnutrition for children from ages three through five. My findings suggest that children in coffee growing regions of Ethiopia experienced worse nutrition and food security outcomes on average compared to children in non-coffee growing regions during the study period. While my analysis does not provide insight into the mechanisms underlying this association, it is possible that families in coffee producing areas are over reliant on food markets that do not adequately satisfy their dietary needs. Researchers should continue to examine the effects of agricultural commercialization on child nutrition and food security in order to develop strategies that promote healthy diets and nutrition for farming families around the world.

In the following section, I outline the existing debate around agricultural commercialization and its association with child nutrition and food security. I then review the theoretical determinants of child nutrition status and their implications for this study. Next, I provide an overview of the agriculture and child nutrition in the Ethiopian context. I then describe the data used in my study and the identification strategy implemented to analyze the association between commercialization and nutrition status. Finally, I present my findings and discuss their implications for current discourse.

Literature Review: Differing Views on the Impacts of Agricultural Commercialization

To improve nutrition and food security, policy makers typically push for agricultural commercialization around the world. Specifically, they advocate for a shift away from subsistence farming where households grow food for their own consumption and toward market agriculture where crops are sold locally and internationally (Shenggen et al., 2019) (Razavi, 2002). As part of this transition, it is recommended that households specialize in growing one or two cash crops and invest earnings into improved production technology such as fertilizer or pesticide. These recommendations are based on research that suggests commercialization would lead to increased food security and better nutrition for the rural poor as a result of increased productivity and economic growth (von Braun, 1995) (Shenggen et al., 2019). A number of studies highlight that commercialization leads to higher incomes, which allows families to buy more and better food as well as access medical care (Kuma et al., 2019) (Bachewe et al.,

2018) (Bershteyn et al., 2015). Additionally, increased productivity associated with commercialization can decrease food prices and expand access to healthy diets in low-income communities (Shenggen et al., 2019). Ultimately, these factors are believed to translate into better nutrition outcomes for farmers and their children.

However, there is also a substantial body of literature suggesting that agricultural commercialization can lead to worse food security and nutrition. In particular, some authors have raised concerns that the transition to commercial agriculture makes small farmers vulnerable to price shocks in global food markets. If prices for a farmer's produce fall suddenly, this may threaten the families income and ability to purchase food (Hamilton & Fischer, 2003) (Dijkstra, 2001) (Razavi, 2002). In addition, there is a concern that commercialization may lead farming families to adopt unhealthy diets. If farmers begin purchasing a larger portion of their food, they may choose to consume relatively cheap and highly processed items instead of healthier crops they otherwise would have grown (T et al., 2017) (Dijkstra, 2001). Finally, many researchers have suggested that commercialization can lead to the over use of land and environmental degradation (Stonich, 1991). These can cause rural economies to collapse and leave rural families without the means to make a living.

Theory: Exploring Linkages Between Agriculture and Nutrition

In order to effectively interpret the results of my analysis, I first grounded this study within the intersection of nutrition and agriculture. As the primary source of food around the world, agricultural processes are closely linked to nutrition outcomes. Farming not only determines the amount and types of food available for consumption in the global economy, but also provides a source of income for a large portion of the global population. These linkages are especially relevant in the context of Ethiopia and much of the Global South where communities predominantly work in small scale farming. The relationship between agriculture and nutrition is comprised of numerous direct and indirect pathways connected to health, education, time use, and other factors. Heady and Masters (2019) provide a comprehensive overview of this system, which I used as the basis for my theoretical framework illustrated in Figure 1.

For rural communities in Ethiopia and many parts of the world, agriculture provides a direct source of food. If families eat a large portion of the food they produce themselves, then decisions about crop production directly influence dietary diversity. Specifically, household that produce a wide variety of crops are more likely to have a diverse and more nutritious diet. Typically, the shift away from subsistence and toward market agriculture has reduced the diversity of crops produced as farmers specialize in an attempt to maximize revenues from sales (Méthot & Bennett, 2018) (Hamilton & Fischer, 2003). As a result, these farmers purchase a larger portion of the food they consume. The net effect of this transition depends largely on the nutritional value of food produced through initial subsistence practices as well as the potential to purchase nutritious food with newly realized agricultural income.

As global agricultural systems have moved toward market integration, many researchers have focused on the linkage between agricultural income and nutrition. If all other variables are held constant, increased earnings are believed to improve nutrition outcomes. In addition to purchasing higher quality food, higher income also leads to greater spending on healthcare, education, sanitation, and other health inputs (Headey & Masters, 2019). These investments have an indirect effect on nutrition by influencing individual behavior, risk of illness, and duration of illness. Increased education, especially for mother's, has led to improved child nutrition by enabling these women to make better informed decisions about their children's diet (Headey & Masters, 2019). Similarly, improved sanitation and healthcare access enhances child nutrition by mitigating the risk of diseases that can prevent children from eating or negatively impact their digestion. The culmination of these variables has led to a strong correlation between wealth and nutrition (Nguyen et al., 2021). Therefore, commercialization could lead to greater nutrition through increased productivity and income.

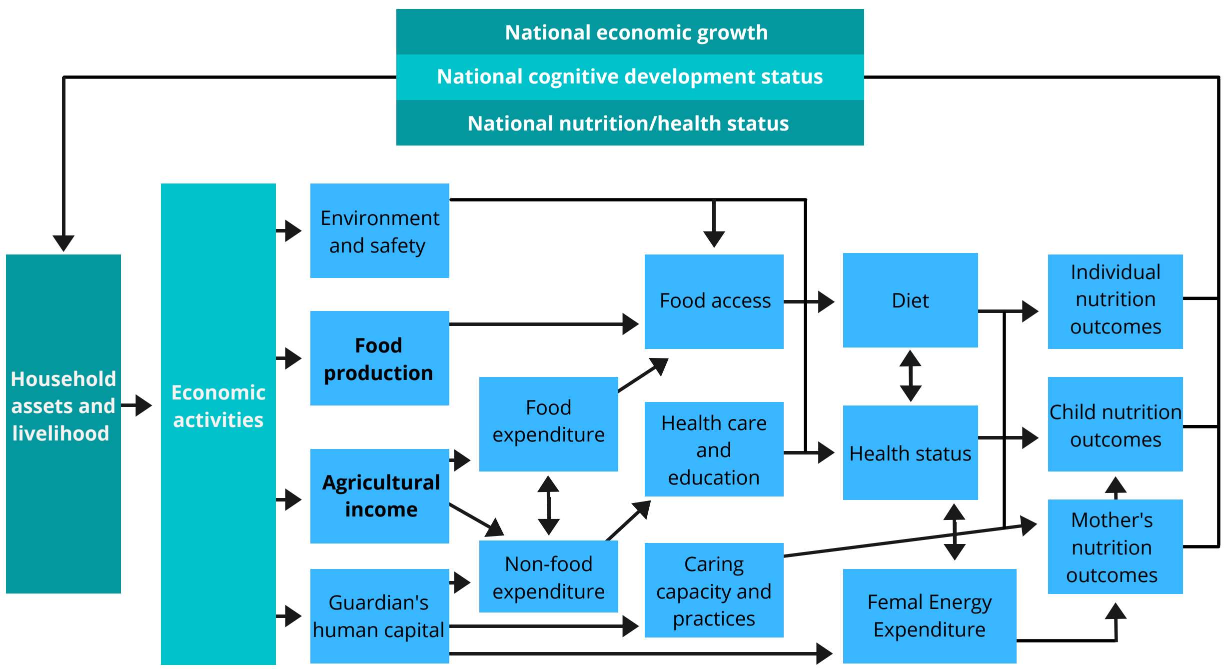
Another primary linkage between agricultural production and nutrition is the relative price of healthy and unhealthy foods. Decisions about the types of food produced as well as the process of production impact prices and access to different foods on both a local and global level. A nutritious diet is typically more expensive than a non-nutritious diet and the size of this difference may play a significant role in family consumptions decisions (Headey & Masters, 2019). Commercialization has been found to reduce food prices overall and may therefore lead to healthier diets. However, this effect varies widely across locations. More remote parts of the world typically lack access to global markets (Headey & Masters, 2019). Instead, these locations are dependent on local production to meet their dietary needs. Furthermore, if some of these regions begin growing crops for export without gaining access to affordable foods produced in other areas, this may lead to a shortage of food crops and higher prices for nutritious foods.

Beyond market considerations, physical location can play an important role in nutrition outcomes through other factors. Specifically, location can determine access to sanitation, healthcare, education, and economic opportunity (Headey & Masters, 2019). Many rural families in Sub-Saharan Africa live in remote locations that can be difficult to reach and are often neglected by public service providers. In these contexts, families may have difficulty accessing healthcare, schools, reliable utilities, and work. In sum, these factors suggest that families in more remote areas are likely to suffer worse health and nutrition outcomes. These challenges may persist even if agricultural commercialization leads to higher earning in these areas.

In addition to their location, farming households are also distinguished by specific types of environmental exposures and work activities that have broader implication for nutrition. Children in these families are more likely to participate in child labor and live in close proximity to the family farm. These conditions can expose them to health hazards including risk of injury and infection. Common concerns include exposure to pesticides, which has been linked to stunting and other illnesses (Headey & Masters, 2019). Similarly, children can become infected from exposure to animal feces, which may lead to serious digestive illness (Headey & Masters, 2019). Activities performed by parents may also have implications for nutrition. Their work in agriculture can expose children to harmful chemicals and diseases as they juggle farm work with childcare. Commercialization may bring about the increased use of chemical fertilizers or change work practices the work practices of parents in ways that effect child nutrition.

Finally, natural environmental factors play an important role in the relationship between agriculture and nutrition. Farmers are heavily dependent on weather conditions in order to produce crops and support their families. There is very little irrigation infrastructure in Ethiopia, so water comes almost exclusively from seasonal rains. Temperatures also determine the yearly growth of crops, especially coffee. Commercialization can lead to the adoption of heat and drought resistant crops, which reduces variation in yields from year to year. All these factors feed back into family nutrition outcomes through their impact on income and subsistence agricultural products.

Figure 1. Child Nutrition and Agriculture Logic Model



Based on model from Heady & Masters (2019)

The logic model in Figure 1 is based on a similar graphic produced by Headey and Masters (2019) and incorporates all of the causal pathways mentioned in the previous paragraphs. Here, it is apparent that child nutrition is determined by diet, child health status, and caring capacity of parents. Furthermore, these factors are affected by numerous economic, social, and environmental variables. The relative importance of these different variables is highly dependent on context. Commercialization primarily affects nutrition by inducing a reduction in household food production while increasing agricultural income. The relative change in both of these factors will then determine the net impact of commercialization on food access as well as health status.

This study primarily drew a comparison between coffee growing regions and non-coffee growing regions of Ethiopia. As explained in the following section, coffee is a cash crop with high earning potential. Therefore, families in these regions are likely to earn more income from agriculture and produce less of their own food relative to other regions. While this analysis was unable to isolate causal relationships between specific variables in the logic model, descriptive analysis was used to explore these components indirectly. Specifically, I examined the relative impacts of agriculture for food production and agriculture for income on child wellbeing.

Context: Small Holder Farming in Ethiopia

Before exploring the data, it is important to consider how the themes outlined in the previous section play out in the relevant context. The economy of Ethiopia is oriented around agriculture and coffee is one of the most valuable commodities in this sector. Over 65 percent of the population is employed in agriculture with many others working in closely related industries (*Trading Economics, 2020*). The vast majority of crops are produced by small holder farmers who work fewer than 25 hectares of land (Taffesse et al., 2013). These are mostly families who grow food for their own consumption and rely on available labor within the household. Cereals such as wheat, corn, and teff are the primary crops, while fruits and vegetables only make up about 5 percent of total production (Taffesse et al., 2013). Coffee is about 1.2 percent of total national production by weight but is the most important cash crop in the country. In 2011, coffee made up nearly 50 percent of total exports and the sector as a whole employed over 15 million people (Mano et al., 2011)(Crentsil & Boansi, 2013). Due to these close ties with global markets, growers face some risk of sudden fluctuations in the international price of coffee, but still enjoy relatively high earnings compared to those producing other crops (Gebreselassie & Ludi, 2007). As mentioned in the previous section, higher income among coffee growers can enable families to purchase more food as well as spend on other nutrition inputs such as healthcare and sanitary infrastructure.

Over the last two decades, the relative value of coffee has contributed to the rapid development of agricultural production in Ethiopia. Between 2004 and 2014, national real gross domestic product (GDP) per capita grew by 7.9 percent per year on average and real agricultural GDP grew by 7.6 percent (Bachewe et al., 2018). This rapid expansion was largely driven by the use of improved agricultural technology. Specifically, use of improved seeds and chemical fertilizer resulted in the total weight of crops produced per year to double during this period (Bachewe et al., 2018). Similarly, coffee production has grown over the same timeframe. In 2004, just over 150,000 tons were harvested and that number increased to over 420,000 tons by 2014 (Knoema, 2019). However, some researchers have noted that coffee growers lagged behind producers of other crops. In particular, challenges such as limited access to improved seeds and climate change have resulted in multiple years of low coffee yields (Minten et al., 2019). Changes in farming practices as well as climate volatility suggest that income from coffee production and its impact on nutrition may vary widely from year to year throughout the period I examined.

Beyond the larger macroeconomic trends that have shaped Ethiopia in recent years, nutrition is also determined by climate and corresponding agricultural practices. A wide variation in climate and landscape has led to a proportional diversity in rural livelihoods. In Ethiopia, agriculturalists typically live in the midlands surrounding the mountains and grow a variety of crops (FEWSNET, 2006). In particular, *enset* is a local staple that can be easily stored and used as a reserve food source for hard times (FEWSNET, 2006). Similarly, crops such as sweet potatoes, Irish potatoes, taro, and cassava are often grown for household consumption (FEWSNET, 2006). However, the most common crops by far are cereals such as corn, which can be found in nearly all agricultural areas both for household consumption as well as for sale (FEWSNET, 2006). This variety of produce provides households with several alternative food sources, which they can rely on as yields of any particular crop may vary from year to year. However, there is relatively little nutritional diversity or value among these plants.

Additionally, several crops in Ethiopia are grown almost exclusively for sale. The most important of these by far is coffee (FEWSNET, 2006). In addition, chili pepper, ginger, and *chat* (stimulant leaf) are common. While almost all households produce some portion of their own food, communities in cash crop regions typically rely on importing food for a significant part of their diet (FEWSNET, 2006). The need to transport foods to these commercial agriculture areas has clear implications for nutrition. Specifically, this may act as a barrier limiting the amount and types of foods available in those places. Alternatively, prices of foods may also be higher in these areas to compensate for transportation costs.

While the climate of Ethiopia is typically favorable for agriculture, farming households often struggle with food security as a result of land shortages. Irrigation infrastructure is extremely limited and crop yields are highly dependent on rain as a result. Although there is some variation from year to year, the majority of crop growing regions typically receive a reliable amount of rain to ensure a successful harvest. The country enjoys two growing seasons allowing farmers to time planting and build up food stores so that some types of food crops are available year round (FEWSNET, 2006). However, these families face significant challenges because of limited access to arable land. In many regions, it is typical for households to plant on less than half a hectare (FEWSNET, 2006). Under these circumstances, they have limited ability to build up sufficient food stores for bad times and are highly susceptible to food shortages in bad growing years.

In addition to growing crops on household farms, members of some families earn income by participating in migrant labor. Specifically, the capital of Ethiopia, Addis Ababa, draws a large number of migrants who are able to work and send remittances home to their families (FEWSNET, 2006). Also, some are able to work seasonally in the few regions of the country with large scale agriculture. Specifically, plantations for sugar, bananas, and coffee will hire workers for the seasonal harvest. This migration can help families adjust to localized production shocks or other production challenges by providing them with an alternative source of income. Ultimately, this should reduce differences in income and food security between different regions within Ethiopia.

This summary of the Ethiopian context provides several pieces of insight for my analysis. Specifically, there seems to be a mixed relationship between coffee farming and household income. While coffee is a major export crop that can be sold at relatively high prices, climate change can cause variability in yields from year to year. In addition, coffee growers have been slow to adopt new agricultural technology, suggesting that the income of other farmers may have grown faster over this period in comparison. Additionally, coffee growing may experience limited access to food if they are overly dependent on imports from other regions. Imports may be more expensive due to transport costs and some foods that cannot be shipped easily may be unavailable. These factors represent potential nutrition challenges faced by coffee growers.

Data Description: Examining the Sample Population

For this analysis, I used four years of panel data from the Demographics and Health Survey (DHS). These observations were collected from Ethiopia in 2000, 2005, 2011, and 2016. This included data on individual children such as age, weight, and height. Additional information on the children, their household, and their community mostly came from surveys conducted with the children's mothers. While individual women and households were tracked across all four years of the study, individual children were not. For this reason, it was not possible to know if the same children are recorded across the different years of the study.

My primary units of observation were children between the ages of two and five years old. Children younger than two were excluded from the sample because they are more likely to breastfeed, which may complicate the underlying relationship between agriculture and nutrition that is the focus of my analysis. Furthermore, anthropometric data on children over the age of five were not included in the sample. This is likely because most concerns about the developmental impacts of malnutrition are associated with early life. In total, 18,636 observations at the child level had sufficient data to be included in my analysis. Approximately 1,526 of these came from coffee producing regions while 17,110 came from other regions. An overview of this data is provided in Tables 1 and 2.

Summary statistics in Tables 1 and 2 are divided into coffee growing regions and non-coffee growing regions. These categories were created using the livelihood zone categorical variables, which organizes Ethiopian household into approximately 170 regions based on the dominant economic activities in each area. Furthermore, coffee regions were identified as livelihood zones where coffee production was listed as a major economic activity. As shown in Table 1, there were numerous significant differences in the characteristics of children and their families between coffee regions and non-coffee regions.

Specifically, parents in coffee regions were younger on average and more likely to work in agriculture. This difference was largest among husbands with over 79 percent of those living in coffee growing regions participating in agriculture compared to 68 percent in non-coffee growing regions. Additionally, children from coffee growing areas were more likely to have been sick in the two weeks leading up to the survey, less likely to have received vitamin A supplements in the six months leading up to the survey, and had a lower weight-for-height z-score on average compared to children in non-coffee growing regions. Also, the negative weight-for-height z-score indicates that the average weight for a child's height was more than 0.7 standard deviations below the healthy reference mean for both groups. More information on the calculation and interpretation of the weight-for-height variable is provided below.

Table 1. Mother and Child Descriptive Statistics

	Coffee Region		Non-Coffee Region		
Variable	Observations	Mean	Observations	Mean	T-value
Mother Age	1526	29.9	18380	30.2	-4.95
Husband Age	1449	37.3	16989	38.6	-7.76
Currently Working (%)	1526	42.8	16989	36.7	2.88
Mo Education (Years)	1526	1.2	18365	1.5	-0.34
Hus Education (Years)	1500	3.0	18380	2.7	8.09
Child Birth Order	1526	3.8	17816	4.0	-4.23
Child Girl (%)	1526	50	18380	49	0.89
Child Age	1526	3.5	18380	3.4	0.78
Sick Two Weeks (%)	1526	27.7	18380	23.5	4.48
Vitamin A (%)	1526	48.5	18380	53.8	-4.98
Weight for Height	1462	-0.77	17174	-0.71	-3.32
Mother Married (%)	1526	92.5	18380	90.6	3.53
Agricultural Work (%)	1526	28.7	18380	26.5	4.63
Husband Ag Work (%)	1526	79.8	18380	68.1	4.54

Beyond differences in individual children and their families, Table 2 highlights substantial variation in household level characteristics between coffee and non-coffee regions. Children from households in coffee growing areas were smaller and less wealthy on average. This is reflected in significantly lower levels of household assets including flush toilets, piped water, electricity, and refrigerators. In addition, the households of children in coffee regions had lower wealth scores on average compared to the households of children in non-coffee regions although this was not statistically significant. Many of these differences may be explained by the fact that children in non-coffee regions were more likely to live in urban areas. While not statistically significant, recorded children from coffee regions were almost eight percentage points less likely to live in urban areas. As mentioned in previous sections, this difference can reflect underlying discrepancies in access to services, education, and economic opportunity for all family members.

Table 2. Household Descriptive Statistics

	Coffee Region		Non-Coffee Region		
Variable	Observations	Mean	Observations	Mean	T-Value
Household Members	1526	6.0	18380	6.2	-0.07
Children Under Five	1526	1.8	18380	1.9	-2.93
All Children	1526	5.1	18380	5.3	-2.0
Age of Household Head	1526	37.0	18380	38.6	-8.11
Female Head (%)	1526	11.0	18380	18.1	-3.71
Rural (%)	1526	91.1	18380	83.3	1.71
Finished Floors (%)	1526	4.2	18380	12.3	-3.36
Flush Toilets (%)	1526	1.3	18380	2.2	-2.37
Piped Water (%)	1526	14.7	18380	24.7	-5.43
Electricity (%)	1526	9.4	18376	17.8	-2.21
Refrigerator (%)	1526	0.8	18380	3.2	-2.01
Mobile Phone (%)	1526	10.8	18380	16.4	-6.01
Bank Account (%)	1526	5.9	18380	9.5	-6.55
Agricultural Land (%)	1526	85.0	18376	71.6	6.17
Number of Cows	1526	1.1	18380	1.7	-11.31
Wealth Score	1526	-0.4	18380	-0.3	-1.61
Average Annual Rain	1526	110.6	18380	44.5	13.7

In addition to comparing average characteristics across all time periods, it is important to consider how changes in different regions over time may affect the relationship between coffee production and child nutrition. Figure 2 shows changes in average wealth index score for the households of children in coffee growing and non-coffee growing regions. The wealth index is calculated based on household assets, productive assets, and income to give an overall estimate of household wealth (*Ethiopia Wealth Index*, 2000). By design, the index has a mean of zero and a standard deviation of one (Rutstein and Staveteig, 2014). In the year 2000, the households of children in non-coffee regions were significantly wealthier than those in coffee regions. However, over the years the two converged as coffee households became more wealthy and non-coffee households became less wealthy so that by 2016 there was no longer a significant difference in wealth score between the two categories. As mentioned in the previous section, several authors have noted substantial increase in Ethiopian agricultural productivity throughout the early 2000s. This would lead me to expect an upward trend for all regions over time. However, it is possible that changes in crops prices or external factors led to the decrease in wealth among non-coffee households despite productivity gains.

Figure 2. Change in Household Wealth Score Over Time

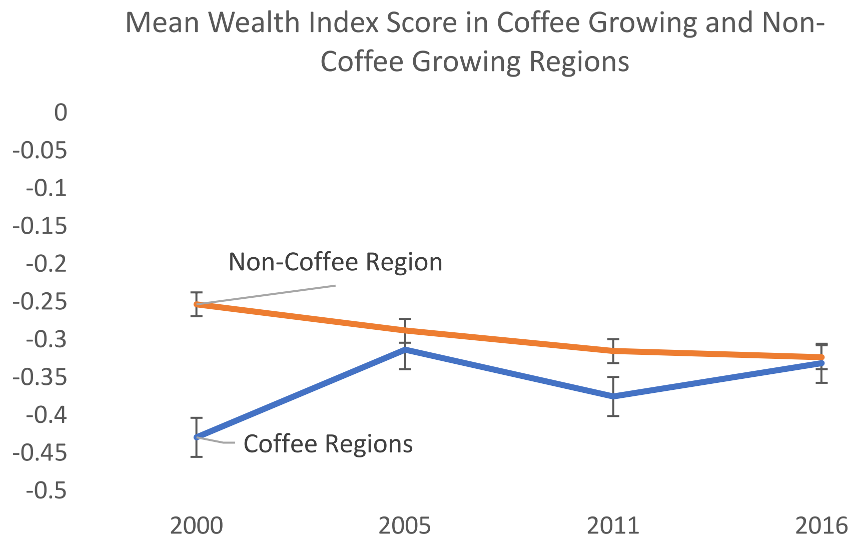
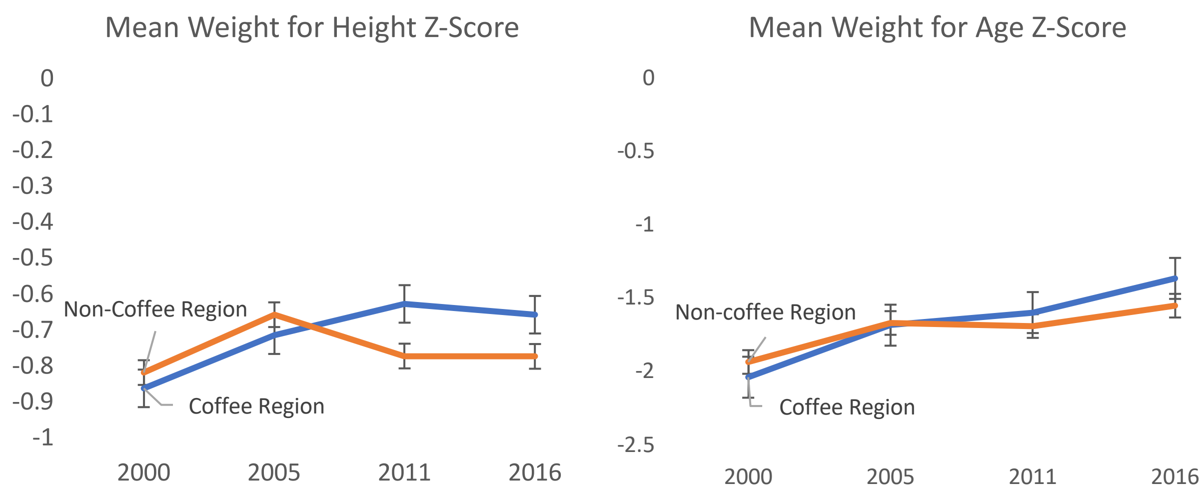


Figure 3 shows changes in average weight-for-height and weight-for-age- z-scores for children in coffee regions and non-coffee regions over time. These two z-scores are commonly used measures of nutrition status. Scores are calculated by comparing a child's weight to a healthy mean for children of the same height or age. This reference mean is calculated by the Centers for Disease Control and Prevention (CDC) using a representative sample of children (Dibley & Trowbridge, 1987). A score of zero indicates that a child's weight was equal to that of the reference mean for their height or age. A score of one indicates that a child's weight is one standard deviation above the reference mean and a score of negative one indicates that a child's weight is one standard deviation below the reference mean. Both graphs show a similar trend. Nutrition appears to improve at a higher rate in coffee growing regions compared to non-coffee regions so that children in coffee growing regions have significantly higher z-scores on average by 2016. This trend may be partially explained by the change in wealth over time observed in Figure 2, which mirrored the change in nutrition status. As income in coffee growing areas grew relative to non-coffee areas, this may have led to improved child nutrition as these households purchased more and better food. However, without controlling for other factors, it is not possible to confirm this association. The following section will outline my regression analysis, which is better able to account for additional variables that may be correlated with region and nutrition status.

Figure 3. Change in Child Nutrition Status Over Time



Identification Strategy: Describing my Regression Analysis and Control Variables

To further explore the differences in child nutrition status related to coffee production, I utilized a multivariate regression strategy with fixed effects. As shown in the summary tables, there were significant differences in underlying characteristics between children in coffee regions and those in non-coffee regions. For this reason, a simple comparison of mean differences in nutrition outcomes would not provide an adequate description of the relationship between agricultural production and child nutrition. Specifically, non-random differences in the characteristics of parents, households, communities, and environments across these two regional categories may influence the nutrition status of children. I attempted to account for these characteristics through regression analysis.

The primary dependent variable in my analysis is weight-for-height z-score. This is an indicator of nutrition status used by the CDC as well as the World Health Organization (WHO). The actual score is the difference between a child's weight at a given height and the healthy average weight for that same height measured in standard deviations. So, a child with a z-score of zero is at the exact weight of the reference mean for their height. Furthermore, a negative score implies the child is below the reference mean and a positive score implies they are above the reference mean. Typically, a score above two or below negative two is considered outside the bounds of a healthy weight for the child's height. Specifically, in the case of weight-for-height and weight-for-age, a score below negative two indicates acute malnutrition. One advantage of this focus is that acute malnutrition is typically determined by factors in the immediate environment such as current food availability. For this reason, long term environmental factors such as stressors prior to birth or food availability over multiple years do not need to be accounted for in this analysis.

My primary independent variable was a dummy equal to one if a child lived in a coffee growing region and equal to zero otherwise. As mentioned in the previous section, this variable was constructed using the livelihood zones categorical variable from the original DHS data set. This provided information on the specific regions where children lived as well as the primary economic activities in each area. In total, the data set contains information on about 170 zones. I categorized all regions where coffee production was listed as one of the major economic activities as a coffee region. This information was also supplemented by detailed descriptions of zones in the Southern Nations, Nationalities, and Peoples Region of Ethiopia provided by the Family Early Warning System Network (FEWSNET), the organization that identified the livelihood zones (*FEWSNET*, 2006). It is important to note that other crops are also grown in the coffee production zones and other major economic activities not included in the livelihood zone descriptions may also occur.

Unfortunately, data about the types of crops grown at the household level is not available in this data set so it is not possible to know the mixture of crops being grown by any observed household. It is possible that some households in coffee growing regions are not involved in coffee production while some in non-coffee regions are. This poses a challenge for accurately measuring the association of interest. However, any bias caused by this inaccuracy would push my estimated association between coffee production and child nutrition toward zero. From this, it is reasonable to assume that any significant associations identified in my results may actually be larger than estimated.

In order to determine the relationship between the dependent and independent variables, I implemented a multiple regression strategy. Specifically, I developed a model with a number of control variables at the child, mother, household, and community level. These were informed by the literature to partially control for bias in the estimated coefficient of my independent variable. Among these control variables, there are several that account for differences in climate and weather conditions. Since crops in Ethiopia are typically rainfed, these factors have significant implications for food security (Bachewe et al., 2018). Rainfall and maximum temperature data are available at the livelihood zone level. Using a common method in climate analysis, I aggregated these data into an average of rainfall and maximum temperature over the 12 months before a child was recorded in the survey (Grace et al., 2021) (Lewis, 2017). These data are specific to the area where the child lived. In addition, I created an indicator for times of year with low food security. Late March through June are typically identified as vulnerable months for families because this is a preharvest season when crops are growing but food reserves may be running low (Belayneh et al., 2021). If observations were taken during or immediately after this period in a non-random form, these children would likely exhibit lower weight-for-height on average and introduce bias into my estimates. To account for this possibility, I created a dummy variable equal to one if an observation was taken between March and July and equal to zero otherwise.

One of the child-level variables was wanted child, which was a dummy equal to one if the mother responded that she had wanted to become pregnant with the child being recorded and equal to zero otherwise. This variable provided insight into the family's preparedness and desire to provide resources for the child (Dereje, 2014) (Vorster, 2010). Another control variable was birth care, which was a dummy equal to one if the mother received care from a trained professional while delivering her child and equal to zero if not. This variable was an indicator of the family's access to healthcare overall as well as the child's health in early life (Schaible & Kaufmann, 2007). In addition, the variable diarrhea 2 weeks, was a dummy equal to one if the child had diarrhea within two weeks of the data collection. This has been found to be negatively associated with weight-for-height since sickness can prevent children from eating or disrupt digestion in other ways (Schaible & Kaufmann, 2007).

My analysis also included a number of variables that controlled for characteristics of the mother and father. These included a set of dummy variables for the parent's occupation, which accounted for different levels of earnings that may determine access to food as well as work hazards that may have affected child health (Shenggen et al., 2019). Mother's body mass index (BMI) was also included in my analysis. This variable largely accounted for genetic differences that may have impacted a child's weight-for-height independently from environmental factors. The model also controlled for parent's education level (Vella et al., 1992). This has important implications for nutrition both through the positive relationship between education and potential income as well as indicating the parent's ability to make informed decisions about their child's diet (Vorster, 2010). Several other variables were included in the model to control for general characteristics.

To capture additional unobserved bias in this estimate that was not address by control variables, I included time and region level fixed effects. These were a set of dummy variables, which accounted for characteristics that do not change over geography or time respectively. Including these variables allowed me to remove some omitted variable bias from the regression results (Angrist & Pischke, 2008). In addition, I accounted for heteroskedasticity in the standard errors by clustering at the community level. This prevented bias in my standard errors that could have led me to falsely conclude significance in associations between my dependent and independent variables (Angrist & Pischke, 2008).

While controls variables and fixed effects accounted for some observed and unobserved differences between children in coffee regions and children in non-coffee regions, it is possible that other omitted variables influenced the coefficient estimate for my independent variable. Furthermore, the coefficient value and significance of my coffee region variable could change if other variables were added. While I could not completely account for this possibility, I explored the potential relationships between my control and independent variables by presenting findings from multiple models. Specifically, I included five models in my primary results where additional controls were added incrementally. By examining changes in the coffee coefficient across these different models, I was able to assess the potential for control variables to influence my estimate on the coefficient of interest.

Results: Children in Coffee Regions have Significantly Lower Weight-for-Height

The primary results of my analysis can be found in Table 3. All five models indicated a significant negative association between coffee production and child nutrition. Specifically, the coefficient for coffee region in Model 4 shows that children living in coffee producing regions had a weight-for-height z-score that was 0.148 points lower on average than children in non-coffee producing regions holding the control variables constant. This model was the most robust and holistic of the five. It accounted for important child, mother, family, and community level characteristics, but did not control for outcomes like household wealth. This is important because wealth and income are major causal pathways through which coffee production influences child nutrition status. Controlling for this variable would possibly remove a primary component of the association of interest from the coefficient estimate for coffee region (Angrist & Pischke, 2008). While Model 4 would appear to be the most reliable, the other models also provided valuable insight.

The rest of the models in Table 3 produced results that were between -0.130 and -0.151. The fact that the coefficient for coffee region did not change much as more control variables were added suggests that these findings were robust against omitted variable bias. In other words, it is unlikely that the estimated association would change significantly if other relevant variables were included in the model. From here it is reasonable to conclude these findings represent a true association and are not simply a product of poor specification. The differences between Models 1 through 4 were the result of additional relevant control variables, which should have increased the precision of the estimation. Model 5 included control variables for household wealth and infrastructure, which are closely related to income. This represents one of the major theoretical pathways between agricultural practices and nutrition. By controlling for these variables, Model 5 provides insight into the other pathways that may be influencing this relationship.

Table 3. Regression Results Comparing Weight-for-Height Z-Score Across Region

VARIABLES	(Model 1) Weight-for-height	(Model 2) Weight-for-height	(Model 3) Weight-for-height	(Model 4) Weight-for-height	(Model 5) Weight-for-height
Coffee Region	-0.130***	-0.131***	-0.130***	-0.148***	-0.151***
	(0.0390)	(0.0386)	(0.0373)	(0.0370)	(0.0367)
Child Girl		0.0388**	0.0388**	0.0356*	0.0351*
		(0.0184)	(0.0184)	(0.0187)	(0.0187)
Child Age		0.0163	0.0216**	0.0191*	0.0177
		(0.0108)	(0.0109)	(0.0110)	(0.0109)
Child Birth Order		-0.00963**	0.00269	0.0129	0.0138*
		(0.00406)	(0.00695)	(0.00838)	(0.00833)
Wanted Child		0.00145	0.0119	0.0141	0.0163
		(0.0213)	(0.0211)	(0.0214)	(0.0213)
Birth Care		0.105**	0.0901*	0.0840*	0.0883*
		(0.0480)	(0.0470)	(0.0469)	(0.0472)
Diarrhea 2 Weeks		-0.134***	-0.127***	-0.118***	-0.115***
		(0.0323)	(0.0318)	(0.0317)	(0.0316)
Mother Age			-0.00278	-0.00248	-0.00302
			(0.00242)	(0.00248)	(0.00246)
Years Education			0.0293***	0.0200***	0.0124**
			(0.00426)	(0.00501)	(0.00508)
Sales			0.0204	0.0203	0.00893
			(0.0345)	(0.0348)	(0.0349)
Skilled Manual			0.000787	-0.00678	-0.0226
			(0.0390)	(0.0401)	(0.0398)
Ag Work				0.0190	0.0339
				(0.0258)	(0.0259)
Husband Ag Work				-0.0991***	-0.0475
				(0.0323)	(0.0335)
Mother BMI			0.000100***	9.88e-05***	9.62e-05***
			(1.91e-05)	(1.96e-05)	(1.93e-05)
Female Head				-0.0505*	-0.0459
				(0.0306)	(0.0303)
Husband Years Edu				0.00781**	0.00376
				(0.00332)	(0.00335)
Average Rain				0.000747	0.000501
				(0.000565)	(0.000581)
Average Heat				-0.000566	-0.000363
				(0.000471)	(0.000484)
Risk Period				-0.0194	-0.0166
				(0.0249)	(0.0249)
Number Children				-0.0185**	-0.0195**
				(0.00785)	(0.00779)
No Toilet					-0.0335
					(0.0292)
Finished Floor					-0.156***
					(0.0508)
Wealth Score					0.168***
					(0.0337)
2005.year	0.177***	0.167***	0.159***	0.177***	0.163***
	(0.0415)	(0.0416)	(0.0411)	(0.0419)	(0.0426)

2011.year	0.126***	0.109***	0.0907***	0.0804***	0.0784**
	(0.0292)	(0.0296)	(0.0287)	(0.0295)	(0.0316)
2016.yeat	0.139***	0.133***	0.0990***	0.100***	0.0971***
	(0.0337)	(0.0338)	(0.0336)	(0.0332)	(0.0336)
Constant	-0.797***	-0.898***	-1.105***	-0.864***	-0.809***
	(0.0216)	(0.0632)	(0.0851)	(0.137)	(0.137)
Observations	18,636	18,621	18,621	18,086	18,086
R-Squared	0.030	0.034	0.047	0.050	0.054

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Coffee Region is a dummy variable equal to one if a household lived in a coffee growing area and equal to zero otherwise. Child Age is the age of the observed child measured in months. Wanted Child is a dummy variable equal to one if the mother stated that she wanted to become pregnant with the child. Diarrhea 2 Weeks is a dummy variable equal to one if the observed child was sick with diarrhea in the two weeks leading up to being measured. Sales and Skilled Manual are dummy variables equal to one if the mother worked in sales or skilled manual labor respectively. Mother BMI measures the Body Mass Index of the mother. Female head is a dummy variable equal to one if the household had a female head. Husband Years Edu measures the number of years of education completed by the mother's husband. Average Rain and Average Heat are the average rainfall in centimeters and the average maximum temperature respectively in the area of the household over the preceding year. Risk period is a dummy variable equal to one if an observation was recorded in March through July. Wealth Score is a measure of household assets compared to the median of the country. The year variables are dummy variables for each year. 2000 is omitted.

Table 4 shows results for a regression of weight-for-height z-score on coffee region for children from farming families only. These were families where one or both parents indicated that they worked in agriculture. In Ethiopia among other places, farming families face unique challenges to health and nutrition. Because many live in close proximity to the farms where they work, they are often exposed to chemicals, livestock, and other factors that may increase the risk of infection or chronic illness. In addition, these families often live in remote places far from health services or sanitary infrastructure. As shown in table one, a larger portion of families in coffee growing regions worked in agriculture. For this reason, this difference may have introduced bias into my regression estimates. By limiting my analysis to farming families, as in Table 4, I was able to make a more accurate comparison between children from similar backgrounds. Other than this difference in the analyzed population, the control variables used in Models 6-10 were the same as those from Models 1-5. These results actually showed a larger negative association between coffee regions and child nutrition. Model 9 indicated that children living in coffee producing regions had a weight-for-height z-score that was 0.157 points lower on average than children in non-coffee producing regions holding the control variables constant. This further reinforces the validity of my findings that children in coffee regions experience worse nutrition outcomes.

Table 4. Regression Results Comparing Weight-for-Height Z-Score Across Region Among Farmers

VARIABLES	(Model 6) Weight-for-Height	(Model 7) Weight-for-Height	(Model 8) Weight-for-Height	(Model 9) Weight-for-Height	(Model 10) Weight-for-Height
Coffee Region	-0.142***	-0.141***	-0.137***	-0.157***	-0.162***
	(0.0423)	(0.0420)	(0.0415)	(0.0414)	(0.0405)
Child Girl		0.0208	0.0209	0.0206	0.0218
		(0.0208)	(0.0207)	(0.0208)	(0.0208)
Child Age		0.0159	0.0200*	0.0186	0.0170
		(0.0116)	(0.0119)	(0.0120)	(0.0119)
Child Birth Order		-0.00367	0.00517	0.0156*	0.0161*
		(0.00423)	(0.00769)	(0.00936)	(0.00929)
Wanted Child		-0.00440	0.00181	-0.00167	0.00141
		(0.0242)	(0.0240)	(0.0241)	(0.0240)
Birth Care		0.106**	0.102*	0.101*	0.103*
		(0.0537)	(0.0534)	(0.0538)	(0.0539)
Diarrhea 2 Weeks		-0.129***	-0.126***	-0.120***	-0.119***
		(0.0364)	(0.0359)	(0.0358)	(0.0354)
Mother Age			-0.00338	-0.00332	-0.00335
			(0.00283)	(0.00288)	(0.00286)
Mother Years Edu			0.0189***	0.0161**	0.0114*
			(0.00584)	(0.00642)	(0.00643)
Sales			0.00116	0.00432	-0.00846
			(0.0441)	(0.0424)	(0.0423)
Skilled Manual			-0.0475	-0.0543	-0.0754
			(0.0459)	(0.0452)	(0.0465)
Mother BMI			0.0001***	0.0001***	0.0001***
			(2.43e-05)	(2.43e-05)	(2.41e-05)
Female Head				-0.0294	-0.0318
				(0.0361)	(0.0358)
Husband Years Edu				0.00580	0.00224
				(0.00435)	(0.00440)
Average Rain				0.00108*	0.000739
				(0.000604)	(0.000611)
Average Heat				-0.000763	-0.000490
				(0.000518)	(0.000524)
Risk Period				-0.0203	-0.0160
				(0.0279)	(0.0279)
Number Children				-0.0192**	-0.0209**
				(0.00920)	(0.00912)
No Toilet					-0.0571*
					(0.0318)
Finished Floor					-0.269***
					(0.0756)
Wealth Score					0.186***
					(0.0486)
2005.year	0.178***	0.167***	0.156***	0.165***	0.132***
	(0.0443)	(0.0445)	(0.0442)	(0.0443)	(0.0460)
2011.year	0.104***	0.0879***	0.0784**	0.0631**	0.0430
	(0.0307)	(0.0311)	(0.0304)	(0.0319)	(0.0353)
2016.year	0.132***	0.129***	0.109***	0.128***	0.0852**
	(0.0362)	(0.0367)	(0.0374)	(0.0362)	(0.0382)

Constant	-0.820***	-0.933***	-1.128***	-0.934***	-0.803***
	(0.0229)	(0.0711)	(0.0980)	(0.145)	(0.149)
Observations	13,459	13,446	13,446	13,261	13,261
R-squared	0.021	0.024	0.033	0.035	0.040

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Coffee Region is a dummy variable equal to one if a household lived in a coffee growing area and equal to zero otherwise. Child Age is the age of the observed child measured in months. Wanted Child is a dummy variable equal to one if the mother stated that she wanted to become pregnant with the child. Diarrhea 2 Weeks is a dummy variable equal to one if the observed child was sick with diarrhea in the two weeks leading up to being measured. Sales and Skilled Manual are dummy variables equal to one if the mother worked in sales or skilled manual labor respectively. Mother BMI measures the Body Mass Index of the mother. Female head is a dummy variable equal to one if the household had a female head. Husband Years Edu measures the number of years of education completed by the mother's husband. Average Rain and Average Heat are the average rainfall in centimeters and the average maximum temperature respectively in the area of the household over the preceding year. Risk period is a dummy variable equal to one if an observation was recorded in March through July. Wealth Score is a measure of household assets compared to the median of the country. The year variables are dummy variables for each year. 2000 is omitted.

Results of several additional regressions can be found in the appendix. These models introduced slight variations to the regression methodology to test the reliability of my findings. Specifically, Table 5 used a WHO measure of weight-for-height z-score instead of the CDC version used in Tables 3 and 4. The control variables used in Models 11 and 12 were the same as those used in Models 4 and 5. The estimated coefficients on coffee region were even more negative for the WHO z-scores than in my primary results. This finding further reinforces the evidence of negative relationship between nutrition status and coffee production. Table 6 shows similar results using weight-for-age z-score instead of weight-for-height. In this case, the coefficient estimates on coffee region were insignificant, but also negative. It may be the weight-for-age is a less sensitive indicator of nutrition status compared to weight-for-height, which would explain these results. Regardless of the underlying reason for these differences, Table 6 did not provide significant evidence against my previous findings.

Discussion: Possible Explanations for Poorer Child Nutrition in Coffee Regions

The results of my regression analysis provide clear evidence of a negative relationship between child nutrition and coffee production. Children in coffee growing regions have significantly lower weight-for-height on average compared to children in non-coffee growing regions when holding a number of other factors constant. This finding was robust to different specifications, populations, and dependent variables. Furthermore, lower weight-for-height indicates that children in these areas have poorer nutrition. Specifically, low weight is a sign that children and families lack food in the short term

(Trowbridge et al., 1987). These shortages can leave children with weakened immune systems and vulnerable to serious illness. In addition, frequent instances of short-term hunger can negatively impact children's physical and mental development into adulthood.

My findings in Tables 3 and 4 suggest that the underlying negative relationship between these two variables is not driven by differences in wealth. Typically, wealth and income, which are closely linked, are seen as a major determinant of nutrition. Families who earn more, are able to consume more and better food. For this reason, one of the main appeals of commercial agriculture is the promise of higher earnings and related benefits to consumption, education, and health. However, Models 5 and 10 identify a negative relationship between weight-for-height and coffee region after holding wealth constant. This suggests that children in coffee regions experiences worse nutrition outcomes event after accounting for differences in income and wealth.

Poorer nutrition outcomes in coffee growing areas may be linked to challenges families face in accessing food markets. Families who focus on growing commercial crops, like coffee, rather than subsistence crops must purchase a larger proportion of their food. Additionally, if all families in a specific area focus on coffee production, then food crops will have to be shipped to them from other regions or countries (FEWSNET, 2006). Many rural communities in Ethiopia are remote and lack transportation infrastructure. This can pose logistical challenges that prevent reliable food delivery and increase food prices. If this is the case, then coffee growing families may face limited access to food even if they earn sufficient income. In contrast, families in non-coffee producing regions grow a larger portion of their own food and save some of their produce for hard times. In addition, the portion of their food that these families purchase is more likely to come from the local area so transportation is easier and cheaper. Together, these factors suggest that non-coffee areas may have greater food security and better child nutrition outcomes as a result.

These findings make several contributions to the existing literature on the relationship between agricultural commercialization and child nutrition. Specifically, no other study uses a region variable to examine differences in nutrition outcomes associated with coffee production. The significance of this variable in my analysis suggests that these associations go beyond individual farms or households to have broader implications for entire communities. In addition, the large negative association identified in Model 5 suggests that non-income links between coffee production and nutrition play a significant role in determining overall outcomes. These findings can also be generalized to provide insight into commercial agriculture broadly. As a major cash crop sold on the global market, coffee provides an excellent case study of agricultural commercialization. Future studies should continue to study the possible spillover effects of shifts to agricultural commercialization on entire communities, including families who are not immediately involved in agriculture. Researchers should also continue to examine the macro-level implications of agricultural systems for individual health. These findings also suggest that policy makers should consider strategies to improve access to food in areas where crops are grown for export.

Limitations: Methodological Critiques

While this study identified significant differences in nutrition status between children who live in coffee growing regions and children who live in non-coffee growing regions, it suffers from several limitations that must be considered when interpreting these findings. In particular, the independent variable of interest, a dummy variable indicating whether a child lives in a coffee growing region or a non-coffee region, does not provide a clear picture of agricultural practices at a household level. It is likely that these practices vary within each livelihood zone, with some families in coffee regions growing other crops and some in non-coffee regions growing coffee. The literature also shows that many families in Ethiopia grow a mixture of different crops, so even those who grow coffee may also grow a portion of their own food. Additionally, while my regression framework seeks to control for key variables, there may be unobserved factors contributing to the association this model identifies. For these reasons, I am unable to provide further insight about the underlying relationships that have brought about these results.

Conclusion: Contributions to the Literature and Future Research

Malnutrition and food insecurity continue to affect millions of people around the world and this problem has only worsened as a result of the COVID-19 pandemic. Children in particular are vulnerable to the long-term adverse health effects of poor nutrition. Policy makers and researchers have often promoted agricultural commercialization as a solution to these problems that would increase incomes and lower food prices for the global poor. However, commercialization policies have also caused land degradation and made many farming communities overly dependent on global food markets. This can actually lead to worse food security and nutrition for these families. Ultimately, a greater understanding of the relationship between agricultural systems and child nutrition is needed to address these challenges.

I contributed to the literature by examining coffee production and child nutrition in Ethiopia. I used a regression framework to compare weight-for-height- z-score of children in coffee growing regions to children in non-coffee growing regions. My results show that children in coffee regions experience significantly lower weight-for-height on average compared to children in non-coffee regions holding other variables constant. Ultimately, this may suggest that farmers in coffee growing regions are over reliant on food markets that do not provide them and their children with adequate access to a healthy diet. Future research should seek to examine these relationships on a household level and gain insight into the causal pathways between agriculture and nutrition.

Appendix

Table 5. Regression Results Examining Weight- fo- Height Z-Score Calculated using World Health Organization Standards

VARIABLES	(Model 11) Weight-for-height WHO	(Model 12) Weight-for-height WHO
Coffee Region	-0.178***	-0.182***
	(0.0443)	(0.0441)
Child Girl	0.0255	0.0249
	(0.0230)	(0.0230)
Child Age	-0.0543***	-0.0559***
	(0.0135)	(0.0134)
Child Birth Order	0.0154	0.0164
	(0.0101)	(0.0101)
Wanted Child	0.0176	0.0205
	(0.0258)	(0.0255)
Birth Care	0.116*	0.121**
	(0.0594)	(0.0599)
Diarrhea 2 Weeks	-0.139***	-0.135***
	(0.0402)	(0.0399)
Mother Age	-0.00496	-0.00558*
	(0.00303)	(0.00300)
Mother Years Edu	0.0204***	0.0121**
	(0.00591)	(0.00601)
Sales	0.0309	0.0185
	(0.0422)	(0.0421)
Skilled Manual	-0.0119	-0.0292
	(0.0485)	(0.0480)
Ag Work	0.0315	0.0485
	(0.0312)	(0.0314)
Husband Ag Work	-0.113***	-0.0559
	(0.0377)	(0.0395)
Mother BMI	0.000112***	0.000109***
	(2.34e-05)	(2.30e-05)
Female Head	-0.0568	-0.0516
	(0.0364)	(0.0360)
Husband Years Edu	0.00774**	0.00321
	(0.00391)	(0.00394)
Average Rain	0.000823	0.000527
	(0.000710)	(0.000733)
Average Heat	-0.000614	-0.000369
	(0.000592)	(0.000611)
Risk Period	-0.0240	-0.0211
	(0.0304)	(0.0306)
Number Children	-0.0214**	-0.0226**
	(0.00988)	(0.00981)
No Toilet		-0.0455
		(0.0356)
Finished Floor		-0.178***
		(0.0614)
Wealth Score		0.183***
		(0.0388)

2005.year	0.184***	0.167***
	(0.0518)	(0.0526)
2011.year	0.0924***	0.0865**
	(0.0348)	(0.0376)
2016.year	0.0931**	0.0855**
	(0.0403)	(0.0402)
Constant	-0.359**	-0.294*
	(0.168)	(0.168)
Observations	17,876	17,876
R-squared	0.046	0.050

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Coffee Region is a dummy variable equal to one if a household lived in a coffee growing area and equal to zero otherwise. Child Age is the age of the observed child measured in months. Wanted Child is a dummy variable equal to one if the mother stated that she wanted to become pregnant with the child. Diarrhea 2 Weeks is a dummy variable equal to one if the observed child was sick with diarrhea in the two weeks leading up to being measured. Sales and Skilled Manual are dummy variables equal to one if the mother worked in sales or skilled manual labor respectively. Mother BMI measures the Body Mass Index of the mother. Female head is a dummy variable equal to one if the household had a female head. Husband Years Edu measures the number of years of education completed by the mother's husband. Average Rain and Average Heat are the average rainfall in centimeters and the average maximum temperature respectively in the area of the household over the preceding year. Risk period is a dummy variable equal to one if an observation was recorded in March through July. Wealth Score is a measure of household assets compared to the median of the country. The year variables are dummy variables for each year. 2000 is omitted.

Table 6. Regression Results Examining Weight-for-Age Z-Score Across Regions

VARIABLES	(Model 13) Weight-for-age	(Model 14) Weight-for-age
Coffee Region	-0.0829	-0.0865*
	(0.0506)	(0.0500)
Child Girl	-0.0329	-0.0342
	(0.0234)	(0.0233)
Child Age	0.0234*	0.0210
	(0.0132)	(0.0131)
Child Birth Order	0.00184	0.00357
	(0.0110)	(0.0109)
Wanted Child	0.0243	0.0271
	(0.0260)	(0.0260)
Birth Care	0.0730	0.0778
	(0.0522)	(0.0529)
Diarrhea 2 Weeks	-0.237***	-0.232***
	(0.0358)	(0.0356)
Mother Age	0.00858***	0.00742**
	(0.00314)	(0.00312)
Mother Years Edu	0.0363***	0.0230***
	(0.00567)	(0.00580)
Sales	-0.0134	-0.0312
	(0.0444)	(0.0446)
Skilled Manual	-0.0342	-0.0540
	(0.0531)	(0.0525)
Ag Work	-0.0249	-0.000282
	(0.0295)	(0.0296)
Husband Ag	-0.112***	-0.0246
	(0.0371)	(0.0396)
Mother Height	0.000101***	9.58e-05***
	(2.16e-05)	(2.04e-05)
Female Head	-0.0592*	-0.0521
	(0.0353)	(0.0353)
Husband Years Edu	0.0211***	0.0143***
	(0.00401)	(0.00409)
Average Rain	0.00175***	0.00147**
	(0.000640)	(0.000652)
Average Heat	-0.00147***	-0.00123**
	(0.000535)	(0.000543)
Risk Period	-0.0773***	-0.0731**
	(0.0291)	(0.0292)
Number Children	-0.0255***	-0.0267***
	(0.00973)	(0.00972)
No Toilet		-0.0291
		(0.0318)
Finished Floor		-0.122*
		(0.0693)
Wealth Score		0.256***
		(0.0421)
2005.year	0.277***	0.262***
	(0.0434)	(0.0444)
2011.year	0.259***	0.264***

	(0.0378)	(0.0401)
2016.year	0.418***	0.424***
	(0.0384)	(0.0416)
Constant	-2.091***	-2.011***
	(0.157)	(0.159)
Observations	17,864	17,864
R-squared	0.094	0.101

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Coffee Region is a dummy variable equal to one if a household lived in a coffee growing area and equal to zero otherwise. Child Age is the age of the observed child measured in months. Wanted Child is a dummy variable equal to one if the mother stated that she wanted to become pregnant with the child. Diarrhea 2 Weeks is a dummy variable equal to one if the observed child was sick with diarrhea in the two weeks leading up to being measured. Sales and Skilled Manual are dummy variables equal to one if the mother worked in sales or skilled manual labor respectively. Mother BMI measures the Body Mass Index of the mother. Female head is a dummy variable equal to one if the household had a female head. Husband Years Edu measures the number of years of education completed by the mother's husband. Average Rain and Average Heat are the average rainfall in centimeters and the average maximum temperature respectively in the area of the household over the preceding year. Risk period is a dummy variable equal to one if an observation was recorded in March through July. Wealth Score is a measure of household assets compared to the median of the country. The year variables are dummy variables for each year. 2000 is omitted.

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