**Market Failure and Child Labor in the Ghanaian Cocoa Industry**

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**Abstract**

Agricultural child labor has proven to be a persistent and challenging issue to address, in large part due to the vicious circle between child labor and poverty; poor agricultural households often depend on child labor to survive, but this comes at the cost of their children’s education. More generally, child labor is a pressing concern in high-income countries, which have taken steps to restrict the sale of goods made with child labor. Most recently, the EU has passed a regulation that will ban all products made with forced labor (including child labor) by the end of 2027. However, altering consumption patterns alone may not resolve the issue. If agricultural sectors fail to adapt quickly enough - and high-income consumers turn elsewhere for agricultural products - then these restrictions run the risk of worsening poverty levels and counterintuitively exacerbating the use of child labor. (Luckstead et al, 2019)

In Ghana, the cocoa sector comprises a significant portion of agricultural employment and up to 25 percent of national export value; as such, it plays an important role in poverty reduction. The industry has also been identified as a target for reductions in child labor, as evidenced by the formation of the international Child Labor Cocoa Coordinating Group in 2010. Previous research indicates the presence of institutional and socioeconomic factors impeding investment and productivity growth (see Goldstein and Udry (2008) or Donkor et al (2023)). Some studies also suggest that increasing land wealth may lead to an increased dependence on child labor - but possibly only in the presence of labor market failures (see Basu et al (2008) or Dumas (2020)).

Our research proposes to empirically test the relationship between market failure and child labor in the Ghanaian cocoa industry. We have access to a unique dataset consisting of household surveys of Ghanaian cocoa farmers; it includes information on their income, consumption, labor, expenditure on inputs, assets, children’s work, and the market cost of hiring labor from outside the household. Survey participants also recorded monthly financial diaries, providing greater insight into their consumption patterns. Using this data, we plan to undertake the following two-step analysis. In keeping with the literature on agricultural household production (see Lambert and Magnac, 1997), we intend to model the production and consumption patterns of agricultural households in Ghana to test whether or not the implicit prices of goods and labor are equal to the market price. If this assumption does not hold, it suggests that households are subject to an imperfect market. Conditional on at least some households failing to meet this assumption, we will then investigate how the gap between implicit and market prices relates to the household’s use of child labor in cocoa production. The results of this research should contribute to furthering our understanding of the determinants of child labor and improving the efficacy of policies designed to reduce it.

*Keywords:* Child labor; Cocoa households; Market wage; Shadow wage

JEL Classification: J22, O15, E24

**Introduction**

The International Labour Organization defines child labor as work that “deprives children of their childhood, their potential, and their dignity, and that is harmful to physical and mental development.”[[1]](#footnote-1) This includes work that is physically or mentally dangerous as well as work that negatively impacts their education. Goal Eight of the United Nations’ Sustainable Development Goals is to “promote sustained, inclusive, and sustainable economic growth,” with one of the benchmarks of success being the elimination of child labor by 2025.[[2]](#footnote-2) The number of children engaged in child labor practices fell from 246 million in 2000 to 160 million in 2020, a reduction of roughly 35% - a significant step, though short of their intended goal.[[3]](#footnote-3)

Agriculture is the primary employer of child labor, accounting for roughly 60 percent of all child laborers worldwide. Due to the nature of the work, it is also one of the most dangerous sectors; it is physically demanding, requires the use of sharp tools, and exposes workers to agro-chemicals. Quantifying the actual prevalence of child labor can be difficult. Part of this is due to limited monitoring capacity; the informal (and undocumented) nature of employment and the overlap between work and home can mask childrens’ activities. Estimation is further complicated by ambiguity between child labor and child *participation* in the agricultural duties of a household.[[4]](#footnote-4) In contrast with child labor, participation is viewed as an age-appropriate means of transmitting culture, skills, and experience from parents to children; this is both additional labor value and economic education. However, there is no universally-accepted standard to delineate benign and harmful levels of work; laws and social views vary from culture to culture.

In the early 2000s, news coverage of enslaved young men on a Côte d’Ivoire cocoa farm incited western fears of child labor in West African cocoa production.[[5]](#footnote-5) While the veracity of these specific allegations is unclear, they spurred both domestic and international efforts to eliminate the use of child labor; most of this attention has centered on Ghana and Côte d’Ivoire, two of the largest producers of cocoa globally. Western countries have responded by restricting the import and use of goods produced by child labor. Ghana and Côte d’Ivoire have undertaken significant investment efforts, improving rural access to education with new buildings and financial assistance, providing government-funded agro-chemical applications, developing systems to monitor both child labor and school attendance, and strengthening child labor laws. It is somewhat difficult to judge these programs’ efficacy, although evidence is tentatively positive. A 2020 NORC report found the use of child labor in Ghana and Côte d’Ivoire remains widespread, with approximately 45 percent of children living in cocoa-producing agricultural households engaged in child labor. However, rates in both countries had not changed since 2014, despite a 14 percent increase in cocoa production over the same period.[[6]](#footnote-6)

Child labor in the cocoa sector persists despite international efforts to eliminate it, suggesting we still have an insufficient understanding of the issue. We intend to contribute to this research by 1) investigating the existence of local market failures, and 2) whether or not these failures influence our surveyed households’ use of child labor in cocoa production. Our baseline data is taken from the Ghana Living Standards Survey 2017, which we augment with two unique data sources: a second survey administered by one of the authors of this paper, along with a series of bi-weekly household financial diaries. We follow Lambert and Magnac (1998) in the estimation of a household production model, which we use to estimate the implicit wages of household farm labor. We compare these implicit wages to the market wage of hired labor, which is taken directly from the Living Standards Survey. Our next step is still preliminary; we need to determine the best way to use this information alongside the diaries.

**Literature Review**

It is generally accepted that poverty is the root cause of agricultural child labor.[[7]](#footnote-7) This is both a direct and indirect effect; not only does escaping (or surviving) poverty motivate the need for child labor, but other factors that influence child labor rates can themselves be viewed as direct consequences of poverty. For example, survey data collected by Ofuoku, Idoge, and Ovwigho (2014) implicated various factors affecting the use of child labor in Nigerian agriculture, including head-of-household education levels, high cost of outside labor, and ignorance regarding child labor laws. It is worth noting that they also identified poverty itself as a major cause. Poverty is also a *symptom* of agricultural child labor, as removing children from formal education contributes to future poverty, making the relationship between the two unfortunately self-reinforcing. The impacts of child labor on the children themselves vary widely, and can include physical harm (work-related injuries), issues with mental health, or long-term physical damage. Many papers in the literature use educational attainment or performance as indicators of harm; educational outcomes are directly linked to future health and economic outcomes. Pirkle et al (2024) provide a useful overview of papers investigating these impacts.[[8]](#footnote-8)

Unsurprisingly, poverty is a common target of policy interventions; a 2023 meta-analysis by the ILO found that out of the 41 studies they reviewed, 29 examined the effects of direct cash or asset transfers, scholarships, or the provision of microcredit.[[9]](#footnote-9) However, there is significant variation in efficacy across interventions; the impact on child labor is affected by the specific form of the policy intervention and potentially the characteristics of the households themselves.[[10]](#footnote-10) Not all poverty-targeting interventions resulted in a reduction in child labor rates. Based on the ILO’s meta-analysis, cash transfers appear to be the most broadly effective in reducing child labor, both in terms of employment status and in hours worked. Conditioning the transfers on school attendance did not appear to significantly change the results. However, the impact of transfers may vary by degree of poverty, with the poorest households less likely to remove children from economic activity. There were also studies in which transfers either had no effect, or, based on a 2019 Ecuadorian study by Chong and Yáñez-Pagans, actually increased child labor rates. Microcredit and asset-based interventions similarly help to alleviate poverty; the former smoothes negative income shocks and the latter increases productivity. In theory, this should lead to a reduction in child labor, but the ILO’s meta-analysis indicates that in aggregate they either had no effect or actually exacerbated the problem. This counterintuitive effect appears to extend to financial literacy, as well. A 2018 study in Ghana by Berry, Karlan, and Pradhan suggested that grade school students exposed to financial education programs were more likely to engage in saving behavior but - absent an accompanying social education course - were also more likely to seek out employment.

Several articles suggest that the presence of imperfections in land, labor, or credit markets may lead to the use of child labor; for example, if households are unable to hire non-household labor or rent out excess land, they may choose to rely on their children instead. Increases in land area or quality - possible results from microcredit or asset-based interventions - may increase child labor rates in the presence of these market issues. Dumas (2007) argued that previous studies attributed child labor rates to poverty or low rate of returns to education but had overlooked the fact that they were analyzing rural areas without labor markets. Her study of agricultural households in Burkina Faso found that labor increased with land size, suggesting that these households were not at “subsistence” levels of consumption and that labor market deficiencies were motivating households to rely on their children. Basu, Das, and Dutta (2008) argued that poverty was the primary cause of child labor, and that poor households may *want* to send their children to work prior to an increase in landholdings; with an increase in wealth (land), they become able to do so. Their results indicate that child labor rates increased with landholdings until approximately 4 acres, after which point rates began to decrease. Interestingly, their results also indicated that increasing levels of female education - though not male education - had a statistically significant effect on reducing child labor. Menon (2010) observed that investment loans for family businesses in Pakistan did nothing to increase childrens’ school attendance rates; in fact, they likely increased the opportunity cost of education by increasing the marginal productivity of childrens’ labor. Menon posited that the need to monitor outside labor for shirking or quality assurance may make it difficult to substitute hired help for childrens’ labor. Dumas (2013) found that child labor increases when the labor market is thin or suffers from high transaction costs. Land market failures - weak or poorly defined property rights - also increase labor rates as excess land cannot be rented out. The impact of these market failures was heterogeneous; households with larger landholdings supplied more child labor when labor markets were less competitive. In a similar vein, Luckstead, Tsiboe, and Nalley (2019) examined the cocoa industry of Ghana, which is overseen by the Ghanaian Cocoa Marketing Board. They suggested that developed countries looking to reduce child labor rates might increase poverty - and thus child labor - if they simply ended their consumption of affected agricultural products. Trying to eliminate child labor directly might have similar results; increased prices would reduce consumer demand. Instead, they recommended the marketing board offer price premiums to farmers that abstained from child labor. They further suggested this be combined with a monitoring arrangement - otherwise, the additional money might be reinvested in new acreage or capital and increase the use of child labor.

Outside of the literature on child labor, several studies indicate that the agricultural sector in Ghana may be subject to various market failures. Goldstein and Udry (2008) discuss how land expropriation in Ghana is affected by social hierarchy and political relationships. They found that insecure property rights significantly reduced land investment and reduced overall land productivity for affected individuals. Tsiboe et al (2018) find that there is heterogeneity between household labor (male and female) and hired labor in Ghana’s cocoa producing households. Their analysis suggests that production and consumption are not recursive, which Lambert and Magnac claim is indicative of a market failure.[[11]](#footnote-11) Donkor et al (2023) investigate the factors influencing land tenure and how those land tenure decisions affect farmers’ choices of farm inputs. Migrants to cocoa producing areas must rely on sharecropping arrangements to gain access to land, but these leases can be canceled at will by the landowner; this introduces land tenure insecurity and disincentivizes investment. Together, these papers are indicative of market imperfections that may lead to households employing child labor in cocoa production.

**Data description**

We use data from the Ghana Living Standards Survey Seven (GLSS 7), which was implemented in 2016/2017. The survey is a nationally representative household survey conducted over a period of 12 months beginning in October 2016 and ending in September 2017. It covered a total sample of 59,864 individuals in 14,009 households. The overall objective of the survey is to estimate the living standards of Ghanaian households. Based on this objective, the survey collected detailed information on demographic characteristics of the population, education, health, employment and time use, migration, behaviour, housing conditions and household agriculture. We limit the sample to the cocoa producing regions. This section provides a brief description of the relevant variables used for modeling cocoa production and its relationship with child labor. The main variables are:

1. Net Value Production (**yvnet**): The annual net value of crop production (revenue), representing the total financial output generated by the household's farming activities over the past 12 months. This variable represents our endogenous variable, the primary outcome variable of the production function, which is the economic output of the farming households.
2. Land Endowment (**landt**): Area of available land owned by the household (in acres). This represents the total land endowment of the household.[[12]](#footnote-12) A key physical capital input in agricultural production. Larger land area is generally expected to contribute to higher output.
3. Capital (**cap**): Value of equipment currently owned by the household if sold (in Ghanaian Cedi, GHC). This serves as a proxy for the household's capital stock used in farming, in other words, it represents the investment in farm machinery and tools, more capital is generally expected to contribute to higher output.
4. Land (**land**): Size of the farm actually cultivated by the household (in acres). This variable reflects the utilized land area for crop production. This is the direct measure of land actively used in the production process, and its size is expected to have a significant impact on output.
5. Chemical Inputs (**chim**): Total expenditure on chemical inputs for crop production (in GHC) during the past 12 months. This includes inorganic fertilizer, organic fertilizer, insecticides, and herbicides. This variable represents the use of modern inputs aimed to improve soil fertility and protect crops, in this sense, it is associated with a positive impact on land yield.
6. Labor input variables, these variables provide a count of all available labor within then household engaged in farming. We divide the labor input variables into:
   1. **nmale** = Number of household males who have worked on a farm during the past 7 days.
   2. **nfemale** = Number of household females who have worked on a farm during the past 7 days.
   3. **nadtm** = Number of adult males (age ≥18) who have worked on a farm during the past 7 days.
   4. **nadtf** = Number of adult females (age ≥18) who have worked on a farm during the past 7 days.
   5. **hmal** = Total annual hours worked by male household members on the farm (in thousands of hours). This is a continuous measure of male family labor input.
   6. **hfem** = Total annual hours worked by female household members on the farm (in thousands of hours). This is a continuous measure of female family labor input.
   7. **hadtm** = Total annual hours worked by adult male household members (age ≥18) on the farm (in thousands of hours).
   8. **hadtf** = Total annual hours worked by adult female household members (age ≥18) on the farm (in thousands of hours).
   9. **chlab** = Indicator variable (1 if child labor is present in the household, 0 otherwise). Child labor is defined based on age and total weekly hours worked according to international labor standards.
   10. **chhrswrk** = Total weekly hours worked by child laborers within the household.
7. Wage (**wage**), Average wage per hour (in GHC). This is derived from individual payments for work. Payments reported by day, week, 2 weeks, month, quarter, half year, or year were converted to an hourly wage based on standard assumptions: 10 hours/day, 6 days/week, 4 weeks/month.
8. Hired Labour (**lab**), Quantity of hired labor (in thousands of hours), derived by converting hired labor expenditure into hours using the average wage. Transforms the monetary expenditure on hired labor into a physical quantity of labor input, which is more directly comparable to family labor hours in a production function context.
9. Price Index (**price**), calculated as the ratio of the value of sales to the quantity sold for crops.

**Methodology**

Following Lambert and Magnac (1998), and considering two quasi factors (land and capital), and the corresponding inputs (hired labor, chemical inputs, male, and family household labor), similarly to the authors, the econometric model is:

From the equation, the parameter determines the returns of scales of inputs and factors, and determines the relationship nature of inputs and factors, in other words, whether they are complements or substitutes.

We aimed to compare the market wage with the cost of hiring labor and incorporate them into the production function. Our hypothesis is that the market wage is higher than the cost of hiring labor in the production of Cocoa; therefore, it is cheaper to hired someone to work in the household land and work in the labor market or use child labor on the land since their cost is lower. In short, larger market wage impulse the usage of child labor in families’ lands.

**Results**

The descriptive statistics presented in Table (1) provide relevant insights about the main characteristics or the behavior of the sample households (5120 observations). One of the first observations is the presence of a relevant amount of potential outliers or high degree of heterogeneity. Variables such as net household income (yvnet), total land owned (landt), capital (cap), chemical inputs (chim), and total labor (lab, twhr) exhibit standard deviations that are larger than their respective means, coupled with vast ranges from zero (or very low) minimums to exceptionally high maximums. Furthermore, The presence of zero values for several input variables like landt, cap, chim, lab, hmal, hfem, nadtm, nadtf, and chlab further points to a considerable number of households operating at very low or non-existent levels for these specific inputs, leading to highly right-skewed distributions. This last characteristic might suggest the usage of data transformation, such as logarithms to achieve a more symmetric distributions and unbiased estimation results.

**Table 1**. Summary Statistics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Obs | Mean | Std. Dev. | Min | Max |
| yvnet | 5120 | 3780.451 | 6532.696 | 26 | 39520 |
| landt | 5120 | 33.79 | 840.761 | 0 | 50000 |
| land | 5120 | 6.823 | 10.658 | .003 | 502 |
| cap | 5120 | 417.367 | 7221.79 | 0 | 450090 |
| chim | 5120 | 419.498 | 4070.689 | 0 | 280469 |
| lab | 5120 | 82.48 | 5850.441 | 0 | 418624.16 |
| hmal | 5120 | 1.538 | 2.362 | 0 | 61.776 |
| hfem | 5120 | 1.141 | 1.547 | 0 | 19.136 |
| nadtm | 5120 | .728 | .709 | 0 | 6 |
| nadtf | 5120 | .717 | .748 | 0 | 7 |
| chlab | 5120 | .356 | .732 | 0 | 8 |
| twhr | 5120 | 78.134 | 87.222 | 0 | 1251 |
|  | | | | | |

Table (2) presents the estimation results for four different specifications of the agricultural production function, with **yvnet** (net value of production) as the endogenous variable. Models (1), (2), and (4) are estimated using the full dataset of 5,120 observations, while Model (3) shows a significant reduction in sample size due to outlier elimination.

The key input variables are: land (land area), cap (capital), lab (hired labor quantity), chim (chemical inputs), hmal (male family labor hours), and hfem (female family labor hours).

**Table 2.** Endogenous Variable: **yvnet**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) |
|  | original | robust | Trimmed | logarithm |
| land | 305.6\*\* | 305.6\* | 1867.5\*\* | 0.12 |
|  | (147.9) | (164.8) | (937.9) | (0.080) |
| cap | 80.1\*\*\* | 80.1\*\*\* | 27.4 | 0.013 |
|  | (16.3) | (20.8) | (113.9) | (0.031) |
| lab | 754.1\*\* | 754.1\* | 1934.1 | 1.05\*\*\* |
|  | (315.1) | (398.0) | (2740.5) | (0.13) |
| chim | 38.2\*\* | 38.2\* | 68.4 | -0.038 |
|  | (17.2) | (20.0) | (86.0) | (0.031) |
| hmal | 1173.5\*\*\* | 1173.5\*\*\* | 2550.6\*\* | 0.71\*\*\* |
|  | (264.6) | (244.7) | (1255.1) | (0.099) |
| hfem | 501.3 | 501.3 | 2379.0\* | 0.33\*\*\* |
|  | (320.7) | (345.2) | (1234.2) | (0.11) |
| land # land | -7.25 | -7.25 | -415.4\*\* | 0.13\*\*\* |
|  | (13.5) | (15.2) | (191.9) | (0.022) |
| land # cap | -8.26\*\* | -8.26\* | 17.8 | -0.00046 |
|  | (3.32) | (4.31) | (34.4) | (0.013) |
| land # lab | 192.5\*\*\* | 192.5\* | 992.8 | 0.033 |
|  | (64.3) | (103.0) | (670.7) | (0.044) |
| land # chim | 7.18\*\* | 7.18 | 1.69 | -0.054\*\*\* |
|  | (3.46) | (8.00) | (39.7) | (0.011) |
| land # hmal | 100.1 | 100.1 | 216.7 | 0.011 |
|  | (93.4) | (100.3) | (683.7) | (0.042) |
| land # hfem | 134.2 | 134.2 | 203.3 | 0.012 |
|  | (101.0) | (138.5) | (503.5) | (0.045) |
| cap # cap | -0.12\*\*\* | -0.12\*\*\* | -2.35 | 0.0093\*\* |
|  | (0.025) | (0.031) | (2.82) | (0.041) |
| cap # lab | 12.3\*\*\* | 12.3\*\* | -59.7 | -0.044\*\*\* |
|  | (3.90) | (4.91) | (63.2) | (0.016) |
| cap # chim | -0.58\* | -0.58 | 1.20 | 0.0031 |
|  | (0.30) | (0.48) | (3.18) | (0.0046) |
| cap # hmal | 12.2 | 12.2 | -20.6 | 0.0042 |
|  | (10.1) | (13.7) | (49.7) | (0.017) |
| cap # hfem | 2.00 | 2.00 | 58.4 | 0.015 |
|  | (11.4) | (19.0) | (46.8) | (0.018) |
| lab # lab | -2.72\*\*\* | -2.72\*\*\* | -462.6 | -0.085\*\*\* |
|  | (0.39) | (0.48) | (907.1) | (0.0085) |
| lab # chim | 34.2\*\*\* | 34.2\*\*\* | 83.3\* | -0.00028 |
|  | (7.87) | (12.2) | (49.6) | (0.018) |
| lab # hmal | -110.0 | -110.0 | 1047.2 | -0.15 |
|  | (191.4) | (237.7) | (1425.2) | (0.074) |
| lab # hfem | 63.5 | 63.5 | -1945.6\*\* | -0.0071 |
|  | (180.6) | (260.9) | (979.9) | (0.069) |
| chim # chim | -0.023 | -0.023 | -2.21 | 0.025\*\*\* |
|  | (0.035) | (0.059) | (1.98) | (0.0049) |
| chim # hmal | -5.19 | -5.19 | 61.2 | 0.0037 |
|  | (10.0) | (13.3) | (52.8) | (0.015) |
| chim # hfem | 3.97 | 3.97 | -45.7 | 0.011 |
|  | (10.3) | (18.1) | (49.2) | (0.016) |
| hmal # hmal | -235.2\*\*\* | -235.2\*\*\* | -1130.3 | -0.013\*\*\* |
|  | (69.2) | (61.7) | (695.7) | (0.038) |
| hmal # hfem | -306.4\*\* | -306.4\*\* | -1069.6 | -0.31\*\*\* |
|  | (145.2) | (137.4) | (661.6) | (0.055) |
| hfem # hfem | -236.8 | -236.8 | -699.6 | -0.054 |
|  | (151.0) | (173.9) | (804.3) | (0.062) |
| Observations | 5120 | 5120 | 342 | 5120 |

Standard errors in parentheses. \* p<0.10, \*\* p<0.05, \*\*\* p<0.01. 'lab' is hired labor quantity.

Column 1 shows the estimation results using the squared root of variables, their quadratic versions, and their interactions. land, cap, lab, chim, hmal all show statistically significant positive effects on yvnet (at the 5% or 1% level), which implies that land usage, capital, hired labor, chemical inputs, and male hours boost production.

On the other hand, we observe strong diminishing returns of scale on capital (cap), hired labour (lab), and male family labour hours (hmal), since the cap # cap, lab # lab, and hmal # hmal are statistically significant. From the interaction terms, we observe that land # lab, land # chim, cap # lab, lab # chim are positive and statistically significant, implying that those variables are complements, in particular, land and labor, land and chemical inputs, capital and labour, and labour and chemical inputs. Similarly, land # cap, hmal # hfem are negative and statistically significant, which means that those pair variables are substitutes, those are land and capital, and male hours and female hours.

Column (2) presents the same model specification with robust results since now standard errors are controlled for heteroskedasticity. In other words, results obtained under this specification are more reliable for inference.

Column (3) This model retains the quadratic form with square-rooted inputs and robust standard errors but applies aggressive winsorization at the 1st and 99th percentiles to all continuous variables (inputs and output). This adjustment aims to mitigate the influence of extreme outliers on parameter estimates. The sample size drops drastically to 342 observations (from 5,120), representing a 93% reduction, which raises concerns about representativeness. Key changes from Model (2) include:

Column (4) specification This specification adopts a translog production function, applying logarithmic transformations to inputs and output while retaining the full sample (N = 5,120) by adding a small constant (+1) to handle zeros and controlling the standard deviations for hetesroskedasticity, we are able to obtain the following results:

* lab (ln): Highly significant (1.05\*\*\*), implying ~1% increase in net production per 1% rise in hired labor (near-constant returns).
* hmal (ln): Significant and positive (0.71\*\*\*), indicating a 0.71% output increase per 1% more male family labor.
* hfem (ln): Significant and positive (0.33\*\*\*), confirming positive elasticity for female family labor.
* land (ln), cap (ln), and chim (ln) main effects are insignificant.
* land # land (ln): Positive (0.13\*\*\*)—land elasticity rises with more land.
* lab # lab (ln): Negative (-0.085\*\*\*)—diminishing elasticity for hired labor.
* chim # chim (ln): Positive (0.025\*\*\*), suggesting increasing elasticity for chemical inputs (unusual).
* Interaction terms (logarithmic): Reveal cross-input elasticity dynamics:
* land # chim (ln): Negative (-0.054\*\*\*)—substitutability between land and chemicals.
* cap # lab (ln): Negative (-0.044\*\*\*)—substitutability between capital and hired labor.
* hmal # hfem (ln): Strongly negative (-0.31\*\*\*), confirming substitutability between male and female family labor.

Taking into account the results obtained from column (2), we can obtain the following wages structure:

Table 3. Wage and Shadow Wages

|  |  |  |
| --- | --- | --- |
|  | Model (2) | Trans-log model (4) |
| Market Wage | 24.6 |  |
| Hired Labour | 14.5 |  |
| Male Shadow Wage | 22.6 |  |
| Female Shadow Wage | 9.6 |  |

GHC/hr = Ghanaian Cedi per hour.

This analysis, based on the results from Model (2) (the quadratic production function with robust standard errors), provides insights into labor allocation incentives and the relative productivity of different labor types.

In the comparison between Market Wage and Hired Labor Cost, we observe that the average market wage (24.6 GHC/day) is notably higher than the average cost of hiring external labor (14.5 GHC/day). This implies a clear economic incentive for farm owners. If a farm owner can earn more by working in the external labor market than the cost of hiring someone to perform similar tasks on their own farm, it is economically rational for them to seek off-farm employment and utilize hired labor for their farm operations. This highlights the importance of opportunity cost in labor allocation decisions. From a neoclassical economic perspective, the proximity between Market Wage and Male Family Labor Shadow Wage, suggests that male family labor is compensated (in terms of its contribution to farm output) at a rate that is nearly equivalent to what could be earned in the external labor market. This implies that for male farmers, working on their own land offers a return on their labor that is quite competitive with external employment opportunities. The labor market, at least for male labor, appears to be relatively efficient in reflecting the value of their agricultural output.

In contrast, there is a substantial gap between the average market wage (24.6 GHC/day) and the shadow wage (marginal productivity) of female family labor on the farm (9.6 GHC/day). The female shadow wage is not only significantly lower than the market wage but also considerably lower than the male family labor shadow wage. This large discrepancy suggests several potential issues: (i) Undervaluation**:** Female family labor on the farm may be significantly undervalued or less productively utilized; (ii) Opportunity Cost: If the average market wage genuinely reflects the opportunities available to female labor, then continuing to work on the farm represents a considerable opportunity cost for women; (iii) Gendered Roles and Constraints: This gap might reflect prevalent gender divisions of labor on farms, where women are disproportionately engaged in tasks (e.g., household chores, specific caregiving roles, post-harvest activities).

**Next Steps**

* We need to use the comparison of market and shadow wages in concert with the financial diaries to estimate the relationship between market failure and child labor usage. We hope to receive feedback on how best to accomplish this.

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12. Different units (poles, ropes, hectares, plots) were converted to acres using standard conversion factors: 1 pole = 0.00625 acres, 1 rope = 0.92 acres, 1 hectare = 2.47105 acres, 1 plot = 0.25 acres. [↑](#footnote-ref-12)