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Benjamin Faber, Benjamin Krause, and Raúl Sánchez De La Sierra

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Benjamin Faber[*], Benjamin Krause[†], and Raúl Sánchez De La Sierra[‡]

Abstract

We conducted a set of representative large-scale surveys in artisanal mining communities of the "copperbelt" (henceforth copper cobalt belt) of the Democratic Republic of Congo (DRC). This report presents the findings from the surveys, covering the economic wellbeing and health of households as well as the role of artisanal mining for their livelihoods. It focuses on the prevalence, forms and causes of child labor in the copper cobalt belt, and on the organization of the artisanal cobalt supply chain. The surveys were administered in 150 mining communities, sampled by random selection among the 426 we identified in total, and contains information gathered from 2,635 households about all household members (a total of 15,023 individuals). In addition, we conducted separate surveys with 1,575 children, 88 traders and cooperatives, 75 schools and 137 community leaders.

We find that households in these communities are on average poor and vulnerable to income shocks. 60% have relied upon mining for their livelihoods, including 40% during the month of the survey. 90% of all mining labor is in artisanal small-scale mining (ASM), there are no forms of collective labor organization in 65% of mining sites, and overall miners appear to capture a significantly smaller price for their output than traders are paid further downstream in the supply chain of DRC. Furthermore, 11% of children (persons below the age of 18) in these communities work outside of the home, of which 23% (or an estimated 4,714 children in the entire population of the 426 communities) work in the mining sector. Of the children active in mining, more than half are 15 years of age or older, and more than three quarters work as sorters, cleaners or surface workers. Poverty, followed by social norms, is the main reason reported for why the children work in the mining sector. The households of such children are on average poorer, have more children, are more likely to have an adult working in mining, have less education, experience greater anxiety, are more superstitious, demonstrate lower mental attention, and live closer to a mining site than the other households in the mining communities. The children active in mining are on average older, more likely to be male, have less education than their peers and are less likely to be currently enrolled in school.

Our findings are relevant for current debates about responsible cobalt sourcing policies: (1) Disengaging from artisanal mining (reducing demand) can have detrimental effects for a large number of households living in the DRC copper cobalt belt, and while it could decrease the prevalence child labor, it could also increase it due to lowering household incomes; (2) Maintained sourcing from ASM, coupled with providing support and incentives to miners can prevent unintended harm, while reducing the prevalence of child labor; (3) Given the causes of child labor are complex, however, the social impact of interventions targeted at reducing child labor should be rigorously evaluated prior to their implementation at scale.

Keywords: Artisanal mining, responsible sourcing policies, Democratic Republic of Congo
JEL Classification: F23, F63, O24, O55

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Benjamin Faber, Benjamin Krause, and Raúl Sánchez de la Sierra designed and directed this project, and retain academic independence including full ownership of the data. Benjamin Faber and Raúl Sánchez de la Sierra, the faculty, have received no financial compensation for this project. Benjamin Krause, graduate student at UC Berkeley, has received a standard graduate student stipend for the work on this project. No attempt has been made to influence our report by any stakeholders. All statements, findings, and errors are fully our responsibility.

1 Executive Summary

1.1 Key Findings

Livelihoods 1: Poverty. Households in the mining communities of the DRC copper cobalt belt are poor. Adjusted for local currency purchasing power, the average per capita monthly household income is USD 35. Two-thirds of households report being worried about not having enough to eat (See Section 4.)

Livelihoods 2: Vulnerability. Households in the mining communities of the copper cobalt belt are likely vulnerable to income fluctuations. Households have limited ability to save (monthly incomes nearly match monthly expenditures). The value of household assets that can be easily liquidated is equivalent to about two months of household income. Households engage in informal risk sharing through various forms of borrowing, but while such networks might be effective at insuring against household idiosyncratic shocks, they would not be effective to insure against aggregate sectoral shocks, which can arise from changes in the cobalt supply chain (See Section 4).

Livelihoods 3: Importance of mining for livelihoods. 60% of households in the mining communities of the copper cobalt belt have mining as a source of revenue for their livelihoods, currently or in the past. 40% of the households relied on mining as a source of their income during the month of our survey (See Section 4).

Prevalence of child labor 1: Work outside the household. 11% of children between the ages of 3-17 in the mining communities of the copper cobalt belt work outside the household. In addition, 57% of children between 3-17 perform domestic household tasks (See Section 5).

Prevalence of child labor 2: Work in the mining sector. Of the 11% of children who work outside the household in the mining communities of the copper cobalt belt, 23% work in the mining sector. In contrast, close to 50% of the children who work outside the household work in agricultural activities, and 30% as domestic labor for other households (See Section 5).

Prevalence of child labor 3: Children as a share of the mining labor force. Of the mining labor force living in the mining communities of the copper cobalt belt, 13% are below the age of 18, a total of 4,714 children. Of these minors, 51% are 15-17 years old, 41% are 10-14 years old, and 8% are younger than 10 (See Section 6).

Forms of child labor: Age and activities. Children living in the mining communities of the copper cobalt belt who work in artisanal mining are mainly sorters (26%), surface workers (23%), and cleaners (17%). Children older than 15 years work mostly in surface excavation (26%), followed by cleaning of minerals (19%). Children younger than 15 years work mostly in sorting of minerals (38%), followed by surface excavation (18%). Considering those under 18 who directly excavate (subterranean or surface), 65% of them are 15 or older (See Section 6).

Causes of child labor 1: Poverty and social norms. Poverty is the main reported cause of child labor in the mining communities of the copper cobalt belt. The most frequently reported reason for why children work outside the household is to generate additional income for the household. Furthermore, child labor outside the household is more than twice as prevalent among the poorest 20% of households (where 23% of households report at least one child to be working) compared to the richest 20%, where the fraction is 9%. The second most reported cause are social norms: 25% of households report that children work outside the household to give a good public impression of the household. (See Section 7).

Causes of child labor 2: Characteristics of households with child labor in mining. Households that report mining child labor in the mining communities of the copper cobalt belt are significantly larger, poorer, and less educated. They live closer to the mines and are more likely to have an adult that works in mining. These households have 7.8 household members on average compared to 5.7 in other households, have 40% lower monthly income, and their children have on average less years of schooling than children of other households of the same age. On average they live 4.0 km from a mine, compared to 6.5 km for other households, and have lived in the area 12.8 years, compared to 9.5 years for other households. While 87% of these households have (or have had) an adult engaged in the mining sector, 61% of the other households do (See Section 7).

Causes of child labor 3: Psychological well-being of individuals in households with child labor in mining. Though they do not score significantly differently on IQ tests, the typical respondents of a household with mining child labor have significantly more anxiety and are more likely to hold superstitious beliefs. They perform significantly worse at psychological tests of mental attention as indicated in the results of the Stroop test, low levels of which are often attributed to anxiety (See Section 7).

Causes of child labor 4: Characteristics of children working in mining. Children working in mines are on average 5 years older than other children, are more likely to be boys than girls, have less education for their age, and are less likely to be currently enrolled in school. In addition, as they are on average one rank higher in the order of birth among siblings, they are more likely to be the elder son (See Section 7).

Supply chain 1: Artisanal mining. 90% of miners living in the mining communities of the copper cobalt belt work in artisanal mining. Of the the artisanal miners, 74% extract from artisanal mining sites while 16% extract from open spaces of industrial mining sites. However only 10% of those working in mining have been employed by an industrial mining company (See Section 8).

Supply chain 2: Price received by artisanal miners. Artisanal miners living in the mining communities of the copper cobalt belt capture a relatively small share of the price paid for their output downstream. The price that miners receive directly for selling the most commonly traded cobalt purity to intermediaries in the supply chain is less than half, and potentially as low as 6%, of the price-by-weight for the equivalent cobalt purity that traders farther down the supply chain obtain from their sale of the mineral to processors in the DRC (See Section 8).

Supply chain 3: Labor organization and the state. In 65% of mining sites of the copper cobalt belt, the only form of labor organization is small teams of workers. This lack of collective organization may contribute to low bargaining power of labor, which could explain why miners receive such a low share of the downstream price of output. In addition, agents from the secret service and the presidential guard are frequently present at the mines (See Section 8).

1.2 Implications for Artisanal Mining Policy

(1) Disengaging from artisanal mining can have detrimental welfare consequences. Since a significant number of households, and children, depend on artisanal mining for their income, interventions that reduce demand for artisanal mining output are likely to harm the livelihoods of children and families living in the copper cobalt belt. The risks are especially high because households are poor, have limited ability to save, and are particularly vulnerable to regional demand shocks. Furthermore, since the search for additional household income is the primary reported cause of child labor, negative shocks to artisanal mining income, by inducing households to search for alternative and less profitable activities, could in principle increase child labor in the region. For these reasons, efforts to reduce or eliminate the sourcing of artisanal cobalt that are not coupled with income support for affected families risk harming thousands of households in the copper cobalt belt region.

(2) Maintained engagement coupled with support can help prevent unintended harm. Maintaining sourcing relationships, while at the same time providing incentives and support to local households to voluntarily reduce child labor, can achieve the objective of reducing child labor without putting livelihoods at risk or imposing the burden of adjustment on local communities. Such an incentive-based approach could be based on, for example, offering accurate machine readings of mineral content at the mines or conditional cash transfers in exchange for a new and strictly enforced rule to not let children near the mining sites. Such approaches could reduce child labor in the supply chain while at the same time protecting local livelihoods.

(3) Interventions should be rigorously evaluated prior to implementation at scale. Child labor in the cobalt mining sector is a critical and complex issue, and at this point, given the uncertainty and risks involved, there is insufficient evidence on which to base a responsible sourcing strategy. This survey provides a detailed and representative account of artisanal mining communities, and should enable the design and subsequent evaluation of smaller-scale interventions to identify the most effective approaches to the issue of child labor in the copper cobalt belt. Much like providing an untested drug to a sick population, interventions implemented without prior testing through smaller-scale impact evaluations can risk being less effective, and potentially harm the beneficiary population at large when their consequences are not well understood prior to implementation. Compared to implementation to scale without prior testing, evaluations maximize the potential impact of the selected intervention for the largest number of people.

2 Background

In this section, we briefly discuss the background of this survey in terms of the policy relevance as well as the existing work on child labor and responsible sourcing.

2.1 Responsible Sourcing, Child Labor, and the Role of this Study

Drastic reductions in trade and information costs across borders have led to the proliferation of global supply chains that link consumers in rich countries to workers in developing countries. These workers enter the global supply chains of multinational enterprises (MNEs) because labor costs are low, but also because their governments are often unable to enforce labor regulations that exist in developed nations to protect workers. In this context, MNEs have increasingly come under pressure from non-governmental organizations (NGOs), consumers and regulators to "clean up their supply chains" and implement responsible sourcing policies (RSPs) to guarantee that their products are not exploiting limited worker protections in the poor countries from which they source inputs to the detriment of workers' human rights.

One of the most prominent examples is cobalt sourcing in the Democratic Republic of the Congo (DRC). Cobalt is an increasingly important input for advanced batteries often used in consumer electronics and electric vehicles. The mining region in southern DRC known as the "copper belt" (henceforth copper cobalt belt) hosts the world's single largest known cobalt reserve and accounts for approximately 50% of the known global stock of cobalt. As a result, cobalt exports from the DRC currently account for more than half of world trade in cobalt. In 2016, the Washington Post and Amnesty International published investigative reports describing the rapid rise of cobalt exports from the DRC, and raising awareness to the prevalence of child labor and the precarious working conditions among artisanal small-scale mining (ASM) sites in the region.

This report is based on a large-scale data collection effort to provide a representative picture of the status quo among ASM communities in the copper cobalt belt. Our data collection focuses on understanding the economic well-being of households, the role of mining in their livelihoods and the prevalence, forms and causes of child labor in ASM and other economic activities. The objective is to contextualize the insights about child labor in ASM within the region's broader socio-economic environment.

2.2 Artisanal Mining in the DRC: What We Know So Far

In this section, we briefly discuss related existing work. We begin by reviewing some of the academic work in this area, and then discuss recent advocacy and policy work.

2.2.1 Academic Research

The academic literature supports the observation that hazardous forms of child labor, in particular for the youngest, can have detrimental consequences. Working with cobalt has been associated with negative health consequences (e.g. Sauni et al 2010; Nordman et al, 2010). In addition to the health concerns, coercive forms of labor (forced or exploitative), can have adverse long-term consequences, not just for the children themselves, but also for societies as a whole (e.g. Nunn 2008; Dell 2010; Lowes et al 2015; Lowes and Montero 2017).

However, solutions to existing forms of child labor are not straightforward and require complex considerations. Basu and Van (1998) argue theoretically that banning child labor can, under certain conditions, worsen the welfare for the poorest households, while under others, it can lead the economy to a better equilibrium. Baland and Robinson (2000) model the local economy and their results suggestthat the net effect of labor bans depends on the local labor market adjustment. Such adjustment in turn depends on the response of adult wages to changes in the supply of child labor. Child labor bans will theoretically depress the welfare of households, unless such changes result in a sufficiently large increase in the wage of adults.

Furthermore, the empirical evidence suggests that banning child labor, or cutting demand from sectors with child labor, can have detrimental effects on households and children. Evidence from the introduction of a child labor ban in Brazil indicates that the ban had long-term negative effects for marginalized families (Piza and Portela Souza 2016). Studies of the de facto mining embargo in Eastern DRC following the passage of the Dodd-Frank act have found significant unintended consequences (Seay, 2012). Paker and Vadheim (2017), for instance, report that "evidence suggests that the legislation increased the probability of civilian looting by at least 143% and that it increased the probability of battles in territories endowed with unregulated gold."

The message that emerges from the existing theoretical and empirical literature on child labor is that i) the welfare consequences of interventions are unclear, and ii) no proven solutions exist if the objective is to limit child labor while also preventing the deterioration of the livelihoods of children and their families who rely on child labor.

2.2.2 Policy, Advocacy, and Reports from the DRC

Multilateral institutions including the ILO, UNICEF and OECD have reported extensively on the dangers and potentially effective policy responses to ASM and child labor within the mining sector (ILO 2013; UNICEF 2014; OECD 2015). ASM in the DRC in general and within the copper cobalt belt in particular has been the focus of considerable attention. Our conclusions are enriched by this body of work and, in particular, on the past two decades of data, briefs, studies and reports generated by stakeholders in the private, public and social sectors. From this work we know that in the 1990's, ASM was quite rare in the region. It was not until the mining liberalization of 1999 and the subsequent policy changes of the early 2000s ending the government's effective monopoly on mineral extraction that ASM began to expand to the levels that we observe in this report.

There is considerable variance in the estimates for how significant this sector has become in the copper cobalt belt, but estimates range between 50,000 to 250,000 are common with most falling between 100,000 to 150,000 (Promines 2010; World Bank 2008). Furthermore, reports of child participation in mining are generally between 20,000-40,000 (Dibwe 2008; UNICEF 2014; Amnesty International 2016), with the World Bank (2008) estimating that "children comprise 40 percent of artisanal miners or are present on artisanal mining sites as members of the family."

In general, the higher estimates mentioned above tend to be across the whole of the ex-Katanga region and not focused exclusively on ASM in copper and cobalt. An exception is Tsurukawa et al (2011) who report that "cobalt mining is estimated to provide employment to between 67,000 and 79,000 permanent full-time miners [and] 90,000 to 108,000 workers" during peak season. Furthermore, Vanbrabant et al. (2009) reported that "between 19,000 and 30,000 of children under 15

years of age, and 9,000 to 15,000 of children aged between 15 and 17 years are estimated to work in artisanal cobalt mines." Vanbrabant et al. went on to report that ASM production accounts for 60 to 90% of total cobalt production in the DRC.

As most reports acknowledge, data collection within the DRC is particularly challenging and as such most research has instead been more qualitative than statistical in nature, providing important contributions to through descriptions of communities and living conditions. For instance, while there is a negative correlation between ASM activities and school attendance (Dibwe, 2008), it also appears to be the case that children rely on ASM to extend their schooling (Godin and Andre, 2014, Pact, 2013). Furthermore, the phenomenon of child labor in ASM appears to be often voluntary or, perhaps more accurately, the response of societal norms as opposed to forceful coercion (World Vision, 2013). Supporting the results in our study, there is evidence that efforts to set top-down restrictions or embargoes may cause harm (Pact, 2016; Saey, 2012).

This report aims to provide a useful and representative update and extension to existing data on the region, and ASM mining in particular. Insofar as we are aware, it is the first to be based on a randomly selected representative sample of the mining communities of the copper cobalt belt and the first to survey more than 250 individuals.

3 Study Methodology

In this section, we describe the methodology that we followed.

3.1 Definition of Children and Child Labor

For the purposes of this report, unless explicitly stated otherwise, "child" refers to a person who has not yet reached 18 years of age. "Child labor" refers to income-generating or livelihood-supporting activities performed by a person who has not yet reached 18 years of age. We distinguish between labor performed inside and outside the household, as well as different types of activities outside the household (such as in agriculture, mining, mineral processing as well as different tasks performed within the mining sector).

3.2 Research Goals and Outcomes of Interest

The first step of the research methodology is to define the goals.

First, this research aims to depict the socio-economic context of the households affected by the mineral supply chain: how rich or poor are they? What is the nutritional and health status of their household members? How vulnerable are they to income shocks? This leads us to focus, in particular, on the role of mining in household economic livelihoods. Answers to these questions provide insights about the likely consequences of changes along the supply chain such as the imposition of new production standards that limit the demand for ASM output in the region.

Second, we aim to study the prevalence of child labor among mining communities in the copper cobalt belt. Given the challenges of the data collection environment in this region and widespread policy interest in these questions, we view this element of our study as particularly relevant. The types of questions this part of our data collection allows us to answer are for example: how much child labor do we observe in these communities? Do the majority of children who work for money

outside the household work in mining-related activities? What resulting share of the labor force in the mineral supply chain is composed of children? How does the prevalence of child labor vary by gender and age?

Third, we aim to study the forms of child labor in the supply chain: What tasks do children perform? Do they excavate in subterranean mines where the potential for toxic exposure and risk to health and safety are highest? Do they play other roles throughout the supply chain? How do these outcomes differ across ages or gender? Answers to these questions may inform the future targeting of interventions.

Fourth, we aim to collect information about the underlying reasons for child labor. Identifying and understanding the root causes of a problem are key to designing a solution. For instance, an effective intervention for parents who send their children to work because of they are unaware of the benefits of extra years of schooling could be quite different from an effective intervention for parents who fully understand the trade-off but will not be able to feed their families without the additional income their child's labor provides. Also, are the majority of children working in mining forced to work, or do they make their own decisions?

Finally we also aim to study the supply chain. Understanding the properties of the supply chain that are relevant to the welfare of households and the question of child labor implies studying the properties of mining sites, social organization at the mines, bargaining power of miners, the presence of armed forces at mines, as well as the characteristics of mineral traders and cooperatives. Linking traders to individual mining sites and understanding the difference in the prices received by ASM workers relative to the market value of their output will provide important insights that could inform future interventions aimed at fostering responsible sourcing in the region.

3.3 Study Population and Sampling Framework

As we describe below, we have identified a total of 426 mining communities, from which we randomly sample 150 study areas for our data collection. We focus on these communities in this study as they host the local population that is most likely to be affected directly and significantly by changes in the way that multinational supply chains decide to engage with the ASM sector. Our sampling strategy is also supported by previous studies. Indeed, there is evidence that 90% of miners live within 5km of the mining site (and 100% within 11km) (Dibwe, 2008).

3.3.1 Sampling of Communities

In a first step, we define our sampling frame (the population from which we sample): what overall population are we interested in learning about? An important challenge is the absence of recent census micro-data for the copper cobalt belt region that would allow us to map the population across dis-aggregated units. To address this challenge, we first identified the universe of active mining sites in the region. Our local research team spent several months identifying active mines and mining communities as well as gathering other preliminary data as they traveled throughout the copper cobalt belt region (extensively covering all areas through various methods). We combined these data with GPS points of mining sites from the Carter Center and a collection of 6 different data sets generated by previous studies that were provided to our research team by RCS Global. Using GIS, we defined a unique mining site in this combined data set as any point located at least

500 meters from any other point. We then visually inspected satellite imagery of each site and manually generated polygons outlining its active mining area. To this set of mining polygons we added two additional data sources. First all polygons identified as mining sites on Open Street Maps. Second a set of mining polygons provided by PACT. The result is a map of 180 distinct mining sites.

To ensure that we are not missing any mine or mining community, we generated a selection catchment area mapped at a 5km perimeter from the edge of each distinct mining site polygon. Of the 401 GPS points representing communities identified by our field team, 22 fell outside of the selection catchment areas. For each of these communities, we verified through both the field teams as well as through visual inspection of satellite imagery that there were not any additional mining sites within their proximity that we had not already identified. Of the 180 polygons representing mining sites, 24 did not have any identified mining communities within their selection catchment area as reported on-the-ground by our field team. To further ensure that there were no systematic omissions, for each of these 24 mines we used satellite imagery to identify all human settlements within a 2.5km catchment area. The result was an additional 47 potential mining communities all of which were added to the selection set.

To ensure our sample was representative in spite the considerable variance in the population of settlements surrounding mining sites in the region, we defined a "mining community" as an administrative unit of not more than 300 households whose closest boundary lies within 5 km of the edge of at least one extraction site and whose population is to some degree engaged in mining. Camps, villages and towns whose total population was reported by our field team as less than this threshold were each considered one community and were added as one unit into our selection set. For villages, towns, neighborhoods and cities with more than 300 households, we worked with local leaders to map the lower-level administrative units so to identify the level(s) for which each unit would have a population below the threshold. We then considered each of these lower-level administrative units as a separate mining community for the purposes of our sampling, and added each to our selection set. We discarded the 22 mining communities that fell outside of the 5 km catchment area mentioned above.

This provides the universe of administrative divisions with communities linked to mining in the copper cobalt belt (our sampling frame). In the end, the sampling frame consists of 426 communities, connected to 180 mining sites throughout the region. The total imputed population of all mining communities in our sample frame is 436,689. It is important to note that the study was designed to obtain representative data of the population living in mining communities, and not of the labor force working at the mines. While very closely related, as we will see in our data, not everyone in a mining community works at the mines. More importantly, while likely a significant majority, it is unlikely that all of those who work in the mines live in mining communities. Finally, from this sampling frame, we randomly selected 150 mining communities for the data collection. This provides a large share of the total population among mining communities in the DRC copper cobalt belt, and hence a representative sample with large statistical power to detect statistics and correlations with reliable precision.

Figure 1: Universe of 426 Copper Cobalt Belt Mining Communities

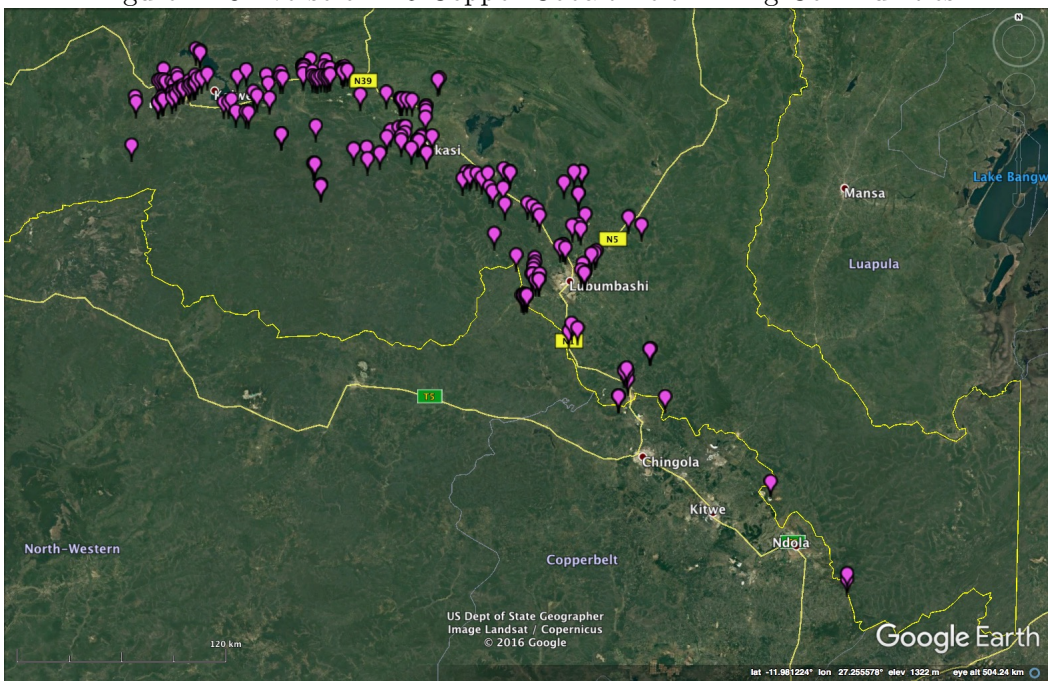
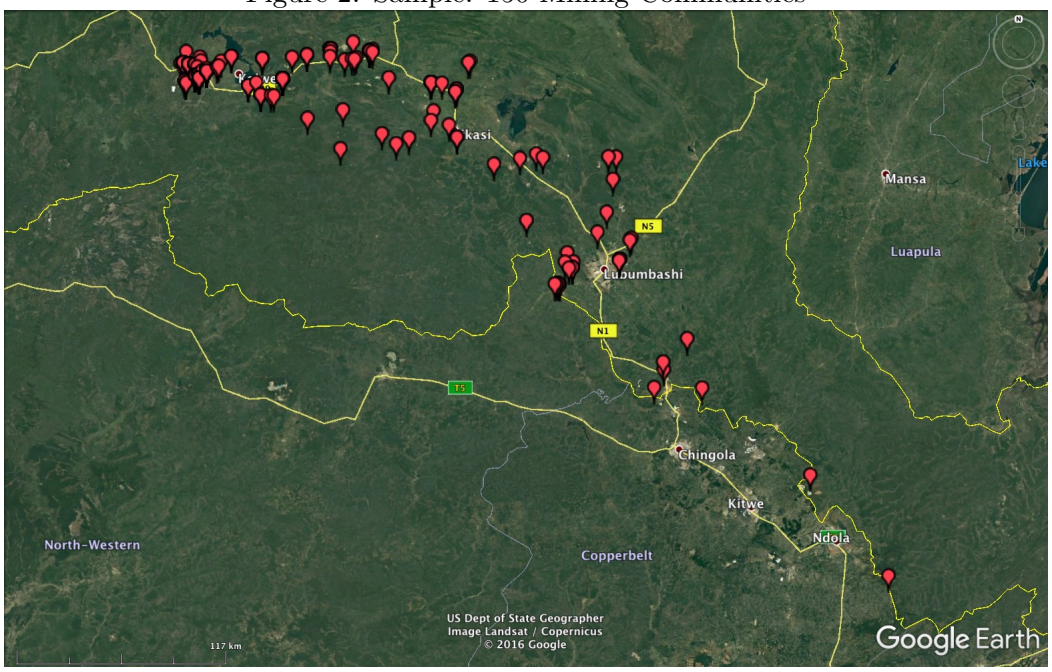


Figure 2: Sample: 150 Mining Communities



3.3.2 Sampling of Households

Within each of the 150 mining communities, we administered the survey to a random sample of 18 households. In most cases (>60%), selection was based on a complete listing of local households in the community. The survey team leader first divided the total number of households by 18. The community leader was then asked to randomly select a number between 1 and 18, which we label N. Starting with N as the first household to be interviewed, the team leader then selected

every N/18th household on the list. Each thereby selected household was then interviewed. For the situations where a list was not available and the community did not wish to produce one, the team would start from the center of the community and follow the direction of a randomly dropped pen to interview every N/18th house they encountered. For each household that we interviewed, we took note of the rate of non-response for the household and the reasons (for instance, because no one was home). The resulting household level non-response rate was 12.5% (all of the missing households were then replaced by another randomly selected household). This number is relatively low in comparison with other surveys in the same province (Humphreys, Sanchez de la Sierra, and Van der Windt 2017), and suggests that the numbers we obtain are unlikely to be driven by selection bias (see further discussion below).

3.3.3 Sampling of Household Members and Children

The last step in the sampling process was to determine who to interview in each household. In each household that provided informed consent, we identified all "responsible individuals of the household" – those who had knowledge of household incomes and expenses and decision making authority within the household – and randomly selected one among such individuals for each household. A surveyor, using a tablet-based randomization application embedded in the survey, whose implementation we monitored, randomly selected one from this list to complete the Household Survey. During the remainder of the household level interview, the surveyor asked this person, henceforth the respondent, to provide information about each individual in the household including him or herself. Additionally, for each household with members younger than 18 years, the surveyor randomly selected one of these members using the tablet and invited to complete the Child Survey. This survey was conducted in the absence of the household's adults and with the assent of the child respondent.

3.3.4 Sampling of Community Leaders and School Principals

Within each of the 150 sampled mining communities, we identified the community leader, and administered a Community Leader Survey. For communities with exactly one school, we administer the School Principal Survey to the school principal of that school. For those communities with more than one school, only the principal of the largest school was selected, as determined by student enrollment which we obtain from the community itself.

3.3.5 Sampling of Traders

We initially identified 146 entities to interview (traders and cooperatives), and it was our intent to sample this identified universe of traders and cooperatives. However, during the two weeks that the survey was conducted, only 95 of those identified were found to still be open and operational. Furthermore, 16 declined to be interviewed. We thus complete 79 interviews or 83% of the identified universe at the time of the survey.

3.4 Measurement Strategy

We next present the five survey instruments we designed.

Tool	Sample
Household Survey: Head of Household	We interview one "responsible individual of the household" (person in charge of household finances with decision making authority), and obtain information on health, labor supply, time use, income, and expenses for all members of the household as well as information about the mines where members of the household have worked.
Household Survey: Child Module	In each household with members younger than 18 (and at least 5 years old), we randomly select one of these members among those that are available for an interview within a reasonable time frame, and to that individual, we ask a subset of the questions of the main survey. For this module, we administer the survey in the absence of other members of the household.
Community Leader Survey	In each mining community, we interview the community leader. We obtain private conversations about the characteristics and the composition of the community, access to public services and infrastructure, sources of income, and expenses. We also obtain information about mines related to the community.
School Principal survey	For each mining community with a school, we interview its principal (where there are more than one, we interview the principal of the largest school in terms of students). The principal provides information about the quality of the school and school attendance as well as information about the activities of children in the community including in relation to mining.
Trader and Cooperative Survey	We interview traders and cooperatives to obtain information of where they source their minerals, where they sell their minerals, frequency, quantities, prices, and about their awareness and perceptions of child labor.

3.5 Presentation of the Results

The majority of our findings in this baseline study will be presented in one of two formats. Figures 3 and 4 describe the typical structure we use to present the results in this report.

Figure 3: Presentation of the Basic Statistics in the Report (1)

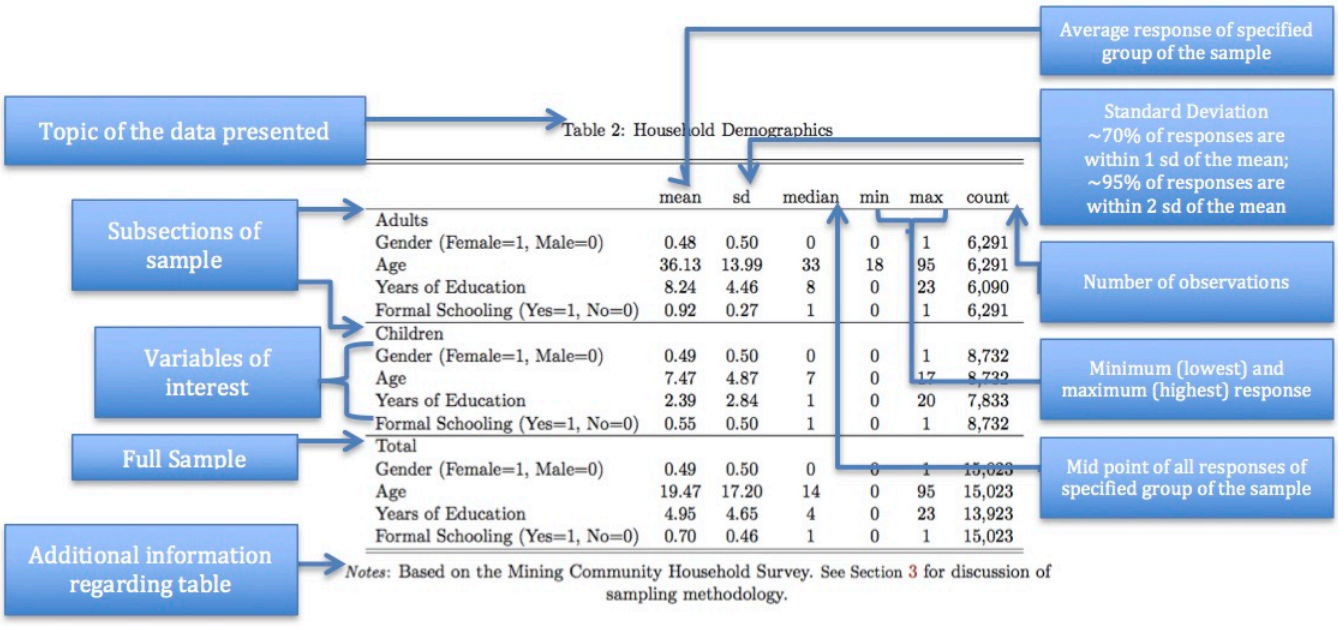


Table 2: Household Demographics

	mean	sd	median	min	max	count
Adults						
Gender (Female=1, Male=0)	0.48	0.50	0	0	1	6,291
Age	36.13	13.99	33	18	95	6,291
Years of Education	8.24	4.46	8	0	23	6,090
Formal Schooling (Yes=1, No=0)	0.92	0.27	1	0	1	6,291
Children						
Gender (Female=1, Male=0)	0.49	0.50	0	0	1	8,732
Age	7.47	4.87	7	0	17	8,732
Years of Education	2.39	2.84	1	0	20	7,833
Formal Schooling (Yes=1, No=0)	0.55	0.50	1	0	1	8,732
Total						
Gender (Female=1, Male=0)	0.49	0.50	0	0	1	15,023
Age	19.47	17.20	14	0	95	15,023
Years of Education	4.95	4.65	4	0	23	13,923
Formal Schooling (Yes=1, No=0)	0.70	0.46	1	0	1	15,023

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Figure 4: Presentation of the Basic Statistics in the Report (2)

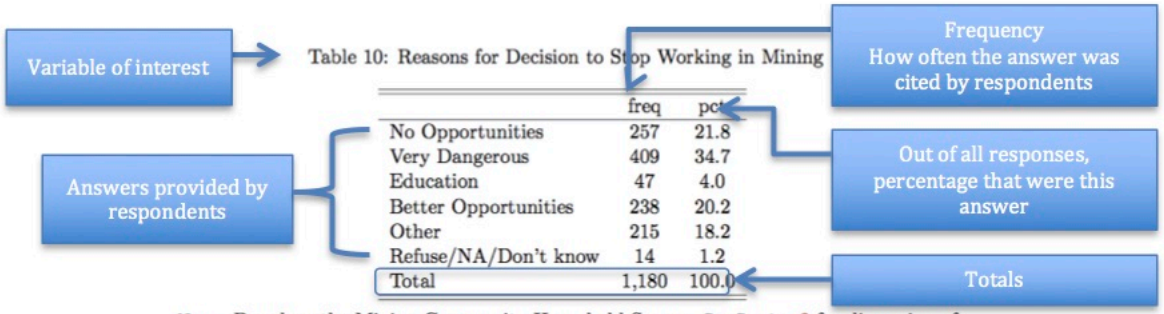


Table 10: Reasons for Decision to Stop Working in Mining

	freq	pct
No Opportunities	257	21.8
Very Dangerous	409	34.7
Education	47	4.0
Better Opportunities	238	20.2
Other	215	18.2
Refuse/NA/Don't know	14	1.2
Total	1,180	100.0

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

3.6 Ethics of the Research

Considering the vulnerable nature of the subjects involved in the research, the potential impact of the research on their lives, and the diversity of stakeholders and interests involved, this research was conducted in strict observance of ethical research standards.

Ethics and Human Subjects: This survey has been overseen and approved under Protocol ID 2016-07-8989 by the Committee for Protection of Human Subjects (CPHS) and the Office for Protection of Human Subjects (OPHS), which serve as Institutional Review Board (IRB) for the University of California, Berkeley. Institutional Review Boards of US universities oversee the

ethics of the research designs, survey instruments, and interventions, as well as their compliance to current research legislation.

Financial disclosure: The cost of conducting such research in the field (which includes compensation and travel costs of 50 surveyors, supervisors, storage, office costs, etc) has been covered through a grant from the Center for Effective Global Action (CEGA) of the University of California, Berkeley. The grant was supported by the following private sector entities: Apple, BMW Group, Samsung SDI, Sony and other anonymous sponsors. Benjamin Faber and Raúl Sánchez de la Sierra received no financial compensation from the grant. Benjamin Krause received a graduate student stipend for the duration of his engagement in the management of operations within the steps defined by UC Berkeley for standard compensation of graduate students to cover against his academic duties at UC Berkeley.

Academic independence: The research team retains academic independence and full legal ownership of the data and full discretion in the publication of results. The sponsors had no influence on the results or analysis of this study, nor did any of them attempt to exert influence or pressure.

Accountability: All results and statements included in this report are the sole responsibility of the research team: Benjamin Faber, Benjamin Krause and Raúl Sánchez de la Sierra. Similarly, all errors are our own.

3.7 Statistical Limitations and Threats to Validity

To the best of our knowledge this study represents the sole comprehensive data collection exercise among mining communities in the DRC copper cobalt Belt. Nonetheless, the study is not exempt of possible shortcomings. We next describe a number of important methodological limitations. Most of these affect any similar study based on survey interviews, which is often the only way to obtain data on social outcomes.

Representativeness. Because we randomized our selection of mining communities, summary statistics within this report can be interpreted as representative for the entire population of mining communities as defined above. Using these numbers to extrapolate to higher-level administrative units (including provinces or the entire country) would be misleading and biased in unknown magnitude and direction. The relevant "sampling frame" must remain in mind when interpreting the numbers. Our definition directly reflects the goals of the study, but it needs not be a universally accepted view of what "mining communities" constitute. Discussing the findings independent from the sampling frame can cause confusion and yield misleading implications.

Omission of Communities. If our mapping exercise failed to include some mining communities in the sampling frame, or included others erroneously, this might lead us to mis-represent the typical household in mining communities of the copper cobalt belt as defined by our sampling strategy,. Though we have sought to identify the universe of mining communities, given the challenges in the region, the limitations in communication and the paucity of available administrative records, our selection may include both errors of exclusion by missing communities that should have been a part of the selection set, and errors of inclusion by mistakenly including communities that did not fulfill all of our criteria. In only two of our initial 150 selected mining communities

were we unable to administer the survey. Both of which were replaced by an additional community which we had drawn as part of an alternate list as part of the original sampling. Furthermore, for two additional communities of our initial 150, we found ex-post that they had been included by error. Both of these were also replaced by alternates as before. It is extremely unlikely that these replacements skewed our findings.

Selection of Households. Our numbers represent the typical household that we were able to find. Such household might differ from the typical household living in these communities, if those that are not found with a reasonable level of effort are systematically different than the rest. Given the constraints discussed earlier, for nearly 40% of our communities, the households were sampled using a different methodology than our preferred approach. This introduces heterogeneity in the data collection methodology, which, while unlikely to bias the responses, could introduce measurement error. In addition, some households refused to participate in the survey despite the remuneration that we offered. Even though the resulting non-response rate of 12.5% is relatively low in this context, we cannot rule out the possibility that these constraints have led us to systematically bias the types of households we were able to sample. Note, however, that the magnitude of the bias created by a 12.5% response rate is unlikely to be large - it could only be large if the 12.5% of households that did not respond were systematically different with an extremely high average difference. In contrast, if the missing households are approximately similar to the majority of 87.5% that we were able to identify, the bias will be zero.

Seasonal Variation. Seasonal changes in household activities and economic conditions might lead us to bias our measurement of the yearly average economic situation of the households. As is common in most household surveys, due to the difficulty to recall yearly expenditures or incomes, most of our questions ask about expenditures in the prior week and month.

First, since our survey was administered in the fall, if households are disproportionately working in agriculture during the rainy season, our numbers might be representative of household activity in the rainy season, but not necessarily of their activity during the entire year.

Second recent price fluctuations for cobalt might change the cross-sectional picture we are able to draw in the short term. As such, the results of this study may also be sensitive to commodity price fluctuations and should be interpreted as representing a particular time frame in the recent context.

Finally, as already mentioned, the policy environment was changing within the country even as we were starting the surveys. Such process might have influenced people's sensitivity to the issues asked in the survey.

This source of bias does not jeopardize the validity of the study, which is still unbiased for the period studied. It just suggests that if one is interested in a picture of the region for the dry season, for instance, minor adjustments to certain numbers (not all), might be necessary.

Selection of Traders. Traders and cooperatives experience significant turnover. This can undermine the representativeness of the traders we were able to interview. For instance, only 65% of those entities identified during the mapping phase of our research were found to be fully operational at the time of our full survey. It is possible that as these entities exit and enter, we may

be missing new ones or new locations in the region. Furthermore, of the universe of entities found to be fully operational, 16% refused to participate in the survey. If those that refused are systematically different than those that did not, we may be systematically misreporting characteristics of the typical trader. Finally, as our survey asks questions that could reveal sensitive information in a competitive market environment as well as illicit behaviors, we would expect strategic non-responses. In this context, our survey data can only reveal information about the typical trader that chooses to participate and answer our questions.

Enumerator Shirking and Entry Errors. If surveyors shirk or fake data entry, this can seriously harm the credibility of our data. We put in place a system of quality management to be as confident as possible that this did not happen. Each person hired to our team had significant and regionally specific experience in enumeration. Furthermore, we spent two weeks training them in the specifics of these particular survey tools. As all survey tools are completed on tablet computers we were able to significantly guard against many common entry errors by restricting potential answers, and we avoid any data entry errors common in the transfer of paper surveys into digital data. For further oversight, we had three independent accountability systems in place to further reinforce data quality.

- First, the tablets were programmed with a series of monitoring tools of which the enumerators were aware but over which they had no control or visibility in the implementation. These included timing the duration of each survey and the time between surveys, recording of multiple GPS readings throughout the survey (and comparing these against each other as well as against the community centroid), and random audio recording of the interview itself through the tablet's built-in microphone.

- Second, we monitored the data remotely in real time. Because the data was collected on tablets, and most teams were able to gain access to the internet by the end of each day in the field, we were able to have near-real-time updates in how each of the teams were advancing. We then designed a set of criteria to monitor and grade performance to identify potential outliers and ensure the overall integrity and quality of the data reported.

- Third, we operated a team of back-checkers who traveled a week behind the rest of the survey teams. This team randomly re-interviewed households to verify compliance of our enumerators with the survey protocol, as well as to ask a randomized subset of the questions in the survey to verify the reliability of the reported answers.

In spite of these data quality management tools, this survey relies heavily on the skills and commitment of each enumerator, and as such is still vulnerable to data entry errors and shirking. This is especially true with regards to the care and deliberateness of questions requiring calculations and recall data.

Strategic Misreporting by Respondents. There are two main concerns regarding misreporting by households. The first is that households could under-report their economic wellbeing in the hope of receiving handouts or transfers. We believe this concern to be of limited relevance because i) our survey protocol was explicit in giving households the information that our data

collection had no link to any kind of social programs, and ii) because of the relatively infrequent presence of NGOs or other social programs among the 150 communities. The second concern relates to strategic under-reporting of child labor by the heads of households. Even though child labor is not associated with social stigma according to local norms in this region (which we also confirm in our survey data below), it is still possible that recent public pressure and developments on the ground surrounding child labor may have influenced the answers of households in mining communities. In general, we found little evidence that local households were aware of the sensitive nature of this issue on the part of Western downstream buyers. However, we also attempt to address remaining concerns in several ways. First, we collect information from various sources. In addition to interviewing the heads of households, we also interview children separately from their parents, and we interview school principals and village leaders asking about the prevalence of child labor.

Having discussed the potential limitations of our study, we note that most if not all of these concerns are challenges that would apply to any data collection effort on this subject and in this region. To the best of our knowledge, this study provides the first regionally representative sample for mining communities in the DRC copper cobalt belt. In addition, we have attempted to address the possible caveats as best as we could using state of the art methodology. As such, we regard this study to be well-positioned to make representative statements about the local populations that are most directly involved in the mining supply chain within the copper belt of the DRC.

4 Results I: Demographics, Livelihoods and the Role of Mining

Having introduced the study methodology, we now present our findings on the economic conditions of the typical household and the role of mining in their livelihoods.

4.1 Household Demographics and Health

Tables 1 and 2 present the demographic characteristics of the households of our sample. The Mining Community Household Survey covered 2,635 households. On average, the households in our sample have 6 household members. The survey covers a total of about 15,023 individuals, of whom 8,732 are children, which we define as individuals below the age of 18. For both children and adults, close to half of the sample are women. Across all individuals, the average age is 19.5 years, while the average adult is 36 years old and the average child is 7.5 years old. Of all adults, 92 % have some formal education, and 55% among children.

Table 1: Size of Households

	mean	sd	median	min	max	count
# of Household Members	5.9	3.0	6	1	20	2,635

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Table 2: Household Demographics

	mean	sd	median	min	max	count
Adults						
Gender (Female=1, Male=0)	0.48	0.50	0	0	1	6,291
Age	36.13	13.99	33	18	95	6,291
Years of Education	8.24	4.46	8	0	23	6,090
Formal Schooling (Yes=1, No=0)	0.92	0.27	1	0	1	6,291
Children						
Gender (Female=1, Male=0)	0.49	0.50	0	0	1	8,732
Age	7.47	4.87	7	0	17	8,732
Years of Education	2.39	2.84	1	0	20	7,833
Formal Schooling (Yes=1, No=0)	0.55	0.50	1	0	1	8,732
Total						
Gender (Female=1, Male=0)	0.49	0.50	0	0	1	15,023
Age	19.47	17.20	14	0	95	15,023
Years of Education	4.95	4.65	4	0	23	13,923
Formal Schooling (Yes=1, No=0)	0.70	0.46	1	0	1	15,023

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Tables 3-5 describe the reported health status of adults and children in our sample.[1] We next describe the health status of the typical individual in the mining region. We begin by constructing Body Mass Indices (BMI) of individuals, standard measurements based on the height and weight that capture the physical development, often useful to detect nutrition shortages. The mean and median BMI are respectively 23 and 22. These fall into the normal range according to the World Health Organization (WHO). About 8 percent of the survey respondents are underweight.[2] Among children, the mean and median of the BMI are 16.7 and 16, which also fall into the normal range according to the WHO for their average and median age groups.[3]

[1]We have also collected urine and saliva samples from heads of households and their children. These allow measurement of toxicity levels (exposure to heavy metals), as well as of stress (using saliva cortisol levels). In future work, we plan to use the laboratory measurements of such samples in combination with the reported health statistics of this section.

[2]The WHO defines for adults: severe thinness < 16; $\leq$moderate thinness <17; $\leq$mild thinness <18.5; $\leq$normal range <25.

[3]Among 7 years old, the WHO defines the median for boys to be 15.5, and 15.4 for girls.

Table 3: Height, Weight and Body Mass Index

	mean	sd	median	min	max	count
Child						
Height (meters)	1.36	0.18	1.34	0.84	2.27	1,463
Weight (kilograms)	31.27	12.31	28.00	8.00	83.00	1,535
BMI	16.68	4.12	16.30	4.08	72.00	1,455
Adult						
Height (meters)	1.64	0.10	1.63	1.00	2.00	2,503
Weight (kilograms)	61.87	12.24	60.00	8.00	172.00	2,626
BMI	23.04	4.51	22.38	3.16	75.00	2,499
BMI<18.5	0.08	0.27	0.00	0.00	1.00	2,650

Notes: Based on the Mining Community Household Survey. The adult measures are based on measurements of the heads of household. See Section 3 for discussion of sampling methodology.

Adults report to have been sick on average 1.2 days over the past four weeks, of which fever and respiratory problems (cough or breathing problems) account for the majority of instances.

Table 4: Adult Health

	mean	sd	median	min	max	count
# of Times Adult Fell Sick During Last 4 Weeks	1.2	2.7	1	0	31	6,272
# of Times Adult Had Fever During Last 4 Weeks	0.9	2.3	0	0	31	6,269
# of Times Adult Had Diarrhea During Last 4 Weeks	0.3	1.2	0	0	30	6,266
# of Times Adult Had Cough During Last 4 Weeks	0.6	1.9	0	0	31	6,270
# of Times Adult Had Blood in Stool During Last 4 Weeks	0.1	1.0	0	0	30	6,256
# of Times Adult Had Breathing Problems During Last 4 Weeks	0.3	1.4	0	0	31	6,266
Did Adult Feel Weak/Tired During Last 4 Weeks?	0.3	0.5	0	0	1	6,181

Notes: Based on measurements for the head of household in the household survey data. See Section 3 for discussion of sampling methodology.

In contrast, children are reported to have fallen sick on average 0.8 days over the past 4 weeks, of which fever and coughing account for the majority of the cases.

Table 5: Child Health

	mean	sd	median	min	max	count
# of Times Child Fell Sick During Last 4 Weeks	0.8	1.8	0	0	31	8,714
# of Times Child Had Fever During Last 4 Weeks	0.7	1.7	0	0	31	8,715
# of Times Child Had Diarrhea During Last 4 Weeks	0.3	1.4	0	0	60	8,709
# of Times Child Had Cough During Last 4 Weeks	0.5	1.6	0	0	30	8,713
# of Times Child Had Blood in Stool During Last 4 Weeks	0.1	0.5	0	0	14	8,703
# of Times Child Had Breathing Problems During Last 4 Weeks	0.1	0.6	0	0	20	8,708
Did Child Feel Weak/Tired During Last 4 Weeks?	0.1	0.3	0	0	1	8,583

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

4.2 Household Economic Livelihoods

Table 6 reports measures of household economic welfare. The mean and median of monthly household income per capita are USD 22 and USD 9.[4] These amount to USD 34.50 and USD 14 when adjusting for purchasing power parity to account for the national price level.[5] Monthly incomes adjusted for net transfers (such as gifts received or given) and monthly consumption expenditures per capita are similar to these values. Part of the low average figures could be driven by reported zero incomes due to seasonality in earnings. When we compute the average and the median monthly household income per capita after excluding all zero observations instead, these figures are 28 USD and 14 USD. Judged by any international comparison, the reported income and expenditure statistics indicate that the vast majority of households living in mining communities in the copper cobalt belt of the DRC are subject to severe poverty.[6]

Furthermore, the consumption measure suggests that households do not accumulate significant savings: average monthly per-capita consumption is very close 20 USD, which is statistically indistinguishable from monthly average household income per capita. The data on assets and financial savings suggest that households have a net worth in physical assets worth about 6 months of the household monthly incomes. However, a small fraction of these assets are liquid: households have on average just about 2 months of income worth of savings in liquid assets that they could use to buffer their livelihoods against negative shocks. Accounting for informal credit they have extended to other households and informal borrowing, the average net financial assets of a household per capita is USD 21 , or about one month of average incomes.

Overall, these findings suggest that if households saw their regular sources of income affected by an unexpected negative income shock, they would have few resources on which to draw to prevent economic hardship. Furthermore, while households are substantially interlinked through

[4]When we use gross incomes instead, rather than incomes net of the expenses incurred to generate such incomes, these values are 24 and 11 USD respectively.

[5]We use the International Price Comparison (IPC) adjustment for differences in consumer prices across countries. Equivalently, these amount to USD 34.84 for the average gross income. For nominal exchange rates, we use 30 Dec 2016 as the reference in the middle of our sample. For the IPC price adjustments, we use the most recent PPP conversion factor from 2013, and adjust for movements in the nominal exchange rate between 2013 and 2016.

[6]For comparison, the average monthly GDP per capita in PPP-adjusted USD among the poorest category of developing countries (low-income countries) was 61 in 2015 according to the World Bank Development Indicators.

loans between households, a negative income shock that would affect the entire community or region, such as a drop in demand for ASM, could not be insured informally by households: it would affect a large part of the local population.

This finding is confirmed by the non-monetary indicators of household economic wellbeing. Close to 70 percent of households report that they have worried about not having enough food for the family during the last week. On average, households have to rely on less preferred foods more than one day per week, limiting the size of portions below their needs and reducing the number of meals. Finally, three quarters of households have no access to electricity, and more than 30 percent do not have solid roofs (metal or better).

4.3 The Role of Mining in Economic Livelihoods

Tables 7-11 provide insights about the role of mining in household economic livelihoods. Table 7 shows that 66% of households rely on mining as a source of income currently or have done so in the past - recall that due to seasonal variation in occupational choice, past reliance on mining is necessary for the picture of mining dependence (40% do so currently). Given the cyclicality of labor due to the growing season, and the fact that the survey was implemented at the start of the rainy season, 40% is a lower bound of the proportion of households of the copper cobalt belt mining communities who derive income directly from mining. Similarly, the 30% of households which have supplied non-zero hours of labor into the mining sector in the month preceding the interview is again a lower bound of those continuously engaged in the mining sector due to seasonal unemployment and seasonal occupational switches (households who move to agriculture during the rainy season).

In turn, Table 8 depicts the hours worked, presence of safety equipment and mining incomes for those currently active in mining-related activities. Mining appears to be a full-time endeavor: the mean and median hours worked in mining, for those currently active, are 38 and 36 per week. Furthermore, mining makes up a significant fraction of total household income for those working in mining: of those individuals currently employed in mining, the mean and median share of their mining income in total monthly household income are 37 percent and 26 percent respectively. Finally, less than half of those currently working in mining report the use of any type of safety equipment.

We then present the causes of labor in the mines, for any individual reporting having worked at the mines (not just children). Tables 9 and 10 list the reported reasons behind the decisions to work in mining (as well as to quit mining) for individuals who have ever started (and ever stopped). First, the modal reason for why individuals work in mining is to sustain their livelihoods due to the absence of better alternatives. Furthermore, the main reason for which individuals who stopped working in mining report having done so is that they perceived the activity to be very dangerous (35%), suggesting that a significant fraction of households believes mining is dangerous. Another 20% of individuals who have quit mining report having stopped because they found better opportunities.

Table 6: Household Economic Conditions

	mean	sd	median	min	max	count
Income per Capita (Weekly)	5.12	9.52	2	0	93	2,609
Income per Capita (Monthly)	21.47	36.81	9	0	372	2,607
Income+Transfers per Capita (Weekly)	5.58	10.62	2	-9	108	2,600
Income+Transfers per Capita (Monthly)	23.26	42.37	9	-33	493	2,599
Consumption per Capita (Weekly)	5.07	4.95	4	0	42	2,612
Consumption per Capita (Monthly)	20.41	23.78	14	0	228	2,591
Value of Assets per Capita, of which:	176.12	670.15	40	0	15,544	2,483
Value of Houses Owned per Capita	86.94	601.31	0	0	14,405	2,483
Value of Illiquid Durables per Capita	48.08	212.76	0	0	4,142	2,483
Value of Liquid Durables per Capita	41.10	87.97	25	0	3,329	2,483
Net Financial Savings per Capita, of which:	21.21	100.94	0	-39	1,394	2,485
Savings per Capita	20.95	101.95	0	0	1,394	2,485
Loans Made Outstanding per Capita	2.04	16.44	0	0	465	2,485
Borrowing Oustanding per Capita	1.78	17.64	0	0	825	2,485
Household Worried about Enough to Eat Last Week (Yes=1, No=0)	0.64	0.48	1	0	1	2,630
# of Days per Week Using Less Preferred Food	2.35	2.43	2	0	7	2,618
# of Days per Week Using Limited Portions	1.73	2.32	0	0	7	2,622
# of Days per Week Reducing Number of Meals	1.53	2.29	0	0	7	2,624
# of Days per Week Limiting Adult Consumption to Feed Children	0.86	1.77	0	0	7	2,617
# of Days per Week Borrowing Food	0.47	1.07	0	0	7	2,625
Meals per Day on Average for Adults Last Week	2.21	2.63	2	0	27	2,634
Meals per Day on Average for Children Last Week	2.22	2.71	2	0	27	2,603
Household Has Access to Toilet (Yes=1, No=0)	0.88	0.32	1	0	1	2,611
Household Has Access to Electricity (Yes=1, No=0)	0.25	0.43	0	0	1	2,630
Household Has Metal Roof or Better (Yes=1, No=0)	0.68	0.47	1	0	1	2,533

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology. Monetary measures expressed in nominal US Dollars. To limit the role of mis-reporting or data entry errors, we trim the monetary measures at the 0.5 percent level from above and below. For income measures that include more than 0.5 percent zeroes, we only trim at the top. Liquid assets are defend as those with unit values up to USD 120.

Table 7: Dependence on Mining (1)

	mean	sd	median	min	max	count
Household Has Relied on Mining at Some Point (Yes=1, No=0)	0.65	0.48	1	0	1	2,546
Household Currently Relying on Mining (Yes=1, No=0)	0.39	0.49	0	0	1	2,545
Household Had Hours Worked in Mining During Last Month (Yes=1, No=0)	0.30	0.46	0	0	1	2,635

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Table 8: Dependence on Mining (2)

	mean	sd	median	min	max	count
Weekly Hours Worked in Mining for Those Currently Active	38.18	29.19	36.00	0.00	140.00	1,278
Monthly Hours Worked in Mining for Those Currently Active	157.44	126.63	150.00	0.00	592.00	1,218
Presence of Any Safety Equipment for Those Currently Active	0.45	0.50	0.00	0.00	1.00	1,329
Weekly Earnings (Net of Expenses) for Those Currently Active	11.45	16.39	0.93	0.00	74.35	1,349
Monthly Earnings (Net of Expenses) for Those Currently Active	53.78	74.35	23.23	0.00	371.75	1,346
Share of Weekly Income in Total Household Income for Those Currently Active	0.33	0.38	0.14	0.00	1.00	818
Share of Monthly Income in Total Household Income for Those Currently Active	0.37	0.38	0.26	0.00	1.00	854

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology. Monetary measures expressed in nominal US Dollars. To limit the role of mis-reporting or data entry errors, we trim income measures at the 99.5 percent level.

Table 9: Reasons for Decision to Start Working in Mining

	freq	pct
Better Pay Than Alternatives	359	13.9
Another Household Member Works in Mining	77	3.0
Had Own Child	311	12.0
Influence of Environment	218	8.4
Only Work Available	1,456	56.3
Other	160	6.2
Refuse/NA/Don't know	5	0.2
Total	2,586	100.0

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Table 10: Reasons for Decision to Stop Working in Mining

	freq	pct
No Opportunities	257	21.8
Very Dangerous	409	34.7
Education	47	4.0
Better Opportunities	238	20.2
Other	215	18.2
Refuse/NA/Don't know	14	1.2
Total	1,180	100.0

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Finally, Table 11 analyzes the share of households who rely on mining for their livelihoods currently or in the past, across different bins of reported household economic wellbeing. The insight that emerges is that mining is an equally major source of household livelihoods across all economic strata. About two thirds of households in the poorest income bin have relied on mining, equally so for households in the highest income bin. Using consumption expenditure or net household assets per capita as indicators of economic strata yields the same result.

5 Results II: Prevalence of Child Labor

Having examined the economic conditions of the typical household in the mining communities of the copper cobalt belt, we now examine how prevalent child labor is in the region, including in mining-related activities as well as non-mining activities. First, in Section 5.1, we report evidence on the prevalence of child labor for the typical household and children living in the mining communities. Second, in Section 5.2, we describe the composition of the mining labor force among workers who live in the 150 mining communities of our sample (thus, likely the almost of all the workforce) and the importance of children play in the mining labor force.

Table 11: Dependence on Mining as a Function of Household Economic Conditions

	Monthly Consumption per Capita	Monthly Income per Capita	Monthly Income+Transfers per Capita	Value of Assets per Capita
	mean	mean	mean	mean
1	0.58	0.64	0.65	0.67
2	0.63	0.61	0.63	0.67
3	0.69	0.66	0.65	0.64
4	0.68	0.68	0.68	0.65
5	0.70	0.68	0.68	0.63
Total	0.66	0.66	0.66	0.65

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology. The rows represent quintiles of the local population from the poorest (1) to the richest group (5) in terms of different measures of economic wellbeing as indicated in the three different columns. Each reported number provides the share of households who rely on mining as a source of income either presently or in the past for a given quintile group. See Table 6 for descriptive statistics on measures of economic wellbeing.

5.1 How Prevalent is Child Labor in the Average Household?

We now turn to quantifying child labor, in general and with a focus on the mining sector. We first ask the following question: using our representative sample of households of mining communities in the copper cobalt belt, what do the typical children do? Are most children working in mining-related activities? Is child labor prevalent outside of ASM? We describe the prevalence of child labor in three steps: for all children, by age range, and by gender. Table 12 presents the activities of children in the typical household in the area. Three important results emerge.

First, it is common for children to work. Second, children who work do so mostly inside the household. Third, child labor in mining-related activities is not common for the average household living in mining communities.

As row 1 indicates, the average household has 2.7 children between the ages of 3 and 17. The following rows present the percentage of children that engage in different types of activities: not working, in school, work in the household, and work outside the household. Of all children, only 42% are not working, while the remaining 58% are working inside or outside the household. Furthermore, whether working or not, 49% of the children in the ages of 3 to 17 are attending school. The following rows suggest that 57% of children work inside the household, and that only about 11% of children work outside the household. What do children who work outside the household do? The following rows show the percentage break-down of activities outside of the household by type: agriculture, mining, processing minerals, business, external domestic labor, and unknown. Clearly, the majority of child labor outside the household is concentrated in agriculture, domestic labor for other households, and business. Of all children who work outside the household (and these are only 11% of all the children encountered among the 2,635 households in our sample), about 19% work at the mines, while 4% work processing minerals. Table 44 in the Appendix shows the breakdown in terms of the total number of children in the sample. Of the 7,053 children above the age of 3 for whom we were able to collect information, 148 work at the mines (2.1% of all children in the sample), and 31 worked processing minerals (0.4% of all children).

Table 12: What Do the Typical Children Do in the copper cobalt belt?

	mean	sd	median	min	max	count
# of children (3-17)	2.68	2.19	2	0	11	2,635
Benchmark: Total Children						
Not Working/NA (%)	42.07	46.01	37	0	336	2,635
In School (%)	48.97	61.54	37	0	374	2,635
Working in Household (%)	56.78	57.77	37	0	411	2,635
Working Outside Household (%)	11.17	27.72	0	0	262	2,635
Benchmark: Working Outside Household						
In Agriculture/Other (%)	48.60	178.12	0	0	2,006	2,635
Inside Mines (%)	18.78	100.87	0	0	1,338	2,635
Processing Minerals (%)	3.93	52.38	0	0	1,003	2,635
Business (External/Own) (%)	12.56	84.27	0	0	1,672	2,635
Domestic Labor (External) (%)	29.95	128.15	0	0	1,672	2,635
Does Not Know (%)	0.76	15.94	0	0	334	2,635
N/A (%)	0.38	11.28	0	0	334	2,635

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology. This table breaks down the activities that children do by type.

Finally, we report how the answers of children differ from the answers of their parents. Table 13 presents the fraction of children who are reported to have ever been engaged in mining-related activities when either self-reported by one of the children in the household in our separate survey, or as reported by heads of households for any of their children. These to fractions could differ in case heads of households have incentives to misreport child labor, or because individual children have a better recollection about their activities over the past years compared to the parents who fill out the survey for all of the members of the household. Nevertheless, the comparison between these two separate data collection efforts can be informative about whether one has to worry about substantial misreporting.

As the table documents, there do not appear to be substantial differences in the reported prevalence of ever having worked in the mining sector. While the fraction is slightly lower for heads of households reporting on all of their children (4.3%) compared to the answers from one of their children (7%), the difference is within reasonable bounds. Having said this, we cannot rule out the possibility that some of the reported prevalence of child labor in the preceding tables that are based on the replies of the heads of households may be somewhat lower than the actual fractions of children engaged in work in mining and other activities. As also discussed at the end of Section 3, this potential bias due to strategic misreporting is unlikely to be large, however.

Table 13: Prevalence of Child Labor –Self-Reported vs Household Respondents

	Children Ever Worked in Mining	
	frac	count
Household Survey	0.043	4,273
Child Survey	0.070	1,452

Notes: Based on Child Survey and Mining Community Household Survey. The reported fractions are based on households for which we have both replies from the heads of households and replies from one the children in the household. See Section 3 for discussion of sampling methodology.

5.2 Composition of Child Labor in the Average Household

In this section, we examine the composition of child labor. Firstly, we examine how child labor varies by age. Is child labor affecting particularly the most vulnerable, youngest children or older children? All forms of child labor are of concern for long-run development, those involving the youngest children are likely to have the most significant negative consequences. We thus break down the previous numbers by age range. Table 14 breaks down child labor by age groups, following the same structure as Table 12. The columns break down the numbers across the following groups: 3-5 years old, 6-8 years old, 9-12 years old, and 16-17 years old. As before, the first row reports the average number of children across the 2,635 households by age group in the sample. The following rows then present the average percentages of these children engaged in different activities. Several findings emerge.

The first finding is that the majority of children work, but this fraction is more than 90% as children approach the age of 17. For instance, row 3 shows that only 9% of children in the ages 16-17 do not work. The equivalent number for the 13-15 group is 10%; 20% for the 9-12 group; 47% for the 6-8 group; and 88% for the 3-5 group. Younger children are less likely to work, but even among the 3-5 year old, about 12% report working inside or outside the household. Worse still, after 9 years of age, all age groups have at least 80% of children working.

The second finding is that ignoring generational changes in access to school, the numbers suggest significant school dropouts: while 68% of children of ages 9-12 go to school, this number drops to 66% for the 13-15 group and to 54% for the 16-17 group. Third, children work in the household from very early ages: while only 11% of children between 3-5 work in the household, the percentage rises to 52% for the 6-8 year old, and increases with age thereafter.

The third finding is that the work outside the household is concentrated among children above 9 years of age: 13% of the 9-12 group work outside the household, the percentage rises to 23% for the 13-15 group, and 34% for the 16-17 group. Importantly, the increase in children working outside the household for later ages is mostly for mining-related labor: while almost no children below 5 work at the mines, the percentage is up to 21% of all children working outside the household for the ages of 13-15, and 31% for all children working outside the household in the ages of 16-17. In contrast, the number of children working as external domestic laborers levels off at the ages 9-12.

Table 14: What Do the Typical Children Do in the copper cobalt belt? –By Age

	3-5	6-8	9-12	13-15	16-17
# of children (3-17)	0.70	0.64	0.71	0.39	0.24
	(0.76)	(0.77)	(0.88)	(0.62)	(0.49)
Benchmark: Total Children					
Not Working/NA (%)	88.64	47.20	20.33	10.32	8.93
	(102.43)	(88.80)	(60.63)	(54.38)	(64.90)
In School (%)	10.71	56.85	68.38	65.86	54.39
	(41.04)	(99.07)	(107.81)	(134.86)	(158.12)
Working in Household (%)	11.09	52.26	78.87	87.75	85.96
	(41.41)	(92.26)	(107.15)	(148.01)	(194.59)
Working Outside Household (%)	0.82	4.88	12.89	22.95	33.81
	(11.48)	(29.22)	(48.75)	(81.73)	(122.27)
Benchmark: Working Outside Household					
In Agriculture/Other (%)	40.00	41.46	47.72	52.94	48.11
	(967.29)	(373.38)	(267.77)	(262.42)	(258.64)
Inside Mines (%)	6.67	6.10	10.37	21.43	31.13
	(342.21)	(139.87)	(118.16)	(172.60)	(203.12)
Processing Minerals (%)	6.67	4.88	3.73	3.78	3.77
	(342.21)	(125.13)	(70.56)	(77.69)	(68.39)
Business (External/Own) (%)	6.67	10.98	11.62	11.76	15.57
	(342.21)	(187.52)	(130.81)	(121.46)	(142.43)
Domestic Labor (External) (%)	40.00	40.24	37.76	25.21	21.70
	(837.46)	(378.72)	(225.31)	(173.43)	(166.38)
Does Not Know (%)	0.00	1.22	0.41	0.42	1.42
	(0.00)	(62.60)	(21.30)	(21.57)	(41.92)
N/A (%)	0.00	1.22	0.00	0.42	0.47
	(0.00)	(62.60)	(0.00)	(21.57)	(24.21)

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology. This table breaks down the activities that children do by type, for multiple age ranges.

Secondly, we examine the prevalence of child labor by gender. Table 15 breaks down the information in Table 12 by gender. There are several findings when examining gender. First, male children are on average less likely to work inside or outside the household: 49% of boys do not work, in contrast to only 35% for girls. Second, boys and girls are equally likely to attend

school: 50% for boys vs 47% for girls. Third, girls are more likely to work in the household on domestic tasks (65% of girls) than boys (49% of boys). Fourth, while boys are slightly more likely to work outside the household than girls (13% vs 10%), their activities outside the household differ sharply. Most of the boys labor outside the household is concentrated in agriculture (54%), in external domestic labor (18%), and in the mining sector (29% inside mines plus processing). In contrast, 47% of the girls who work outside the household work as domestic laborers (more than twice the proportion of boys), and only 41% work in agriculture. Overall, only 15% of girls who work outside the household work in the mining sector, roughly half the fraction of boys. Table 46 in the Appendix shows the total numbers in the sample. Of 3,570 boys, 109 work at the mines, while of 3,483 girls, 39 work at the mines.

Table 15: What Do the Typical Children Do in the copper cobalt belt? –By Gender

	Male	Female
# of children (3-17)	1.35	1.32
	(1.38)	(1.37)
Benchmark: Total Children		
Not Working/NA (%)	48.99	34.97
	(67.64)	(53.98)
In School (%)	50.64	47.26
	(76.50)	(73.79)
Working in Household (%)	48.91	64.86
	(70.97)	(79.17)
Working Outside Household (%)	12.80	9.50
	(37.16)	(32.34)
Benchmark: Working Outside Household		
In Agriculture/Other (%)	54.05	41.09
	(217.80)	(215.48)
Inside Mines (%)	23.85	11.78
	(141.44)	(114.43)
Processing Minerals (%)	4.81	2.72
	(69.09)	(63.90)
Business (External/Own) (%)	12.69	12.39
	(99.68)	(116.45)
Domestic Labor (External) (%)	17.51	47.13
	(113.22)	(231.51)
Does Not Know (%)	0.66	0.91
	(19.45)	(26.85)
N/A (%)	0.66	0.00
	(19.45)	(0.00)

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology. This table breaks down the activities that children do by type, for males and females separately.

To summarize from this section, we find the following results for the mining communities of the copper cobalt belt:

- 57% of children between 3-17 work for their households, but most of this work are domestic chores.

- Children start working for their household at very early ages (12% are working already in the 3-5 age group). However, work outside the household is concentrated among older children.
- Of the 11% of children who work outside the household, 48% work in agriculture, against 23% in the mining sector. Boys are much less likely to work in the household than girls, but more likely to work outside the household. Boys who work outside the household work mostly in agriculture (54%) and the mining sector (29%). In contrast, most girls work inside the household, and those who work outside work mostly as domestic laborers (47%) and in agriculture (41%). Relatively few girls work in the mining sector (15%).

6 Results III: Child Labor in the Mining Sector

We now turn to describing the composition of the mining labor force residing in mining communities across different age groups. To do so, we use the data that we collect in the Mining Community Household Survey: households were asked to provide information on who in their household works at the mines or other mining-related activities. Aggregating across all randomly sampled households, we can obtain a representative estimate of the share of the labor force in mining that are children, among the households in our sample. To this end, we weight each of the 150 communities' information on mining labor in proportion to their population of the sum of all those communities, and then multiply this number by the factor (426/150) to get a representative estimate for all mining communities in the region (see also discussion in Section 3). As discussed in Section 3, one important caveat of this analysis is that we capture the mining labor force that lives in mining communities (an important fraction of the total), while the numbers do not speak to the composition of the mining labor force in the region more generally (residing outside of mining communities).

The findings reported in Table 16 suggest that, in our sample, of all mining workers on which we obtain information, 11.89% are below 18 years old. When taking into account our sampling weights to estimate the share of children in the mining force, we obtain that in the 426 mining communities, 12.65% of mining employment is in age groups below 18 years of age. The 95% confidence intervals are respectively [11.56; 12.22] and [12.29; 13.01]. This is our best estimate of the proportion of child labor in the mining labor force.

Table 16: What Fraction of Mine Workers Are Children?

	Percent
Reported Fraction of Child Mine Workers	11.89
Imputed Fraction of Child Mine Workers	12.65

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

We then breakdown the children working in the mining sector into the different age categories. Table 17 presents the breakdown.

Table 17: How old Are the Children Who Work in the Mining Sector?

	Total Workers imputed	Percentage of Child Workers imputed
All Workers	37,274	
Workers 15-17	2,393	51
Workers 10-14	1,915	41
Workers 5-9	406	8
Workers <5	0	0

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

We can now turn to study the different forms that child labor takes related to the mineral supply chain. Table 18 shows the types of work performed by all current mining workers in the sample. In our random sample 1,249 individuals above the age of 17 are currently working in mining-related activities. Their tasks are divided into the following ones: subterranean workers, surface workers, transporters of minerals, cleaners of minerals, sorters of minerals (who sort the quality rocks), traders, and other activities. We find that 54% of those involved in the mineral supply chain work as subterranean workers in the tunnels where minerals are excavated, arguably one of the riskiest occupations due to the exposure to toxicity in the air and to the risks of collapsing tunnels. In addition, 14% work as surface mine workers, who excavate open mines. The rest of occupations are relatively less important: 8.5% work as mineral cleaners, washing out the rocks from dirt, 3% work as mineral sorters, 4% are traders, and 3% are transporters of minerals.

Table 18: Forms of Mining Labor –Adult Workforce

	>17	
	freq	pct
Subterranean Worker	680	54.4
Surface Worker	174	13.9
Transporter	40	3.2
Cleaner	106	8.5
Sorter	37	3.0
Trader	53	4.2
Other	159	12.7

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

We then examine which of these forms of labor are most common among children. Table 19 breaks down labor by age ranges for the 141 mining workers below the age of 17 in our sample. Of all children, 26% work as sorters, 22% work as surface workers, and 17% work as cleaners. Children appear to specialize in the tasks that require the least physical force. This can be seen in the fact that only 12% work as subterranean workers in contrast to 50% for adult workers, and that the proportions of subterranean and surface workers increase with age, while the proportions of cleaners, sorters decrease with age.

Table 19: Forms of Mining Labor –Children

	15-17		10-14		5-9		Total	
	freq	pct	freq	pct	freq	pct	freq	pct
Subterranean Worker	12	8.5	4	2.8	1	0.7	17	12.1
Surface Worker	20	14.2	11	7.8	1	0.7	32	22.7
Transporter	7	5.0	3	2.1	0	0.0	10	7.1
Cleaner	14	9.9	10	7.1	0	0.0	24	17.0
Sorter	11	7.8	16	11.3	9	6.4	36	25.5
Trader	1	0.7	0	0.0	0	0.0	1	0.7
Other	10	7.1	10	7.1	1	0.7	21	14.9
Total	75	53.2	54	38.3	12	8.5	141	100.0

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

To summarize from this section, we find the following results:

- 12.65% of the mining work force living in mining communities are below the age of 18.
- Mine labor by children is driven by older children: 51% of children working in ASM are 15-17 years old, 41% are 10-14 years old, and 8% are younger than 10.
- Mining-related labor overall is mostly subterranean and surface excavation, but also includes sorting of minerals, cleaning of minerals, transport of minerals, trading of minerals and other activities.
- Of all mining workers who are under the age of 18, 91% are 14 or older, and 53% are 15 or older.
- Adults specialize in subterranean and surface excavation. Workers below the age of 18 work mostly as sorters (26%), surface workers (23%), and cleaners (17%).
- Of all mining workers under the age of 18, those 15 or older are most likely to be surface excavators, while those under 15 are most likely to be sorters of minerals after these have been excavated.

7 Results IV: Causes of Child LaborReported causes of child labor

We next turn to examining the causes of child labor. Tables 20-30present insights from different surveys on the underlying reasons behind child labor in the mining region. Tables 20-27 focus on the replies of the respondents whom we interviewed in the household survey. Tables 28-47 then provide the answers of the children of these households, whom we interviewed separately about these questions (and in absence of their parents). Appendix Tables 48-49 provide answers from village chiefs and local school principles. In the final part of this section, we then investigate the differences between households and children who have reported mining child labor in the past

or present relative to households and children who have not reported any child labor in mining. Several insights emerge from these tables.

The dominant reason for child labor –as reported by the household respondents– is the search for income. The most frequent reason for child labor reported in Table 20 is to earn additional household income. Table 21 reports the same information, but now broken up into above and below-median household consumption expenditure (an informative measure of household economic wellbeing). Interestingly, among the poorest half of households, the fraction that report the need for income generation is even more dominant than before. Corroborating these findings, Table 22 reports the prevalence of children working outside and/or inside the household as a function of household economic level (across quintiles of monthly consumption expenditure per capita). The fraction of households reporting child labor of any form is substantially larger in the poorest strata than in the richest strata. For example, while only 9% of the richest 20% of households report that their children work outside the household, for the poorest 20% of households, the rate is 23% .

Another insight from Table 20 is that roughly 24% of the cases of child labor in our sample report that social norms/conventions play a role. The answer that the child is working to "make a good impression" signals that child labor is viewed positively through the eyes of the community (i.e. the child is contributing positively to the household and thereby to the community at large).

Table 20: Main Reason Child Works Outside the Home

	freq	pct
Income	271	36.5
Needs to Stay with Parent	48	6.5
Nothing else to do	73	9.8
Seeking to Become Independent	47	6.3
Make a Good Impression	180	24.2
Other	111	14.9
Refuse/NA/Don't Know	13	1.7
Total	743	100.0

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Table 21: Main Reason Child Works Outside the Home –Reported Across Income Groups

	Below Median Consumption		Above Median Consumption	
	freq	pct	freq	pct
Income	159	39.1	109	33.3
Needs to Stay with Parent	21	5.2	27	8.3
Nothing else to do	40	9.8	32	9.8
Seeking to Become Independent	23	5.7	24	7.3
Make a Good Impression	96	23.6	80	24.5
Other	59	14.5	51	15.6
Refuse/NA/Don't Know	9	2.2	4	1.2
Total	407	100.0	327	100.0

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

In Table 23, parents report that children do not dislike working outside the household.

Table 23: How Does the Child Like the Work Outside the Home?

	freq	pct
Enjoys Very Much	252	33.9
Enjoys	413	55.6
Indifferent	44	5.9
Dislikes	25	3.4
Dislikes Very Much	3	0.4
Refuse/NA/Don't Know	6	0.8
Total	743	100.0

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Parents also report making the decision about the child's working activity for 44% of the children who work in Table 24. In contrast, for 52% of the working children the parents report that it is the the child who makes the decision.

Table 24: Who Decides Whether and How Much the Child Works Outside the Home?

	freq	pct
Himself/Herself	391	52.6
Parent	324	43.6
Another Household Member	14	1.9
Another Family Member Outside the Household	3	0.4
Someone Else Outside the Household	3	0.4
Other	8	1.1
Total	743	100.0

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Table 22: Prevalence of Child Labor as a Function of Economic Wellbeing

	Households with Child Working fraction	Households with Child Working Outside the House fraction
1	0.73	0.23
2	0.76	0.24
3	0.73	0.21
4	0.67	0.14
5	0.47	0.09
Total	0.67	0.19

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology. The rows represent quintiles of the local population from the poorest (1) to the richest group (5) in terms of monthly consumption expenditure per capita.

The next table, taken from the household survey, reports answers on the desired years of schooling of the respondents for their children, as well as measures of local school access in the mining communities. Lack of interest in schooling or lack of access to local schools do not appear to be strong determinants of child labor: parents consistently report that they believe children should go to school until a late age, and the mean and median distances to local schools of different types are far from being prohibitive in terms of walking distances.

Table 25: Local Access to Schools

	mean	sd	median	min	max	count
Distance to Nearest Primary School (in minutes walking)	4.1	47.8	0	0	2,001	2,438
Distance to Nearest Secondary School (in minutes walking)	3.3	16.1	1	0	400	2,406
Distance to Nearest Technical School (in minutes walking)	6.5	17.4	1	0	300	2,252
Until What Age Should Boys Go to School?	19.4	7.4	23	0	28	2,307
Until What Age Should Girls Go to School?	19.0	7.0	20	0	28	2,436

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

When asked about the main obstacles for why parents do not send their children to school for as many years as they would ideally like to, the dominant reason is the cost of the school fees, followed by the need for extra income from child labor. This pattern is close to identical between boys and girls.

Table 26: Main Obstacles Why You Cannot Send Your Child to School for as Many Years as You Would Like

	Boys mean	Girls mean
Cost of School Fees	0.59	0.59
Need to Work	0.11	0.11
Need to Look After the Family	0.047	0.076
No Nearby School	0.031	0.032
Poor Academic Performance	0.023	0.027
Death of Officials	0.10	0.10
None	0.073	0.079
Refused/NA/Don't know	0.16	0.16

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

When asking heads of households for the main reason why the child in question has started to work in mining-related activities, the dominant reasons are mining being available for work locally and household-related factors (such as other members working in mining, or the mother needing to be around her child). The high proportion of both boys and girls for which the household reports "Influence of the environment" as a factor reinforces the insight above that local social norms play a role beyond economic and other determinants of child labor. This answer was coded similarly

to "Make a good impression" in Table 20 above, suggesting that both households and children can perceive child labor as part of a positive signal to be contributing to their community.

Table 27: Main Reasons for Why the Child Started Working in Mining

	Boys		Girls	
	freq	pct	freq	pct
Better Pay Than Alternatives	10	6.5	1	1.8
Another Household Member Works in Mining	15	9.8	11	20.0
Parental Obligation	27	17.6	11	20.0
Influence of Environment	62	40.5	19	34.5
Only Work Available	28	18.3	11	20.0
Other	11	7.2	2	3.6
Total	153	100.0	55	100.0

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

We now turn attention to the same answers as provided by the children themselves, who we interviewed separately. Among all of the interviewed children (including the younger ones), only 25% report that they make their own decisions on whether or not to work outside the household. This might suggest that some parents are forcing children to work and under-reporting the cases in which they decide for the children, as revealed by the child module. However, the reported proportion of children that report that they make their own decision increases to 66% when we focus on those children who are currently working in mining-related activities (Table 30). This difference is likely driven by the fact that, on average, children who work in mines tend to be older than children who work anywhere. Since older children tend to make their own decisions more often than young children, it is plausible that children in mining make their own decision to work at an equal rate than children of the same age elsewhere. Finally, one third of the children report that they can spend their earnings freely as they decide to.

Table 28: Who Decides Whether Or Not You Go to Work Outside the Household?

	freq	pct
Myself	360	22.9
Mother	641	40.7
Father	212	13.5
Both parents	161	10.2
Village Chief	1	0.1
Other	60	3.8
Refuse/NA/Don't know	140	8.9
Total	1575	100.0

Notes: Based on child survey data. See Section 3 for discussion of sampling methodology.

Table 29: What Happens to the Money that You Earn by Working?

	freq	pct
Spend it As You Like	87	29.6
Mother Decides	44	15.0
Father Decides	5	1.7
Both Parents Decide	18	6.1
Other	14	4.8
Refuse/NA/Don't know	126	42.9
Total	294	100.0

Notes: Based on child survey data. See Section 3 for discussion of sampling methodology.

Table 30: Who Has Decided that You Go to Work in Mining?

	freq	pct
Myself	68	63.6
Mother	13	12.1
Father	8	7.5
Both parents	3	2.8
Other	10	9.3
Refuse/NA/Don't know	5	4.7
Total	107	100.0

Notes: Based on child survey data. See Section 3 for discussion of sampling methodology.

The next insight from the child survey relates to children's views about the opinion of their family members regarding the benefits of schooling, and their own. Interestingly, the majority of children report to think that both their parents and their siblings believe that schooling will improve the child's future. This belief is also held by the children themselves.[7]

[7]In the Appendix (Tables 48 and 49), we corroborate these insights by reporting the views of village chiefs and school principals about the prevalence of child labor in general and in mining, as well as the perceived prevalence of child labor in each of those categories for which the children do not make their own decisions. Village chiefs on average report that 27 percent of local children work outside the home (median is 20 percent), and that 17 percent work in mining related activities (median is 5 percent). And they on average report that 8 percent of all children work without making their own choices (median is 0), and 4 percent in mining-related activities (median is 0). In turn, school principals in Table 49 report on average that 20 percent of their pupils work for money (median is 10), and that 9 percent work in mining-related activities (median is 0). In line with our findings from the household, child and village chief surveys above, principals evaluate on average that the majority of the children working in mining do so by their own choice (6 percent of 9 in total). Note that the reported fractions of both child labor and child labor in mining are larger than those estimated from the from the household survey data, especially in the case of the village chiefs. Some caution has to be taken with respect to the survey data from village chiefs and school principals: these data are not based on individual-level data that is reported directly by households, but rather based on the best guesses that chiefs and principals reply about the overall fraction of children in their villages or schools. Naturally, these answers are harder and will be noisier than individual households reporting about the work status of their members. Reassuringly, the median replies of the village chiefs and principals are much closer to the fractions that we estimate from the household data, suggesting that a small number of very large reported fractions are driving the differences. Especially for school principals, who are also likely to be reasonably well informed about the children, the median replies are closely in line with the prevalence of child labor that we have estimated from the household survey data.

7.1 Characteristics of individuals and children in households with child labor in mining

In the final part of this section, we focus on how households who report child labor in mining differ from households who do not report mining child labor, as well as the comparison of child characteristics among children who have ever worked in mining relative to all other children. Tables 31-33 report these results. The first column of Table 31 reports the mean of various household outcomes among households who have not had any of their children involved in mining to the present day. The second column reports the mean of these outcomes among households who have reported mining child labor in the past or present. The third column displays the difference in the two means and indicates whether this difference is statistically significant at the 1, 5 or 10% level in our sample.

We find that households who report to have children working in mining-related activities are on average significantly poorer in terms of income. The means of other economic outcomes (such as consumption expenditure, savings, assets) are all below the averages among households without mining child labor, pointing in the same direction, but not statistically significantly so given the large standard errors on these hard-to-measure outcomes. Regarding other outcomes, households with mining child labor have a larger number of children, are more likely to have an adult working in mining, have children who have on average less education compared to children of a similar age, less educated adults, and live on average closer to a mining site.

Regarding psychological outcomes, we find that the typical survey respondent of a household who reports to have children working in mining-related activities experiences significantly higher levels of anxiety, as measured in a standard scale test with self-reported answers. Consistent with the literature linking anxiety to superstition, we also find that these households are more likely to hold supernatural beliefs, as measured in a standard test for tendency to hold supernatural beliefs based on a scale of answers. This result is consistent with existing recent studies that show a positive relationship between poverty and anxiety. While poverty tends to generate anxiety as individuals struggle to search for income for survival, anxiety itself tends to induce poorer focus, and thus poorer choices, reinforcing poverty.

To confirm our psychological anxiety results and examine their potential relationship with worse performance and decision-making, we administered a Stroop test to the respondents, aimed at measuring "cognitive load," or the tendency to be unfocused due to excessive energy devoted to other tasks, which is often the case with anxious subjects. We find that respondents in households with mining child labor tend to perform worse in the Stroop test, indicating lower levels of mental focus, and consistent with such hypothesis.[8] In contrast, such respondents do not perform worse in the Raven Matrices test of IQ nor in a working memory test. This suggests that they are no less intelligent, but simply suffer from anxiety and cognitive load, which leads to underperformance in tasks such as the Stroop test. Given the other differences observed in this population discussed above as well as results documented in the economics and psychology literatures, it is thus plausible that anxiety due to income - and survival - concerns, which plausibly leads such households to

[8]The Stroop test measures the cognitive load of subjects. A lower score indicates worse performance, higher cognitive load and poorer focus which the literature has associated with higher stress levels. Higher numbers on the Stroop test indicate better performance, lower cognitive load, and better focus thus less stress.

supply child labor in dangerous but profitable occupations such as the mines, may be reflected in higher cognitive load on the individuals of these households. The resulting reduction in focus then likely undermines their ability to make choices. Note, however, that this causal interpretation is only suggestive, given that the current study was not designed to elicit causal channels but instead paint a picture of the correlations.

Table 32 displays the composition of ethnicities among households with reported mining child labor compared to other households in our sample. Households with mining child labor seem to be slightly less likely to identify as Luba, Sanga and Bemba, and slightly more likely to identify as Rund, Katshokwe and Other. However, these appear to be relatively minor differences, and the small sample size of households with reported mining child labor would warrant some caution regarding strong conclusions on this dimension.

Table 32: Ethnic Compositions of Households with and without Mining Child Labor

	Child Mine=0		Child Mine=1	
	N	pct	N	pct
Luba	671	28.41	38	25.50
Sanga	312	13.21	13	8.72
Kaonde	61	2.58	4	2.68
Lamba	67	2.84	4	2.68
Bemba	107	4.53	2	1.34
Rund	260	11.01	20	13.42
Katshokwe	245	10.37	23	15.44
Other	634	26.84	45	30.20
NA	5	0.21		
Total	2362	100.00	149	100.00

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology. ***, ** and * indicate statistical significance at the level of 1, 5 and 10 percent.

Finally, Table 33 reports the differences in child characteristics among children who have worked in mining in the past or present compared to all other children in the sample. The table follows the same format as described above for Table 31. We find that children active in mining are on average significantly older than other children (by more than 5 years on average), are less likely to be girls (by 23%), have on average 70% of one school year less of education relative to children of similar ages that are not active in mining, and they are on average more than 1 rank above in the household's birth order relative to other children.

Table 31: How Do Households with Mining Child Labor Differ?

	Mean (Child Mine=0)	Mean (Child Mine=1)	Diff	SE	N0	N1
HH with Adult in Mining Sector	0.61	0.87	-0.27***	0.04	2486	149
Size of Household	5.74	7.81	-2.07***	0.25	2486	149
Monthly Consumption (per capita, USD)	20.49	19.14	1.35	2.03	2445	146
Monthly Income (per capita, USD)	21.94	13.66	8.28***	3.11	2459	148
Savings (per capita, USD)	21.45	12.96	8.49	8.73	2340	145
Net Saving (per capita, USD)	21.79	11.85	9.94	8.64	2340	145
Assets (per capita, USD)	180.07	111.47	68.61	57.72	2340	143
Loans (per capita, USD)	2.14	0.40	1.74	1.41	2340	145
Credits (per capita, USD)	1.79	1.50	0.29	1.51	2340	145
Number of Children	2.57	4.48	-1.91***	0.18	2486	149
Number of Children in School	1.28	1.83	-0.55***	0.14	2486	149
Years of Schooling Residual	0.00	-0.39	0.40***	0.12	1875	149
Height of Respondent	1.64	1.62	0.02*	0.01	2353	136
Weight of Respondent	61.97	60.31	1.66	1.04	2465	146
BMI of Respondent	23.06	22.90	0.16	0.40	2351	134
Age of Adults	36.52	39.31	-2.80***	0.91	2417	147
Years of Schooling of Adults	7.97	7.09	0.88***	0.30	2408	147
Raven Score (percentage correct out of 12)	21.38	21.64	-0.26	1.51	2486	149
Stroop Score (percentage correct out of 8)	37.55	31.54	6.01*	3.15	2486	149
Memory Score (percentage correct out of 7)	74.30	72.02	2.28	2.50	2371	145
Anxiety (percentage yes answers)	57.70	65.61	-7.92**	4.01	877	57
Superstitious beliefs (scale of 1-5)	2.46	2.66	-0.20***	0.06	2486	149
Age of Children Working Outside HH	12.67	14.25	-1.58***	0.28	359	149
Gender of Children Working Outside HH	0.46	0.27	0.19***	0.04	359	149
Distance to Mining Site (km)	6.45	4.03	2.42**	1.16	792	112
Years in Area	9.52	12.80	-3.27*	1.87	911	44

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology. Years of schooling residual refers to the deviation of children's years of schooling relative to the mean in their age group. ***, ** and * indicate statistical significance at the level of 1, 5 and 10 percent.

Table 33: How Do the Children Who Work in Mines Differ?

	Mean (Child Mine=0)	Mean (Child Mine=1)	Diff	SE	N0	N1
Gender	0.50	0.27	0.23***	0.03	6830	223
Age	8.80	14.00	-5.19***	0.28	6830	223
Years of Schooling	2.74	4.83	-2.09***	0.19	6392	223
Currently in School	0.49	0.40	0.09***	0.03	6830	223
Years of Schooling Residual	0.02	-0.68	0.71***	0.12	6392	223
Birth Order	2.77	1.62	1.15***	0.11	6830	223

Notes: Based on the Mining Community Household Survey. See Section 3 for discussion of sampling methodology. Years of schooling residual refers to the deviation of children's years of schooling relative to the mean in their age group. ***, ** and * indicate statistical significance at the level of 1, 5 and 10 percent.

8 Results V: Organization of the Cobalt Supply Chain

In the last section, we present insights about the organization of the supply chain in the copper cobalt belt. The vast majority of people working in mining in our sample are artisanal miners: less than 10% of the people who have been active in mining report to have been employed by an industrial mining site. In Section 8.1, we first present basic characteristics of the typical mine, and then provide the breakdown of mines by type (industrial vs artisanal). In Section 8.2, we focus on social aspects at the mine, such as the political organization of mining workers as well as the type of security provision and control at the mining sites. Finally, in Section 8.3, we move one step downstream in the mineral supply chain and provide descriptive statistics of the typical mineral traders in the region.

8.1 Basic Characteristics of the Mining Sites

We first present the basic physical and economic characteristics of the typical mining site. Table 34 shows the number of miners, distance and transport costs to the average community where households who work at the mine are living, entry fees and output taxes. As seen above, the average mine has approximately 1,000 workers, and there are about 270 reported mining sites in the area.[9] The average distance to a mine for communities that have households working at a mine is 7 km. Note, however, that this number includes all reported mines at which local households have ever been active at, so the mean distance may be slightly inflated. In contrast, the median distance is 3 km, suggesting a few mines, far away from the households reporting about them, are driving the average distance up. The average transportation cost to reach the mine is USD 1.12. Some mines have an entry cost: on average, workers have to pay USD 1.40 monthly to be working at the mine. Some mines also have a selling tax that is on average reported to be USD 0.15 per kilogram of output.

[9]This number represents an upper bound as it is the number of unique names we have matched in the data. However, as many subsections of an individual mining site may go by different names, each of these unique names likely does not represent a unique mining site as defined in our sampling methodology. Our field team is currently working to map these names to our identified universe of mining sites so to better aggregate this information.

Table 34: Basic Characteristics of Mining Sites

	mean	sd	median	min	max	count
Total Number of Mines: 270						
# of Workers per Mine	1,182.16	5,323.13	300.00	0.00	75,150.00	229
Distance to Mine (km)	11.50	36.47	3.00	0.00	410.00	257
Transportation Cost (USD)	1.15	1.88	0.70	0.00	16.73	265
Entry Cost (USD, monthly)	7.44	46.10	0.00	0.00	557.62	246
Point of Sales Tax (USD)	0.43	2.44	0.00	0.00	27.88	237

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Table 35 shows the breakdown of mines across industrial and other types. We find that 31% of mining sites are recognized as Artisanal Exploitation Zones (ZEA), 26% are industrial sites, 24% are open artisanal mining sites and 17% are inactive industrial mines.

Table 35: Types of Mines: Industrial vs Artisanal Mining

	freq	pct
Industrial Site	62	26.1
Non-Operating Industrial Site	41	17.2
Open Artisanal Mining	57	23.9
Artisanal Mining (ZEA)	73	30.7
Other	2	0.8
Refuse/NA/Don't know	3	1.3
Total	238	100.0

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

In sum, the majority of the mines where households work are ASM sites, either as abandoned industrial sites, informal artisanal sites, or ZEAs. Only a quarter of the mines relevant to this population are industrial mines. This suggests that labor safety conditions, usually poor for artisanal mines, are likely weak (as also reported in Table 8).

8.2 Social Organization at the Mining Sites

We now turn to the social organization at the mines. Since power relations are an important determinant of the share of the production surplus that artisanal miners get to keep, it is important to understand what type of social and political forces operate at the mines and how miners are organized to bargain over the surplus. We find two major results.

First, miners do not tend to be organized in associations, cooperatives or other groups. As a result, they likely have reduced bargaining power.

Second, armed security services, many of which are not supposed to be present at the mining sites, are quite active at the mines. This is not surprising given the economic rents they can potentially generate.

We first show the forms of collective organization of miners. Table 36 breaks down the mines in terms of the most important labor organization. The majority have no general organization. While in 69% of mines miners are organized in small teams, only 2.5% of mines have a union or cooperative, and only 2% have a worker elected as member of a committee or president.

Table 36: Collective Organization of Miners

	freq	pct
Union or Cooperative	6	2.5
Directly for the Mine	19	7.8
Directly for a Buying House	8	3.3
Worker Elected a Committee and President	5	2.0
Organized in Small Teams	169	69.3
Other	5	2.0
Refuse/NA/Don't know	32	13.1
Total	244	100.0

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

We then examine how security is provided at the mines. Table 37 breaks down the mines into the most important security providers. While only 49% receive protection by the Mine Police (per government policy this number should be 100%), 30% of mines are secured by private security companies (mostly industrial mines) and 16% of mines are secured by the Congolese National Police. Interestingly, 18% of mines are secured by the secret service and 13% by the presidential guard. These organizations have been found to act as predatory networks for rent-extraction (Verweijen, 2013) and do not have a mandate for working at the mines. In general, these organizations likely generate rents by using their positions for private gain. Further, as the secret service and presidential guard are accountable to the central government, they may be extracting rents for patronage networks that reach senior levels of government.

Table 37: Who Provides Security at the Mines?

	Total	Proportion
Secret Service	46	0.18
Mining Police	126	0.49
National Police	42	0.16
Presidential Guard	33	0.13
Security Firm	76	0.30
Other	30	0.11

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Table 38 replicates Table 37, showing the intensity with which each security actor is present at the mines –independently of whether they provide security or not. The Mine Police is present on average for 18 days per month. However, in addition, other police agencies are present 6.5 days per

month on average, the Congolese National Police are present 4 days on average, the presidential guard are present 4.5 days on average, and 1.5 days for other armed actors.

Table 38: Presence of Armed Actors: Number of Days Per Month

	mean	sd	median	min	max	count
# of Days per Month Mine Police Are Present	18.3	13.5	30	0	31	262
# of Days per Month Other Police Are Present	6.6	11.3	0	0	31	258
# of Days per Month Congolese Are Present	4.2	9.7	0	0	30	258
# of Days per Month Presidential Guard Are Present	4.6	10.3	0	0	30	259
# of Days per Month Other Armed Actors Are Present	1.7	6.5	0	0	30	258

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

8.3 One Level Downstream: Wholesale Traders of Minerals and Cooperatives

We now turn to the next step in the supply chain: the wholesale traders and cooperatives.[10] We examine the following four aspects of traders: what types of mines do they source minerals from?; what is their impression of child labor at the mines?; how many children work in the wholesale trading business according to traders?; and what prices are they buying the minerals for locally and selling them for afterward?

We begin by showing the basic characteristics of the mining sites from which mineral traders source their product. Table 39 shows the breakdown of such mining sites. The typical trader is active in about 2 mining sites, and the maximum number of mines that a trader works with is 8. According to the traders, children work at the mines for 50% of the mines from which they source.

Table 39: Supply Chain: Number and Types of Mines the Typical Trader Sources From

	mean	sd	median	min	max	count
# of Mines Trader Works With	1.8	1.5	2	0	8	87
# of Mines Trader Works With in which Child Labor Present	0.9	1.0	1	0	4	87

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

We then examine the perceptions of traders about child labor at those mines. Table 40 presents evidence of the type of child labor awareness among traders. The majority of traders answer that children work to contribute to their household income (32%) or to make money (27%). Some traders also believe that children might be working because of social pressure (15%).

[10] While traditionally thought of as different entities, in this setting wholesale mineral traders and cooperatives largely play the same role of aggregating mine-level output to sell on to larger processing companies. We will refer to both as 'traders' for this section unless we state otherwise.

Table 40: Perceptions of Child Labor Among Traders: Why Do Children Work at the Mines?

	freq	pct
Forced	5	6.4
Contribute to Household Income	25	32.1
Parents Work There	2	2.6
Nothing Else To Do	1	1.3
Money	21	26.9
Social Influence	12	15.4
Other	12	15.4
Total	78	100.0

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Having obtained the perceptions of child labor among traders, we next examine how many children work in the trading business. We do so in two ways: first, we ask each trader to reveal how many children work in their trading firm. Of course, traders might have incentives to under-report this number. Thus, we also asked traders to estimate how many children work in local market of which their business is a part. Table 41 presents these results. Few traders report having children who work inside their firm: for example, the average number of 15-18 year-olds working for their operation is 0.4. When asked about the total number of children in the trading business, the average total number of children reported are 48 children in the age group of 15-18, 28 children in the 10-14 group, 13 children each for the 5-9 and the below-5 groups. Given the relatively hard task to make guesses about the trading sector as a whole, these numbers should be interpreted with some caution.

Table 41: Perceptions of Child Labor Among Traders: How Many Children Work in the Trading Business?

	mean	sd	median	min	max	count
# of 15-18 Year Olds in the Team	0.4	1.1	0	0	5	86
# of 15-18 Year Olds in the Market for Trading	48.3	122.1	0	0	500	86
# of 10-14 Year Olds in the Team	0.1	0.5	0	0	4	83
# of 10-14 Year Olds in the Market for Trading	27.6	58.7	0	0	300	88
# of 5-9 Year Olds in the Team	0.1	0.6	0	0	5	84
# of 5-9 Year Olds in the Market for Trading	13.0	39.2	0	0	150	88
# of <5 Year Olds in the Team	0.1	0.4	0	0	4	88
# of <5 Year Olds in the Market for Trading	12.7	39.9	0	0	150	88

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology.

Finally, we present the purchase and selling prices for traders, for all types of minerals. While we collected both purchase and selling prices, almost no trader accepted to provide their selling price, making estimation of their markups impossible. Instead we simply present the purchase

prices of traders. Prices downstream in the supply chain are well-known by exporters and from international markets, thus the trader's selling prices are a good indication of how much surplus the supply chain keeps from miners. We present these results in Table 42. The median price is USD 0.58 per one kilogram of 6-pct cobalt, and 1.86 USD for one kilogram of 12-pct cobalt, and 3.85 US Dollar for one kilogram of 23-pct cobalt. The most reliable answer is the purchase price of 6-pct quality cobalt, where 47 out of 87 traders accepted to provide a number.[11] Table 43 corroborates these reported trader values from the perspective of mining households. The table shows that artisanal miners report to receive even lower prices for their output: the median price of 6-pct quality cobalt is 0.52 USD per kg, 0.84 USD per kg for 12-pct and 1.39 USD per kg for 23-pct cobalt quality. Though difficult to determine with precision, our data indicate that miners receive less than half and potentially as low as 6% of the price-by-weight that traders receive for their production.[12]

Table 42: Purchase Price by Wholesale Traders

	mean	sd	median	min	max	count
Purchase Price of Kilo of 13pct Copper (USD)	0.99	2.70	0.19	0.03	13.94	27
Purchase Price of Kilo of 20pct Copper (USD)	1.63	2.03	0.49	0.05	7.63	36
Purchase Price of Kilo of 30pct Copper (USD)	2.38	3.96	0.88	0.08	14.87	31
Purchase Price of Kilo of 6pct Cobalt (USD)	5.92	14.79	0.58	0.06	65.72	47
Purchase Price of Kilo of 12pct Cobalt (USD)	2.23	2.24	1.86	0.16	14.21	44
Purchase Price of Kilo of 23pct Cobalt (USD)	2.79	1.87	3.58	0.35	8.46	26
Purchase Price of Kilo of Malachite Jewelery (USD)	1.09	0.11	1.02	1.02	1.21	3
Purchase Price of Gram of Gold (USD)	0.68	.	0.68	0.68	0.68	1
Purchase Price of .5 Carat Diamond (USD)	2.07	.	2.07	2.07	2.07	1
Purchase Price of 1 Carat Diamond (USD)	0.91	1.25	0.91	0.03	1.79	2

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology. To avoid the influence of data entry errors, we trim the monetary variables at the 0.5% and 99.5% level from below and above.

[11] Note that the means are significantly higher, but this is driven by large outliers in the data that are apparent when looking at the maximum values. These suggest that the price data are quite noisy. When trimming the data to restrict attention to reported values within 5-95 percentiles of the distribution, the mean is much closer to the medians that we report here.

[12] The share is calculated from reported prices in the 6-pct purity market. The range indicated is calculated from the ratio of mean miner unit values to mean trader unit values both as reported from the trader survey (46%); the ratio of mean miner unit values from the household survey to mean trader unit values from the trader survey (41%); the ratio of mean miner unit values from the trader survey to mean trader unit values from conversations with cobalt processing firms (6.5%), and mean miner unit values from the household survey to mean trader unit values from conversations with cobalt processing firms (5.8%). The research team wishes to note that in all of these ratios at least one and sometimes both the numerator and denominator potentially suffer from selection bias and small response rates. As a result, we present the range as informative and recommend further research to better identify how the surplus is distributed throughout the value chain.

Table 43: Purchase Price by Trader –Reported by Households

	mean	sd	median	min	max	count
Selling Price of Kilo of 0-13pct Copper (USD)	1.75	7.64	0.28	0.00	65.06	152
Selling Price of Kilo of 14-20pct Copper (USD)	1.31	4.88	0.46	0.00	55.76	197
Selling Price of Kilo of Above 20pct Copper (USD)	0.96	2.50	0.46	0.00	23.23	194
Selling Price of Kilo of Copper (USD), Unknown Grade	0.96	1.91	0.46	0.09	11.15	73
Selling Price of Kilo of 0-6pct Cobalt (USD)	2.21	7.33	0.52	0.00	55.76	98
Selling Price of Kilo of 7-12pct Cobalt (USD)	4.59	16.30	0.84	0.07	111.52	107
Selling Price of Kilo of Above 12pct Cobalt (USD)	27.96	217.29	1.39	0.02	1,858.74	73
Selling Price of Kilo of Cobalt (USD), Unknown Grade	4.26	10.22	0.46	0.14	37.17	15

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology. To avoid the influence of data entry errors, we trim the monetary variables at the 0.5% and 99.5% level from below and above.

To summarize from this section, we find the following results:

- Mining labor in the region is mostly concentrated in artisanal mining: 74% of the mines in which households report to have worked are artisanal mining sites.
- Mining labor is mostly unorganized: 69% of mines have only workers organized in small teams. This may weaken bargaining power and result in a reduced share of the surplus.
- The Mining Police (Police des Mines et Hydrocarbures) provides security in only 49% of mining sites. The remaining mines are secured by private security firms, the secret service, the presidential guard, and other police agencies. Yet, these are often absent from the mines on a typical workday.
- The typical wholesale trader sources from 2 mines, 1 of which they report as having child labor.
- Miners' selling price for the most commonly traded type of cobalt is less than half and potentially as low as 6% of the price-by-weight that traders receive.

9 Appendix

Table 44: What Do the Typical Children Do in Mining Communities? Total Numbers in Sample

	Total	Fraction
# of children (3-17)	7,053	1.000
Not Working/NA	2,967	0.421
In School	3,454	0.490
Working in Household	4,005	0.568
Working Outside Household	788	0.112
In Agriculture/Other	383	0.054
Inside Mines	148	0.021
Processing Minerals	31	0.004
Business (External/Own)	99	0.014
Domestic Labor (External)	236	0.033
Does Not Know	6	0.001
N/A	3	0.000

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology. This table shows the total number of children in the sample, and breaks down their activities.

Table 47: Questions to Children About Views of Schooling

	mean	sd	median	min	max	count
Do You Think it's Good for Your Future to Go to School?	1.0	0.2	1	0	1	1,496
Does Your Mom Think it's Good for Your Future to Go to School?	1.0	0.2	1	0	1	1,485
Does Your Dad Think it's Good for Your Future to Go to School?	1.0	0.2	1	0	1	1,455
Do Your Siblings Think it's Good for Your Future to Go to School?	0.9	0.3	1	0	1	1,476

Notes: Based on child survey data. See Section 3 for discussion of sampling methodology.

Table 48: What Do Children Do? Estimations Of Village Chiefs

	mean	sd	median	min	max	count
Fraction of Children Working Outside Home	0.27	0.24	0.20	0.00	0.95	122
Fraction of Children Working in Mining	0.17	0.23	0.05	0.00	0.90	128
Fraction of Children Forced to Work Outside Home	0.09	0.18	0.00	0.00	0.80	123
Fraction of Children Forced to Work in Mining	0.04	0.11	0.00	0.00	0.70	121

Notes: Based on chief survey data. See Section 3 for discussion of sampling methodology.

Table 45: What Do the Typical Children Do in Mining Communities? Total Numbers in Sample, by Age

	3-5		6-8		9-12		13-15		16-17	
	Total	Fraction	Total	Fraction	Total	Fraction	Total	Fraction	Total	Fraction
# of children (3-17)	1,840	1.000	1,680	1.000	1,869	1.000	1,037	1.000	627	1.000
Not Working/NA	1,631	0.886	793	0.472	380	0.203	107	0.103	56	0.089
In School	197	0.107	955	0.568	1,278	0.684	683	0.659	341	0.544
Working in Household	204	0.111	878	0.523	1,474	0.789	910	0.878	539	0.860
Working Outside Household	15	0.008	82	0.049	241	0.129	238	0.230	212	0.338
In Agriculture/Other	6	0.003	34	0.020	115	0.062	126	0.122	102	0.163
Inside Mines	1	0.001	5	0.003	25	0.013	51	0.049	66	0.105
Processing Minerals	1	0.001	4	0.002	9	0.005	9	0.009	8	0.013
Business (External/Own)	1	0.001	9	0.005	28	0.015	28	0.027	33	0.053
Domestic Labor (External)	6	0.003	33	0.020	91	0.049	60	0.058	46	0.073
Does Not Know	0	0.000	1	0.001	1	0.001	1	0.001	3	0.005
N/A	0	0.000	1	0.001	0	0.000	1	0.001	1	0.002

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology. This table shows the total number of children in the sample by age range, and breaks down their activities.

Table 46: What Do the Typical Children Do in Mining Communities? Total Numbers in Sample, by Gender

	Male		Female	
	Total	Fraction	Total	Fraction
# of children (3-17)	3,570	1.000	3,483	1.000
Not Working/NA	1,749	0.490	1,218	0.350
In School	1,808	0.506	1,646	0.473
Working in Household	1,746	0.489	2,259	0.649
Working Outside Household	457	0.128	331	0.095
In Agriculture/Other	247	0.069	136	0.039
Inside Mines	109	0.031	39	0.011
Processing Minerals	22	0.006	9	0.003
Business (External/Own)	58	0.016	41	0.012
Domestic Labor (External)	80	0.022	156	0.045
Does Not Know	3	0.001	3	0.001
N/A	3	0.001	0	0.000

Notes: Based on Mining Community Household Survey. See Section 3 for discussion of sampling methodology. This table shows the total number of children in the sample by gender, and breaks down their activities.

Table 49: Questions to School Principals

	mean	sd	median	min	max	count
Fraction of Children in Your School Working For Money	0.19	0.24	0.10	0.00	0.92	61
Fraction of Children in Your School Working in Mining	0.09	0.17	0.00	0.00	0.65	60
Fraction of Children in Your School Working For Money By Their Own Choice	0.07	0.14	0.01	0.00	0.60	34
Fraction of Children in Mining Working By Their Own Choice	0.06	0.11	0.00	0.00	0.60	47

Notes: Based on principal survey data. See Section 3 for discussion of sampling methodology.