Sustainability Implications of Galamsey on Rural Poverty and Child Labor in Cocoa Districts of Ghana

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Sustainable and good agricultural practices (SGA) are increasing been recognized as viable pathway to accelerate poverty reduction and eliminate child labor in Cocoa growing communities in West Africa. Despite farmers effort to adopt SGA practices, increasing informal artisanal and small-scale mining activities (referred to as galamsey) in most cocoa growing districts seem to be a serious impediment to the fight against poverty and child labor. The paper attempts to investigate how galamsey activities affect poverty and child labor in cocoa growing districts of Ghana. To undertake this investigation, the paper draws on baseline and on-going financial surveys of 360 households and a series of key informant interview from eighteen cocoa growing districts in Ghana. The sampling period of the study is between January 2020 and June 2021. We employ probit regression analysis to examine the impact of galamsey on poverty and child labor. Preliminary findings from the survey indicate that most farmers

are worried about their future livelihood because galamsey activities in their communities have resulted in a competing land use, degradation of assets and decreasing production.

1. Introduction

Informal artisanal and small-scale mining often referred to as galamsey, has increasingly influenced Ghana's political, economic, and environmental trajectory. According to one estimate, Galamsey in Ghana represents approximately 60% of workers in the mining sector and about 30% of production (Liege 2021). Galamsey appears to have cost the Ghanaian government greatly; one estimate places this amount at 2.3 billion USD in 2016 alone (Liege 2021). According to some estimates over 1 million Ghanaians work directly in informal mining (Hilson 2016). Thus, the effect of galamsey has been vast as many miners have turned to this sector to avoid poverty and lack of employment opportunities in other economic sectors (Kwadwo, Ganle and Abrafi Adomako 2016).

Cocoa farming has been an important economic sector in Ghana, with over 800,000 households' dependent on it (Bymolt, Laven and Tyszle 2017). In fact, given Ghana's competitive two-party system, elections often hinge on farmers' perceptions of different economic policies related to the cocoa sector (Banful 2011a; 2011b; Munier and Amponsah 2020). The growth of galamsey has clearly impacted cocoa farming in Ghana. Many cocoa farmers have been forced to sell their farms or enter the mining sector themselves, thus presenting a longstanding challenge for the cocoa sector (Schwartz Taylor and Taylor 2018).

In this paper, we examine the effect of galamsey on cocoa farming districts of Ghana. The intersection of these economic sectors has a clear impact on important issues such as sustainability, child labor, poverty, environmental degradation, and the performance of certification schemes that have been implemented in the cocoa sector to avoid adverse social outcomes. To examine these issues, we use baseline household surveys from 18 cocoa-growing districts with 360 participants over 18 months starting

in January 2020. These surveys help to understand how galamsey has affected the cocoa sector form the farmers perspective. Our research question solicits cocoa farmers' view on the effect of galamsey on their farming activities. We employ coincidence analysis to do content analysis of their responses and create variables for assessing their views of galamsey on their farming activities. Furthermore, given the challenge from the covid-19 pandemic, while these surveys were taking place, this study examines whether this context influenced the effect of galamsey on cocoa farming communities and how this varied overtime, during the pandemic. Past studies had shown that before the pandemic, there were already many challenges from poverty, lack of employment in other economic sectors, or difficulties in farming that influenced individual decisions to engage in galamsey (Kwadwo, Ganle and Abrafi Adomako 2016; Schwartz Taylor and Taylor 2018). It is likely that the covid-19 crisis accelerated these trends even further, and that this varied overtime while these surveys were being conducted.

2. Literature Review and Definition

2.1. Informal Mining and Farming

Informal mining is often portrayed as incongruent with farming globally. However, a body of literature has developed, arguing that this is not necessarily the case. For instance, Hilson (2016), argues that next to agriculture, small-scale mining employs the most people, over 1 million in Ghana and that in many contexts, the sectors can mutually benefit each other. According to this view, it has been a mistake to overlook informal mining when studying development, and informal miners should be viewed more as people trying to support a livelihood and less as economic opportunists. On a similar note, Maconachie (2011), found that in post-war Sierra Leone, proceeds from

mining allowed the agricultural sector to develop; in time, mining became more difficult, and more people decided to focus directly on farming. Despite a long civil war, links between mining and agriculture persisted and were an essential dynamic in allowing both sectors to recover (Maconachie and Binns 2007). In Tanzania, Aizawa (2016) finds that informal mining has become an "informal safety net" for miners, and the poorer the region, the more it serves this purpose.

In a meta-analysis of studies that examine the relationship between small scale mining and agriculture Ofosu et al (2020) find that there has developed a debate in the literature. Some studies point to the benefits of small-scale mining for funding rural communities, while others focus more on environmental destruction, land invasions, and resource curse dynamics. The authors believe that since most small-scale mining takes place in rural areas, its influence on agriculture is inevitable, and good policy should engage with and develop both sectors. Ofosu et al. (2020) believe that while literature with a negative view of small-scale mining brings up some important issues, research should focus on comparing what works and what does not for both sectors, given the reality that they will interact extensively.

Despite the literature mentioned above, there is evidence of the detrimental influence of small-scale mining on farming. Some of this has to do with these sectors' inherent nature. Mining is non-renewable, and resources become depleted, often quickly to the point where it is no longer economically advantageous to continue mining. The lack of sustainability in mining has been a core dynamic of the "resource curse" literature. This literature argues that states with a large amount of resources have many political and economic problems as a result (Badeeb et. al 2017). On the other hand, if it is done sustainably, farming is a renewable source of income and can provide a permanent livelihood to workers in a way that mining cannot. Thus, when the interests

of the mining sector clash with farming, the inherently more sustainable nature of farming often leads to the sector getting priority legally, in development strategies and overall legitimacy.

Many studies have proposed a "resource curse" along with many different mechanisms to explain why states that have a lot of resources appear to be more corrupt, authoritarian, and economically undeveloped than they would be otherwise (Ross 2015). The concept from the resource curse literature that is most clearly applicable for this study is the lack of economic diversification that can develop when resources extraction is dominant in a local and national economy (Sachs and Warner 2001). There has been a global tendency that other economic sectors decline or fail to develop at all when resource extraction takes place. Thus, when looking at the influence of galamsey on Ghana's cocoa sector, it will be important to see if this dynamic is present here.

2.2. Galamsey and Cocoa Farming in Ghana

There have been some influential studies on galamsey in Ghana. Past studies on galamsey in Ghana have primarily focused on the legal complexity of the sector. For instance, Teschner (2012) argues that formal and informal mining in Ghana does not act as a dichotomy but are increasingly intertwined on many levels and that legal codes have been unable to keep up with this reality. On a similar note, Afriye, Ganle and Abrafi Adomako (2016) find that miners often participate in galamsey because of high poverty and unemployment levels instead of economic opportunism. Thus, the nexus of local authorities, large mining companies and resource traders have often facilitated a context in which galamsey has grown. Given the motivations of many who participate in galamsey, legal crackdowns are unlikely to be effective at changing longstanding

patterns that have led to an increase in galamsey compared to policy reforms that would make it easier to bring informal miners into the formal sector.

Past research has often tried to understand the scale of galamsey in Ghana. Because of the illegal nature of many galamsey activities, it can be challenging to estimate how much is taking place in Ghana. However, Owusu-Nimo et al (2018) use a series of geographical tools: Open Data Kit system, ArcGIS and Google Earth Imagery, to find that galamsey activities are vast, probably beyond even past estimates. They categorize nine different activities associated with galamsey and see that galamsey takes place in many different geographical areas in Ghana, both urban and rural. However, the potential availability of resources alone does not account for the geographical variation in galamsey; the presence of formal mining, other economic opportunities, and local authorities' behavior all matter as well.

Some studies have directly examined the relationship between cocoa farming and galamsey in Ghana. These studies have found that many environmental issues brought about by galamsey are a challenge for cocoa farmers, along with land use issues. Boateng et al (2014) surveyed 100 cocoa farmers and found that galamsey causes air and water pollution and lower crop yields in affected areas. In a survey of 211 cocoa farmers in Ghana's Upper Denkyira West District, Agyei-Manu et al (2020) found that mining had a negative impact on the local community and cocoa production. Thus, many farmers had to find other sources of income outside of cocoa farming. On a similar note, Boadi et al. (2016) interviewed 60 respondents who lived near the Offin Shelterbelt Forest Reserve and found that farming dropped from 90% to 76% after galamsey and about 50% percent of the respondents said that galamsey destroyed land used for cocoa. Nonetheless, it appears as though some respondents left cocoa farming for galamsey, or had increasingly participated in both. Bryant and Mitchell (2021) used

131 interviews with Ghana's cocoa trade stakeholders. They found that galamsey was a significant problem when examining the future of the cocoa sector as it brings about a series of environmental and sustainability issues. Thus, this previous research shows a clear set of challenges brought about by galamsey for cocoa farming communities.

Given the nature of galamsey it is hard to estimate the number of non-Ghanaians involved in the sector. However, there is reason to believe that the influence is non-Ghanaians is significant and consequential. One estimate place the number of just Chinese citizens in the trade at over 50,000 (Kane 2013). The participation of Chinese immigrants in galamsey has received much attention from the media and civil society groups, prompting an extensive response from the military (Hilson, Hilson and Adu-Darko 2014). The widespread presence of non-Ghanaians in the galamsey sector brings about another dynamic to issues associated with the galamsey sector more generally, such as the environment, legality and sustainability.

There is some evidence that non-Ghanaian involvement in galamsey has directly influenced cocoa farming. Crawford and Botchway (2017) found from interviews with cocoa farmers that non- Ghanaians involved in galamsey often offered more money for farmland and were able to use private payments to get local authorities to allow them to continue their activities. In their view, the problem is not lack of state capacity in Ghana; corruption allows for galamsey to take place on a wide scale. When it comes to environmental cooperation, Ghana is a party to the Minamata Convention on Mercury treaty, but given the widespread use of Mercury in galamsey, compliance with this treaty is likely to be a challenging long-term project (Clifford 2017; Hilson et al 2018). Compliance with this treaty has been difficult for many states with a large informal mining sector, especially those with large gold mining sectors. Some of the challenges

for states to cooperate with Minamata Convention on Mercury is the often unclear legal status of informal mining, and this dynamic is also present in Ghana.

The issue of child labor in Ghana's mining sector is important, given that informal mining can often be hazardous. The Ghanaian government has pursued many strategies to lessen child labor in the mining and cocoa sector. There is some evidence that the Ghana Child Labor Monitoring System has been more effective in gathering data about the cocoa sector when compared to the mining sector (Human Rights Watch 2015). Some of this might be because international donors have focused on child labor in the cocoa sector, far more than other sectors (Human Rights Watch 2015). Furthermore, a significant body of literature shows that compliance with certification schemes in the mining sector is particularly challenging for states (Childs 2008;2014; Munier 2016a; 2016b; 2020).

While it is clear from past research that there are many negative aspects of galamsey in Ghana, some studies suggest that there might be some contexts in which galamsey can positively influence farming. Hilson and Garforth (2012) argue that many Ghanian farmers have gone into galamsey because economic globalization has made it increasingly difficult for smallholding farmers to get a viable livelihood from this alone. Thus, many farmers have had to diversify their income sources and galamsey has been a way to do this, especially in parts of the year when farm work is absent. This study is interesting because it proposes a mechanism where it is the structure of the global economy and the farming cycle that makes participation in galamsey more likely. Building on this study, Hilson and Garforth (2013), argue further those neo-liberal economic policies have hurt smallholding cocoa farmers by giving them less government assistance and lower profits levels due to having to compete more openly with the global market. Thus, galamsey has filled this gap for some farmers, allowing

them to maintain a comparable livelihood by mining seasonally or using money from one sector to participate in the other. In further research, Hilson (2016) argues that money from informal mining has helped build infrastructure and invest more in the farming sector in Ghana. A common theme across this research is that with over a million people directly participating in galamsey, global economic dynamics and domestic economic policy changes have made the relationship with cocoa farming inevitable. Given this reality, policymakers should pursue ways to make galamsey and cocoa farming stakeholders more cooperative and include both as part of an overall developmental strategy.

2.3. Defining Child Labor

In this paper, our definition of child labor is based on the International Labor Organization (ILO) conventions, including ILO 182 on the Worst Forms of Child Labor (WFCL) and existing legislative, and institutional frameworks for the protection of labor and human rights in Ghana, notably, the Children's Act (1998), the Labor Act (2003) the Human Trafficking Act (2005). The ILO defines child labor as work that deprives children of their childhood, their potential and dignity, and that is harmful to physical and mental development.[1] In defining child labor, the ILO also makes a distinction between working children and child labor. This means that not all the economic activities of child could be classified as child labor. For example, there are some children who occasionally help on the cocoa farm, this kind of activity could contribute to their development and help prepare them to become productive members of society.

[1] "What is Child Labor?" The International Labor Organization. https://www.ilo.org/ipec/facts/lang--en/index.htm and "Child labour statistics" (ilo.org) (Accessed December 8, 2021)

According to the Children's Act (1998) of Ghana, the minimum age for a child to participate in "light work" is 13 years and for regular work is 15 years[2]. The ILO defines Light work as work which is not likely to be harmful to the health and development of the child and does not affect the child's attendance at school or the capacity of the child to benefit from schoolwork.[3] The laws in Ghana, also make provision for eliminating the WFCL as defined by Article 3(1) of Convention No. 138 and Article 3(d) of Convention No. 182.[4] WFCL includes all forms of slavery or practices similar to slavery; the use, procuring, or offering of a child for prostitution, for the production of pornography or for pornographic performances; and the use or offering of a child for illicit activities, such as the production and trafficking of drugs as defined by the relevant international treaties.

The law in Ghana, prohibits the engagement of a child in exploitative labor.[5] Labor is defined as exploitative if it deprives the child of its health, education, or development. Based on this, the law makes it explicit that children must not be engaged in night work. Night in this sense, is defined to be between the hours of eight o'clock in the evening and six o'clock in the morning.

By ratifying the ILO conventions, the law in Ghana has 18 as the minimum age of employment for activities that can be describe as hazardous – that jeopardize "the health, safety, or morals of young person." These activities include going to sea, mining and quarrying, porterage of heavy loads, work in manufacturing industries where chemicals are produced or used, work in places where machines are used, and work in places such as bars, hotels and places of entertainment where a person may be exposed to immoral

[2] Section 90 of the Children's Act 1998 (Act 560)
[3] ILO Convention N0. 138 and Section 90 of the Children's Act 1998 (Act 560)
[4] "Worst forms of Child Labor Convention No. 182" The International Labor Organization. https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C182 (Accessed December 8, 2020)
[5] Section 87 of the Children's Act 1998 (Act 560)

behavior, and work under particularly difficult conditions such as work for long hours or during the night or work where the child is unreasonably confined to the premises or the employer.

The ILO provides two indicators for reporting child labor when one takes into consideration, Sustainable Development Goals (SDG). These indicators are:

> Proportion and number of children aged 5-17 years engaged in economic activities at or above age-specific hourly thresholds (SNA production boundary basis), which includes: (a) children aged 5-11 working at least 1 hour per week in economic activity; (b) children aged 12-14 working for at least 14 hours per week in economic activity; and (c) children aged 15-17 working for more than 43 hours per week in economic activity (Child labor 1).
>
> Proportion and number of children aged 5-17 years engaged in economic activities and household chores at or above age-specific hourly thresholds (general production boundary basis), which includes: (a) children aged 5-11 working at least 1 hour per week in economic activity and/or involved in unpaid household services for more than 21 hours per week; (b) children aged 12-14 working for at least 14 hours per week in economic activity and/or involved in unpaid household services for more than 21 hours per week; and (c) children aged 15-

17 working for more than 43 hours per week in economic activity (Child labor 2).

3. Data and Methodology

3.1. Source of Data

Our analysis relies on baseline data from an ongoing financial diary survey of cocoa farmers in Ghana. The survey is a multipurpose household survey collecting information on many different dimensions of living conditions of cocoa farmers in Ghana and Cote d'Ivoire.

The field data collection for the survey took place in three different periods. In February 2020, we conducted the first baseline survey for 98 households in two cocoa districts. This was followed by another baseline data collection for 180 households in 12 cocoa districts in June 2021. While the final data collection took place in January 2021 for 80 households in 4 cocoa districts. In all, we conducted interviews for 360 households in 18 cocoa districts. In terms of political districts, our survey covered 27 districts. We used probability sampling distribution to select the 360 households.

3.2. Methodology

In this study, four different methods were adopted. These are coincidence analysis, chi-square test of association, probit regression and ordinary least square regression.

3.2.1. Coincidence Analysis

The first part of the study employed coincidence analysis, which is a set of techniques whose objective is to detect which, people, subjects, objects, attributes or events tend to appear at the same time in different delimited spaces (Escobar, 2014). We adopted this method of analysis because we used an open-ended question in the questionnaire to solicit farmers opinion on galamsey and its effect on their farming activities. The specific question that we ask is: What is the effect of Galamsey on cocoa production? Using coincidence analysis and the coin command in Stata, we created network graphs, showing the frequencies of the categories as well as the coincidences or relationship between them.[6] Some of the variables such as galamsey, pollution, productivity, farmland and cocoa were used as explanatory variables in our regression models.

3.2.2. Chi-square Test of Association for Children Activities

The chi-square test of association (independence) is used to test the relationship between two categorical variables. The null and alternative hypothesis of the test can be stated as follows:

> Null hypothesis (H_0:) There is no relationship between the two variables in the population.

[6] We refer interested readers to Escobar (2015), "Studying coincidences with network analysis and other multivariate tools. Available at "Studying Coincidences with Network Analysis and Other Multivariate Tools (sagepub.com)", accessed on December 10, 2021.

Alternative hypothesis ($H\alpha$:) There is a non-zero relationship between the two variables in the population. [i.e., within the population there is an association between the two variables].

We employed this test to examine the relationship between children's economic activities and their region of residence, and their age group. When we reject the null hypothesis, we are inferring a relationship between variables in the population.

3.2.3. Model Specification for Effect of Galamsey on Child Labor

Following studies that analyze child labor issues, we adopt a binary regression technique to estimate our model, where child labor is estimated as a dichotomous dependent variable. The binary outcome-dependent variable in this study is whether a child is child labor or non-child labor.

Specifically, a household with a child considered to be child labor is represented by CHL, then the household's indicator variable is:

$$CHL = \begin{cases} 1 \text{ if yes} \\ 0 \text{ if no} \end{cases} \qquad (1)$$

IF p, shows the probability that household has a child labor, then $p[CHL = 1] = p$; and if a household has no child labor, $p[CHL = 0] = 1 - p$. The probability function for this model is given as:

$$f(CHL) = p^{y}(1-p)^{1-y}, CL = 0,1 \qquad (2)$$

where p, is the probability that CHL, is equal to one and the expected value $E(CHL) = p$; variance $(CHL) = p(1 - p)$.

There are two ways that this model could be estimated. One is the use of logit regression estimation technique and the other is the use of probit regression technique. Studies have shown that the choice between logit and probit is usually with regards to assumptions about the distribution of the error term. Both techniques produce quantitatively similar result, however, the the logit model assumes a logistic distribution for the error while the probit model assumes normal distribution.

3.2.4. Empirical Model

After extensive literature review, the following explanatory variables were included in the model estimation; household head age, household head highest level of education, household head gender, household head marital status, household head farm ownership status, household head land holder rights, and household head district as well as region of residence.

Other variables in our model are those we call galamsey variables which we created using coincidence analysis. For these variables, we argue that if child labor is significantly influence by cocoa farming activities, then the effect of galamsey should have negative effect on child labor. Based on this we would like to test the following hypothesis:

H_1: the more farmers perceive a reduction in productivity the lower the demand for child labor.

H_2: the more farmers perceive pollution on their farms the lower the demand for child labor.

H_3 the more farmers perceive a reduction in farmland the lower the demand for child labor

The economic model for our child labor analysis is given as:

$$f(CHL) = f(Gal, Pol, Prod, Fland, Age, Agesq, Sex, Educ, Mrst, Fown, Right, Cdist, Reg) \quad (3)$$

The probit model is:

$$pCHL = P(CHL) = \phi(\beta_0 + \beta_1 Gal + \beta_2 Pol + \beta_3 Prod + \beta_4\, Fland + \beta_5 Age + \beta_6 Agesq + \beta_7 Sex + \beta_8 Educ + \beta_9 Mrst + \beta_{10} Fown + \beta_{11} Right + \beta_{12} Cdist + \beta_{13} Reg) \quad (4)$$

The OLS model for poverty analysis is given as:

$$POVR = \alpha_0 + \gamma_1 CHL + \gamma_2 Gal + \gamma_3 Pol + \gamma_4 Prod + \gamma_5\, Fland + \gamma_6 Age + \gamma_7 Agesq + \gamma_8 Sex + \gamma_9 Educ + \gamma_{10} Mrst + \gamma_{11} Fown + \gamma_{12} Right + \gamma_{13} Cdist + \gamma_{14} Reg \quad (5)$$

In estimating these two models, we control for the galamsey variables as the first step before estimating the full models by including the household characteristics, district and regional dummies. The results for the first step of estimation are reported in column (1) and column (3) of Table 4 and Table 5 while the results for the full model are reported in column (2) and column (4) of each table.

4. Results and Discussion

4.1. The Influence of Galamsey on Cocoa Production

The first outcome we examine is the coincidence analysis, where network graphs showing the frequencies of each of the words as well as the coincidence or relationship between them. These words are used by farmers to address the effect of galamsey on their cocoa production.

We can see from Figure 1 that respondents consistently associated galamsey with farmlands and decreased productivity. Also, many saw galamsey as being destructive to water bodies and being a cause of pollution, as these are some of the strongest associations here. Here we can see that galamsey is viewed negatively by cocoa farming households as strong associations are made with words such as destroy, decrease and pollute. Interestingly, cocoa farming households saw farmland as being threatened by galamsey through pollution and destruction of water bodies, illustrating the interconnections of farming to a region's overall ecology. Different thickness of line is used to represent the degrees of significance. The dotted lines correspond to a $p < 0.05$, the discontinuous lines to $p < 0.01$; and the continuous lines to $p < 0.001$.

When controlling for different cocoa farming regions, we see some interesting dynamics. Respondents from the Ashanti district have robust word associations with galamsey. This suggests that galamsey is more widespread in the Ashanti district, or at least has more influence on cocoa farming than other districts. In the Ashanti district, many respondents also bring up a decrease in cocoa productivity from galamsey, suggesting that these dynamics are closely intertwined.

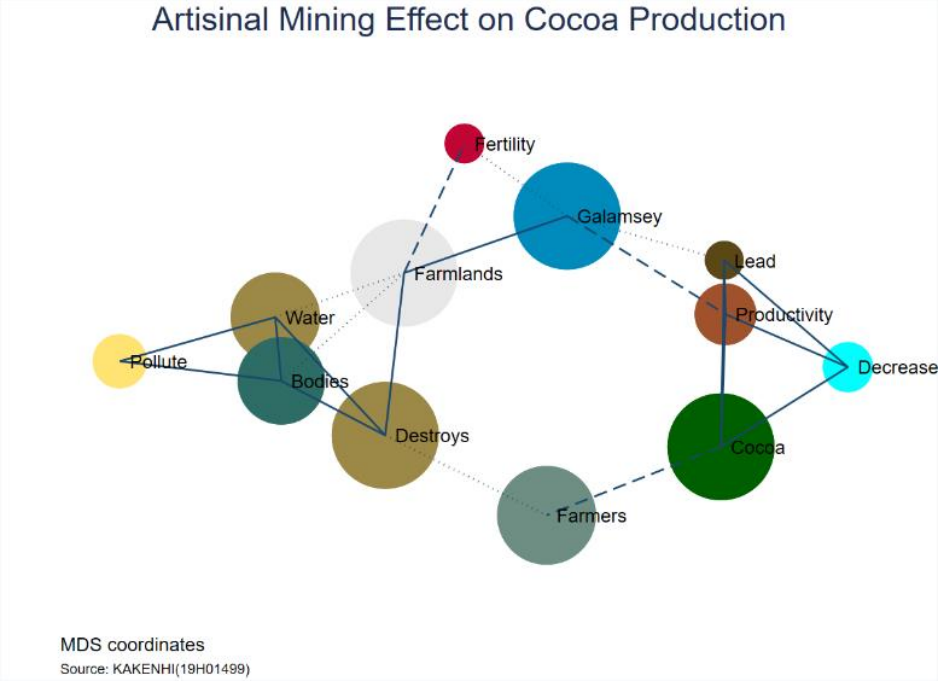

Figure 1: Effect of Galamsey on Cocoa Production

There is a strong association between galamsey and the destruction of water bodies in the Western region, suggesting that this is the biggest issue. When comparing this region to Ashanti, it is interesting how in Ashanti, respondents associate galamsey more with decreasing cocoa productivity. In the Western region, respondents are more concerned with water pollution and the destruction of water bodies. Some of this variation is probably due to the Western region being a coastal region with many rivers, whereas the Ashanti district is inland with fewer water bodies. Nonetheless, it is interesting how respondents in these two major cocoa-producing regions tend to associate galamsey with different dynamics.

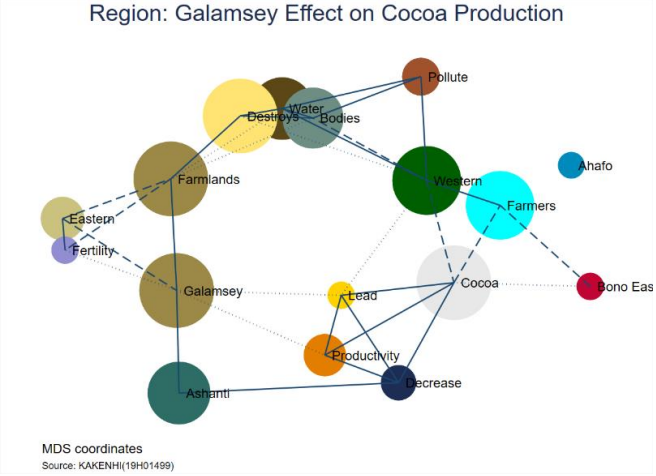

Figure 2: Effect of Galamsey on Cocoa Production by Region

In the Eastern region, associations with galamsey are not as strong as in Ashanti or Western. However, there is a clear association with the destruction of farmland and water bodies. The association with a decrease in cocoa production is weaker in Eastern. Bono east has an even weaker association with galamsey, but it is still present. Interestingly, Ahafo does not appear to associate with galamsey more broadly.

Our results show that the most robust relationship between galamsey and cocoa production is in Western and Ashanti, as many respondents automatically associate negative dynamics here, albeit somewhat different ones. These results paint a fascinating picture of the relationship between region, galamsey and cocoa farming. While galamsey influences cocoa farming, this varies heavily by region. In some regions, the interactions between these sectors appear intense and longstanding; in others, there is little connection. Furthermore, the type of interaction between different regions appears to vary as in some areas it is more about water pollution whereas in others it is more about a decrease in productivity.

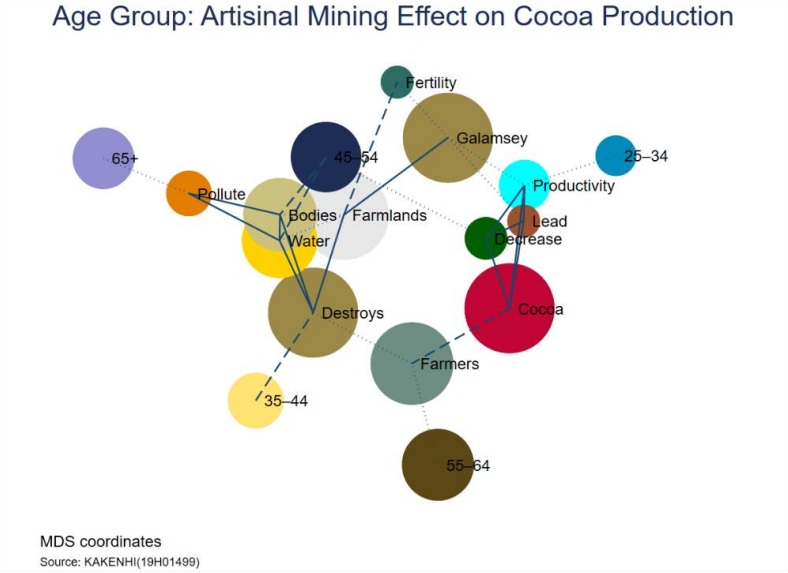

Figure 3: Effect of Galamsey on Cocoa Production by Age Group of Household Head

When controlling for age in our survey, we found that respondents aged 35-44 saw the strongest association between artisanal mining and cocoa production. While there is an association between other age groups, they are weaker; thus, this brings about substantial variation in our sample. One reason for this may be that respondents between 35-44 are more likely to be engaged in cocoa farming and galamsey; thus, they see a stronger connection between the sectors. Respondents in the 35-44 age range are more likely to see a negative link between the sectors as they often associate galamsey with the destruction of water and farmland.

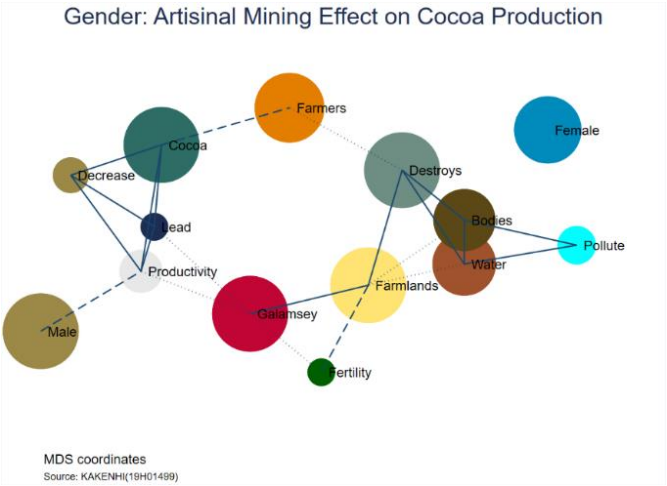

Figure 4: Effect of Galamsey on Cocoa Production by Gender

When controlling for gender in our survey, we find that men have primarily driven our model as women do not appear to have strong associations with artisanal mining and cocoa production. This might be because men are more likely to work in either sector directly, thus seeing more of a connection between them. From our data, this would be particularly the case with men between 35-44, who seem to find the strongest connection between these sectors. Thus, demographic factors appear to explain some of the variation in how respondents viewed the relationship between galamsey and cocoa production.

4.2. Economic Activities by Children in our Survey

We used Pearson's χ^2 and Fisher's exact test to compare responses of children's economic activities between regions and also between age groups. We report all the frequencies and percentages for the whole sample and separately for each region as well as for each age group. The Pearson's χ^2 and p-values showing the level of significance

are also reported in the table. For interpretation of the effect size of the χ^2 test, we report Cramer's V and Cohen's ω. [7]

While some children reported that they engaged in some economic activities in the week preceding the survey, the type of activity varied across regions: about 8% ($n = 37$) of them reported engaging wage activities, 23% ($n = 103$) reported engaging in domestic work, 36% ($n = 164$) reported working on the farm, 11% ($n = 49$) reported managing a non-farm business, and 16% ($n = 76$) reported engaging in non-farm activities. As noted in Table 1, compared to Ashanti, Central & Eastern, and Western regions, a larger proportion of children in the Brong Ahafo region had more engagements in almost all economic activities except farm activities.

The Pearsonχ^2 and Fisher exact tests are all statistically significant at the 1% level for all the activities reported in the table. Using Cohen's (1998) convention [ω =.10 (small); ω =.30 (medium); ω =.50 (large)] for judging effect size, we would interpret the effect size for wage, farm, managed non-farm and non-farm activities to be above medium. And since the Cohen's ω is more than 0.5 for domestic, would interpret the effect size to be large.

In terms of hours of work, Table 1 shows that children in the Brong Ahafo region have the highest average hours of work per week. Children in this region work about 26 hours per week. This is followed by the Western region with an average of 21 hours per week. Children in the Central & Eastern regions work about 19 hours per week on

[7] Cramer's V can be thought of as a measure of effect size, where a value of 0 indicates no relationship between the two variables. Since this index varies depending on the dimensionality of one's table – getting smaller with the smaller of the two dimensions, we converted Cramer's V into Cohen's omega (ω), which has conventional benchmarks of .10, .30, and .50 reflecting small, medium, and large effects, respectively.

average, while those in the Ashanti region seems to have the lowest average hours of work (17 hours per week).

Table 1: Regional Distribution of Economic Activities by Children and Farm Size

	Region						
	Ashanti	**Brong Ahafo**	**Central & Eastern**	**Western**	**Pearson's $\chi^2(3)$**	**Cramer's V**	**Cohen's ω**
Variable	38 ($n = 176$)	11 ($n = 55$)	11 ($n = 52$)	38 ($n = 178$)	Test (P)		
Economic Activity							
Wage % (n)		8 (37)			25.81 (0.000)	0.2366	0.4098
	5 (8)	13 (9)	0 (0)	9 (16)			
Domestic % (n)		23 (106)			114.90 (0.000)	0.4992	0.8646
	16 (29)	80 (44)	13 (7)	15 (26)			
Farm % (n)		36 (164)			22.24 (0.000)	0.2196	0.3803
	24 (42)	33 (18)	54 (28)	43 (76)			
Managed Non-Farm		11 (49)			21.13 (0.000)	0.2141	0.3708
	10 (18)	27 (15)	2 (1)	8 (15)			
Non-Farm% (n)		16 (76)			16.69 (0.001)	0.1903	
	15 (28)	32 (18)	4 (2)	16 (28)			
	($n = 186$)	($n = 80$)	($n = 55$)	($n = 188$)			
Child labor 1 % (n)		35 (178)			14.023 (0.003)	0.1660	0.2875
	27 (51)	47 (38)	47 (56)	33 (63)			
Child labor 2 % (n)		25 (126)			11.842 (0.008)	0.1525	0.2641
	20 (38)	17 (14)	40 (22)	28 (52)			
	17.19	25.58	19.30	21.16			
Mean hours of work	(13.86)	(14.90)	(18.13)	(17.64)			
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)			
	($n = 100$)	($n = 32$)	($n = 61$)	($n = 124$)			
	13.627	9.366	11.601	15.228			
Mean farm size	(13.142)	(11.220)	(9.529)	(13.561)			
	121222.632	77387.097	72140.541	108205.785			
Value of farm	(105670.193)	(82453.897)	(96589.755)	(95484.563)			

In Table 2, we report the results for the different economic activities undertaken by children in age groups 5-11, 12-14, and 15-17. Once again, only 8% ($n = 37$) reported

engaging in some wage activities. Like the regional distribution, there is significant difference among these age groups for this economic activity. However, unlike the regional results presented in Table 1, we do not observe significant difference for manage non-farm and domestic activities. But the table shows that children's farm activities are significantly different for the age groups. Overall, 36% ($n = 164$) of the children reported engaging farm activities (Pearson' $\chi^2(2) = 23.33, p = .000$). Also about 16% ($n = 76$) of the children reported engaging in non-farm activities (Pearson' $\chi^2(2) = 5.64,\ p = .060$).

The Pearson Chi-square test indicate there is a significant relationship between age and frequency of working on the farm or engaging in a non-farm activity. Based on the values for Cramer's V and Cohen's ω, with the exception of farm activities, which we would interpret the effect size to be medium, the rest will be interpreted to be below medium.

For the age groups, children aged 5-11 on average work about 16 hours per week, those aged 12-14 also work roughly 22 hours per week, while those aged 15-17 work about 24 hours per week.

Table 2: Children's Economic Activities by Age Group years

	Age Group			**Pearson's**	**Cramer's**	**Cohen's**
	5-11	12-14	15-17	$\chi^2(2)$	**V**	**ω**
Variable	(n = 207)	(n = 86)	(n = 168)	Test (P)		
Economic Activity						
Wage % (n)		8 (37)		8.96 (0.011)	0.1394	0.1971
	4 (8)	10 (9)	12 (20)			
Domestic % (n)		23 (106)		6.55 (0.112)	0.1192	0.1686
	20 (42)	31 (41)	19 (23)			

Farm % (n)		36 (164)		23.33 (000)	0.2250	0.3182
	24 (49)	44 (59)	46 (56)			
Managed non-farm		11 (49)		2.00 (0.368)	0.0658	0.0931
	9 (18)	12 (10)	12 (21)			
Non-Farm% (n)		16 (76)		5.64 (0.060)	0.1106	0.1564
	12 (25)	18 (25)	21 (26)			
Child labor 1 % (n)		35 (178)		53.661 (0.000)	0.3247	0.4591
	36 (83)	55 (79)	12 (16)			
Child labor 2 % (n)		25 (126)		38.306 (0.000)	0.2743	0.3879
	21 (48)	43 (62)	12.31 (16)			
	Mean (SD)	Mean (SD)	Mean (SD)			
	($n = 87$)	($n = 86$)	($n = 83$)			
Mean hours of worked	16.30	21.66	23.64			
	(13.326)	(16.415)	(18.052)			

4.3. Results on Child in the Cocoa Sector

In Table 1 and Table 2, we also report the results for our chi-square test of association between region and child labor as well as between age group and child labor. Based in the first ILO indicator, the results reported in Table 1 and Table 2 indicate that about 35% ($n = 126$) of the children in our sample could be considered to be in child labor. The region distribution indicates that about 27% ($n = 51$) of the children in the Ashanti region are in child labor, 47 % ($n = 38$ & $n = 56$) of children in the Brong Ahafo and Central & Eastern regions, respectively, are in child labor. For the Western region, the results indicate that about 33% ($n = 63$) of the children are in child labor (Pearson' $\chi^2(3) = 14.023, p = .003$). When we use the second indicator, the proportion of children in child labor reduces. The result indicates that about 25% ($n =$

126) of the children in our sample are in child labor. The result for Brong Ahafo region is worthy of note when this second indicator is used. The proportion of children in child labor reduces significantly. We also observe reduction in the proportion of children in child for the other regions when is second indicator is used. The Pearson chi-square test of association between region and the two indicators reveal a significate relationship between region and the frequency of observing child labor. From the Cohen's convention, we would interpret the effect size to be low-medium.

For both child labor indicators, children in the age group of 15-17 had less child labor compared to 12-14 or 5-11 age groups (Pearson' $\chi^2(2) = 53.661, p = .000$ for the first indicator and Pearson' $\chi^2(2) = 38.306, p = .000$ for the second child labor indicator): 55% of 12-14 ($n = 79$), 36% of 5-11 ($n = 83$), and 12% of 15-17 ($n = 16$) are in child labor.

4.4. The Effect of Galamsey on Child Labor

4.4.1. Descriptive Statistics

Descriptive statistics for the variables used in our regression analysis are presented in Table 3. We note that household heads in our sample are aged 53 on average. Overall, male household heads constitute 66% of our sample, while female heads are 34%. The average head of the household in our sample is more like to be married (72%) and own a farm with deed (54%). About 85% of the households have the right to sell their cocoa farm or use the farm as security for a loan. The mean farm size of the household is about 13 acres and the average farm value is about 104,497 Ghanaian cedis (i.e., about US$16,587, using an exchange rate of 6.3 Ghanaian cedis to the dollar).

Table 3: Descriptive Statistics

	Mean	Standard Deviation
Age of head in year	53.088	13.492
Male	0.659	0.475
Female	0.341	0.475
Married	0.722	0.449
Divorced	0.092	0.289
Never Married or Separated	0.041	0.199
Widowed	0.146	0.353
Owned farm, yes with deed	0.539	0.499
Owned farm, yes without deed	0.309	0.463
Owned farm, no	0.151	0.359
Owned farm with right to sell	0.158	0.365
Owned farm with right to use as security	0.104	0.306
Owned farm with rights or use as security	0.587	0.493
Owned farm, no	0.151	0.359
Proportion of child in child labor	0.341	0.475
Mean farm size	13.433	12.605
Value of farm	104497.359	98992.857
Observations	317	

For the galamsey variables, we present in Figure A1, bar plots of the incident percentages of each of the event (word used in describing the effect of galamsey on cocoa production) ordered from the greatest to the least present, coincidence bar plots and conditional coincidence bar plots. The coincidence bar plots are specific for each event. With the coincidence bar plots, coincidence of all the events analyzed appear in light colored bars, and the coincidences of the event represented by the set appear in a darker color. This plot helps to detect with ease what events coincide in absolute terms with a particular event by ordering the bars according to their corresponding percentages of coincidence. As explain in Escobar (2015), with conditional coincidence bar plots, the probability of every event is conditional to the event that is represented;

consequently, the event chosen to be represented does not appear in the plot. The bar with the darker color represents the conditional probability.

A few things should be noted from Figure A1. For the bar plots for incidence of event, we see that destroys, farmlands, galamsey and cocoa are the most frequently used words. These words are followed by water, bodies, productivity, pollute and decrease. The coincidence bar plots show coincidence between events like destroys and cocoa, galamsey and cocoa, farmland and cocoa, water bodies and cocoa, and pollute and cocoa.

4.4.2. Analysis of Probit Results for Child Labor

Table 4 reports marginal effects of the probit model of equation (1). The Wald Chi^2 and the Pseudo R^2 of the models provide an indication that our model is in explaining child labor when we use Indicator 1.

The results show strong influence of how household head's opinions on galamsey effects are largely linked to reduction in child labor in rural Ghana. Household heads in communities that hold the perception that galamsey is affecting their productivity or polluting their land or destroying their farm land are more likely to observe a reduction in child labor. In addition, the negative and statistically significant marginal effect of pollution dummy implies that communities where galamsey have led to serious environmental degradation are more likely to have less demand for child labor on the cocoa farm. Child labor is observed to decline with perception of a decreased in production based on the negative and statistically marginal effect of productivity in our models. For farmers perception of a decrease or destruction of their farmland due to the activities of galamsey also has negative effect on child labor, but this is only significant

at the 10% level and becomes insignificant when we control for household head's characteristics, regional and district dummies.

Table 4: Marginal Effects of Probit Regression Model of Child Labour

Independent	(1)	(2)	(3)	(4)
Variables	Child labor 1	Child labor 1	Child labor 2	Child labor 2
Galamsey	-0.0278	-0.0014	0.0232	0.0085
	(0.0602)	(0.0738)	(0.0552)	(0.0638)
Pollution	-0.2857***	-0.2047**	-0.2115***	-0.1867***
	(0.0624)	(0.0876)	(0.0565)	(0.0649)
Productivity	-0.2409**	-0.1682*	-0.1401**	-0.1054
	(0.0634)	(0.0795)	(0.0624)	(0.0687)
Farmland	-0.1374*	-0.0306	-0.0670	-0.0461
	(0.0621)	(0.0748)	(0.0586)	(0.0.0662)
Education level of head				
Primary		-0.1201		0.0031
		(0.0985)		(0.0954)
Junior high		-0.1170		-0.1088
		(0.0986)		(0.0780)
Middle		-0.1052		-0.0288
		(0.0831)		(0.0725)
Senior secondary or over		-0.2111**		-0.0960
		(0.0926)		(0.0879)
Other head characteristics				
Age		0.0036		-0.0107
		(0.0153)		(0.0127)
Age squared		-0.0001		0.0001
		(0.0001)		(0.0001)
Sex		0.0680		-0.0458
		(0.0844)		(0.0717)
Farm ownership without deed		-0.0623		0.0164
		(0.1108)		(0.0998)
Farm ownership with deed		-0.1353		-0.0122
		(0.1145)		(0.0994)

Holder with right to sell		-0.0725		-0.0349
		(0.0945)		(0.0814)
Holder with right to security		0.0701		-0.1013
		(0.1340)		(0.0896)
Marital Status		Yes		Yes
Region				
Brong Ahafo		0.4148**		-0.0503
		(0.1929)		(0.1466)
Easter and Central		-0.1865		0.0303
		(0.3315)		(0.3548)
Western		-0.0202		0.0278
		(0.1420)		(0.1240)
Districts dummies		Yes		Yes
Constant	0.116	0.652	-0.325*	1.231
	(0.170)	(1.201)	(0.176)	(1.186)
Pseudo R^2	0.0665	0.212	0.0360	0.120
Wald Chi^2	24.27	75.31	11.77	38.34
Observations	317	313	317	313

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Our findings are interesting because Agyei-Manu et al (2020) found that mining had a negative impact on the local community and cocoa production, to the extent that many farmers had to find other sources of income outside of cocoa farming. Boadi et al. (2016) also found that farming dropped from 90% to 76% after galamsey was introduced to their communities, they also found that about 50% of their respondents said that galamsey destroyed land used for cocoa. Thus, these findings support our hypothesis that the effects of galamsey activities results in lower demand for child labor demand in the cocoa sector for the following reasons:

1) Through the loss of farmlands

2) Through the decrease in productive
3) Due to the change in employment of some farmers because of the loss of their cocoa farm or farmlands.

The marginal effects of other control variables including age, sex, farm ownership, marital status, educational dummies, regional and district dummies are mostly not statistically significant. However, a strong positive marginal effect of the regional dummy for Brong Ahafo confirms that child labor is high in that region than in the Ashanti region when we consider the child labor indicator one.

4.4.3. The Effect of Galamsey on Poverty (OLS Results)

Estimates of the poverty model are presented in Table 5. In columns 1, we estimate without any controls expect child labor indicator 1 and galamsey perception variables. We control for child labor indicator 2 and galamsey perception variables in column 3. In column 2 and column 4, we control for household head's characteristics, districts and regional dummies.

For galamsey, we do not find significant effect for the models without controls for household characteristics, district and regional dummies. However, when we control for variables, we find positive and significant effect of galamsey on district poverty rate. The results show that galamsey is associated with roughly a 12 percentage points increase in district poverty rate. These findings provide evidence that is contrary to the objectives of farmers and community members who according to Afriyie, Ganle and Abrafi Adomako (2016), often participate in galamsey because of high poverty and unemployment levels. Specifically, these results suggest that an increase in galamsey activities result in an increase district poverty rate because of the increase in

environmental effects, such as pollution, loss of farm lands, and sale of cocoa farms to galamsey operators (Schwartz Taylor and Taylor 2018).

Across all specifications, child labor is linked to lower levels of poverty. The coefficients on child labor indicators are negative, but statistically insignificant. This observation is in line with studies that find evidence of a link between poverty and child labor (Bhalotra and Heady, 2007 and Bhalotra, 2003).

In terms of education, there does not seem to be significant difference between household heads with education and those without education. We observe a negative but insignificant association between the level of education of the household head and the district poverty rate. Despite the insignificant association, the direction and magnitude of our findings are consistent with previous studies (Abaidoo 2017, Awan et al., 2011; Bilenkisi et al., 2015).

With the exception of household's age, all the other explanatory variables for the household head were insignificant. The OLS estimates indicated that an addition increase in age decreases the district probability rate by about 2%. Our findings indicate that poverty among cocoa farmers in our sample are very much driven household head's region of residence. The strong negative effects for the Brong Ahafo and Central &Eastern regions relative to the Ashanti region show high levels of poverty in Ashanti region.

Table 5: District Poverty Level and Galamsey (OLS Model)

	(1)	(2)	(3)	(4)
	District	District	District	District
Independent Variables	**Poverty Rate**	**Poverty Rate**	**Poverty Rate**	**Poverty Rate**
Galamsey Perceptions				

Galamsey	0.139	0.116**	0.142	0.118**
	(0.0892)	(0.0583)	(0.0893)	(0.0584)
Pollution	0.0232	-0.00708	0.0215	-0.00564
	(0.0975)	(0.0492)	(0.0953)	(0.0495)
Productivity	-0.0302	0.0250	-0.0293	0.0283
	(0.127)	(0.0375)	(0.124)	(0.0370)
Farmland	0.0262	0.0486	0.0273	0.0500
	(0.0937)	(0.0537)	(0.0921)	(0.0539)
Child labor indicator				
Child labor	-0.0386	-0.0443	-0.0597	-0.0303
	(0.0907)	(0.0556)	(0.0990)	(0.0534)
Education level of head				
Primary		-0.0407		-0.0363
		(0.0627)		(0.0630)
Junior high		-0.0382		-0.0371
		(0.0574)		(0.0576)
Middle		0.00755		0.0111
		(0.0589)		(0.0585)
Senior secondary and above		-0.0764		-0.0704
		(0.0792)		(0.0778)
Other head characteristics				
Age		-0.0149**		-0.0152**
		(0.00698)		(0.00704)
Age squared		0.000107*		0.000110*
		(0.0000)		(0.0000)
Sex		0.0415		0.0376
		(0.0628)		(0.0611)
Farm ownership without deed		-0.0675		-0.0639
		(0.0971)		(0.0978)
Farm ownership with deed		-0.0365		-0.0340
		(0.116)		(0.117)
Holder with right to sell		0.0266		0.0287
		(0.0626)		(0.0627)
Holder with right to security		0.0952		0.0905
		(0.0655)		(0.0670)
Marital Status		Yes		Yes

Region				
Brong Ahafo		-1.047***		-1.062***
		(0.0817)		(0.0727)
Easter and Central		-1.233***		-1.221***
		(0.0955)		(0.0971)
Western		0.702		0.705
		(0.562)		(0.557)
Districts dummies		Yes		Yes
Constant	2.735***	4.256***	2.736***	4.246***
	(0.0926)	(0.251)	(0.0864)	(0.248)
Observations	317	316	317	316
R-squared	0.013	0.811	0.014	0.811

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

The study was conducted to primarily assess the effect of informal artisanal and small-scale (galamsey activities) on rural poverty and child labor in cocoa districts of Ghana. Baseline data from an on-going financial diary survey in Ghana with a sample size of 360 was used. To achieve the objective of the study, coincidence analysis, chi-square test of association, probit and OLS models were employed.

Our findings suggest that galamsey activities negatively affect cocoa production, through the pollution of water bodies, destruction of farmlands, decrease in productivity and the forced sale of cocoa farms. Thus, our findings have serious implication for the cocoa sector. Long-term sustainability of cocoa production is threatened by the activities of galamsey operators. Also, the livelihood of cocoa farmers in the cocoa

districts where galamsey operations are on the rise are also threatened because the probability of farmers losing their farmland is high.

On one hand, we note from our probit model that a high degree of galamsey activities resulting in higher levels of pollution and a decrease productivity of cocoa farmers leads to a lower demand for child labor. On the other hand, our OLS results indicate that galamsey increases the district poverty rate. While the reduction in child labor is positive, when one considers the fight towards elimination of child labor, the increase in the district poverty rate and the environmental destruction poses a much more serious threat.

Per our findings, the following recommendations have been suggested for policy making in Ghana. Although, Ghana government is clamping down on illegal mining and pushing people towards legal alternatives, such as the Community Mining Scheme (SMC), the study recommends that the government should commit to long-term transformation of registered small-scale miners so that they can scale to become medium to large scale miners. Such transformation will increase employment opportunities of farmers who may lose their land to legal mining activities. Secure employment means access to sustainable source of livelihood for farmers who move out of the farming sector, this is likely to lead to a reduction in the poverty levels of the districts.

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Appendix

Table A1: Explanation of variables

Variables	Explanation
CHL	This is a binary outcome dependent variable with 1 = child labor and 0 = non-child labor
POVR	This is a district poverty rate.
Independent variables	
Educ	This represents the highest level of education attained by the head of household.
Sex	Household head gender with a dummy for 1 if male and 0 for female.
Mrst	Household head marital status.
Cdist	Household district of residence.
Reg	Household head region of residence.
Fown	Household farm ownership status.
Right	Household farm ownership right
Gal	A dummy for perception of galamsey activities
Pol	A dummy for perception of galamsey activities leading to pollution
Prod	A dummy for perception of galamsey activities leading to reduction in productivity
Fland	A dummy for perception of galamsey activities leading to destruction of farmlands

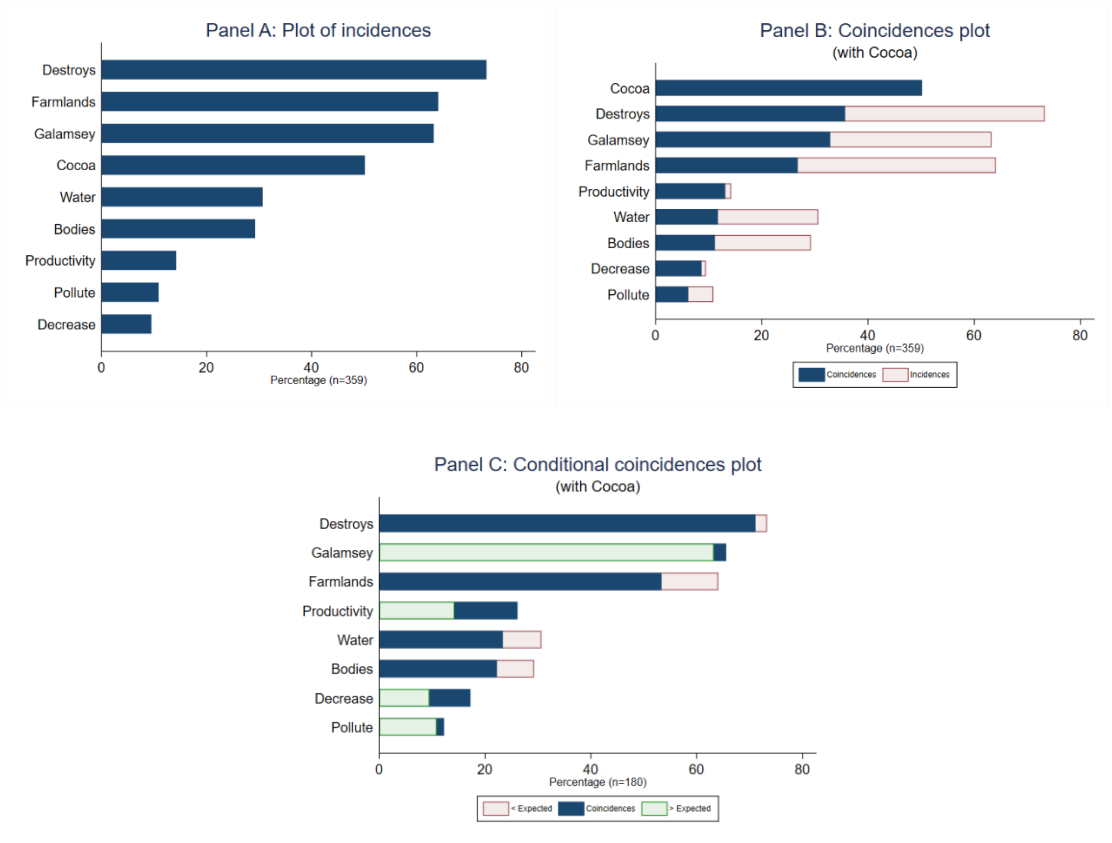

Figure A1: (Co)incidence Bar Plots for Galamsey Effect on Cocoa Production