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Gold mining and education: a long-run resource curse in Africa?

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Abstract

We provide evidence on an important channel through which gold mining may adversely affect development in the long-run: lower educational attainment. Combining Afrobarometer survey data from three waves with geocoded data on the discovery and shutdown dates of gold mines, we show that survey respondents who had a gold mine within their district when they were in adolescence have significantly lower educational attainment as adults. Regarding mechanisms, we conclude that gold mines likely affect educational attainment adversely because households make myopic decisions when employment in gold mining is an alternative. We explore and rule out competing mechanisms such as endogenous migration, under-provision of schools, and a higher propensity for violent conflicts in gold mining districts. We also find that gold mines have a uniquely negative effect on educational attainment compared to other mineral resources, likely because of the amenability of gold mining to small-scale activities. Overall, our results suggest that gold mining may have adverse effects on human capital that are only visible in the long-run.

Keywords: Education, mineral resources, gold mining, survey data, Africa

JEL codes: H70, O10, D74

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1 Introduction

Since the turn of the century, the mineral resource sector has been booming in many African countries (AfDB et al., 2013; Chuhan-Pole et al., 2013). This growing importance of mineral resources will likely reshape the structure of African economies for the foreseeable future. It is, however, unclear what the resource boom portends for Africa's economic development and its inhabitants' well-being in the long-run. On the one hand, mineral resources and the income they may deliver can have immediate positive effects. People can find employment and earn, compared to the available alternatives such as subsistence agriculture, relatively high wages (Hilson, 2016). Fiscally constrained governments might receive additional revenues, which they can use to fund essential public goods and generally better the living conditions of their citizens (Calder, 2014).

On the other hand, an influential literature argues that mineral resources may be a curse rather than a blessing for developing countries (van der Ploeg, 2011). Mineral resource booms may lead to exchange rate adjustments that work to make non-resource sectors less competitive, an effect termed the "Dutch Disease" (Corden, 1984). The existence of mineral resources has also been associated with political economy mechanisms that have adverse effects: resources can be a tempting target for predatory political groups and lead to corruption (Leite and Weidmann, 2002; Knutsen et al., 2016) and political instability, including violent conflicts (Lujala et al., 2005; Ross, 2004b). Further adverse effects include heightened volatility in public revenues (Humphreys et al., 2007) and a reduced need for rulers to bargain with their citizens over taxation and thus less democracy and worse governance (Baskaran and Bigsten, 2013; Ross, 2004a).

In this paper, we contribute to the discussion on the benefits and drawbacks of mineral resources and, more specifically, to the debate on the implications of resource booms in Africa by focusing on the production of gold, a major mining resource for Africa. One important feature of gold production in Africa is the disproportionate importance of small-scale, artisanal operations (Hilson, 2016). The ability to profitably extract gold in small-scale operations implies that children and young adults can easily find employment in gold mining. Families may hence neglect the education of their children and instead allow or even encourage them to work. Thus, one subtle curse of gold, one that could only be observable in the long-run, may be lower educational attainment.

In line with this hypothesis, we provide micro-level evidence that men and women have lower levels of education as adults if they had a gold mine in their neighborhood when they were in adolescence. We also offer suggestive evidence for the mechanism discussed above, i. e. that the lower educational attainment comes about because families in gold mining districts encourage their children to work, by ruling out other transmission channels, notably a reduced provision of schools in mining districts by the government, endogenous migration, and a higher propensity of conflicts. Various extensions provide further support for this interpretation. In particular, we show that smaller gold mines have a more adverse effect on educational attainment than larger mines and that mineral resources other than gold have no negative effect on educational attainment. These results suggest that gold affects educational attainment negatively because of its amenability to small-scale activities and hence the possibility for children to work in this sector.

Finally, our results indicate that respondents who had mines in their neighborhood during their youth witness as adults no better and possibly worse economic conditions than respondents without any gold mines. This result implies that in the long-run, the negative educational effects of gold mining are not outweighed by persistently higher incomes. Overall, our findings indicate that the presence of mines may induce children or their parents to make life choices that are myopic and do not pay off in the long-run. These broader implications of gold mines should be taken into account to properly assess the benefits and drawbacks of the mineral resource boom in Africa.

To explore individuals' educational attainment during adolescence in mining and non-mining districts, we match data on the location and dates of operation of gold mines to georeferenced survey data on educational attainment from the 3rd to 5th wave of the Afrobarometer surveys. Using a sample of 30 countries, we find that the presence of a gold mine in the district of a respondent when she was in adolescence has a significantly negative effect on her educational attainment as adult.[1] This effect is robust to the omission of individual countries, to the use of different ages to indicate adolescence, and in a number of further robustness tests.

As mentioned, our findings contribute to an influential literature on the drawbacks and benefits of mineral resources.[2] A substantial body of anecdotal evidence suggest that mineral resources do not necessarily lead to higher incomes and may, in fact, have negative consequences. Bevan et al. (1999), for example, show that despite a large increase in oil revenues, income stagnated and poverty increased in Nigeria until the turn of the century. Growth and poverty reduction were similarly disappointing in many other resource rich countries (Stokke, 2008). On the other hand, Botswana is often cited as one prime example where natural resources can be beneficial: even as 40% of its GDP is due to diamonds, it has managed to generate high growth rates since 1965 and to invest a substantial share of its national income for public education (Sarraf and Jiwanji, 2001). Another positive example is the United Arab Emirates, where hydrocarbon wealth has led to better infrastructure and an expansion of various public goods and services (Fasano, 2002).

Anecdotal evidence on whether mineral resources are a curse or a blessing is thus contradictory. More systematic evidence is offered by a large literature that explores their consequences at the cross-country level. The seminal work by Sachs and Warner (1995)

[1]The Afrobarometer data is georeferenced in that it provides information on the "district" of a respondent. District is the the name used by the Afrobarometer surveys for the lowest administrative tier of a country on which information on the place of residence of an Afrobarometer respondent is available (the next higher administrative tiers are regions and the country). The information on districts is available form the 3rd wave onwards.

[2]For theoretical work on the effect of mineral resources, see e. g. Auty (2001) and Hodler (2006).

suggests that natural resources tend to depress economic growth. On the other hand, Bhattacharyya and Hodler (2009) and Mehlum et al. (2006) find that mineral resources have positive economic effects if pre-existing institutions are "producer friendly". Brunnschweiler and Bulte (2008) argue that commonly used measures for resource abundance conflate abundance with dependence. Using ostensibly more accurate measures for resource abundance than the previous literature, they find that natural resources have a positive effect on institutional quality and growth. James (2015) finds that the resource curse is a "statistical mirage": a slow-growing resource sector disproportionately affects overall growth in resource-dependent countries and may show up as a negative growth effect of natural resources in statistical analyses.

A related literature explores various transmission channels through which natural resources may depress long-run growth. Collier and Hoeffler (2004, 2005) suggest that mineral resources increase the propensity of conflicts. Jensen and Wantchekon (2004) find that resource wealth and the level of democracy are negatively correlated. Finally, Gylfason (2001), arguably the study that is most closely related to our work, observers that resource-rich countries tend to neglect education: public expenditures as share of national income for education as well as gross secondary-school enrollment is lower in these countries.

One problematic aspect of of the above literature is that it relies on cross-country variation. Given the heterogeneity across countries, it is unclear whether this literature is able to identify a causal effect. A new but relatively small literature hence uses micro-level data and exploits within-country variation. Tolonen (2014), for example, finds with geocoded data on mines and survey data from the Demographic and Health Surveys that the opening of large, industrial-scale gold mines improves gender equality. Knutsen et al. (2016) find that the opening of mines increases bribe payments using Afrobarometer data. Aragón and Rud (2013) conclude that mines increase incomes even for unskilled workers in non-mining sectors due to backward linkages and thus have positive spillovers across sectors. Loayza et al. (2013) identify similarly positive effects on local incomes of mining. Black et al. (2005), on the other hand, observe only limited spillovers of coal mining into non-mining sectors. Berman et al. (2014) find with georeferenced data on both mining activities and violent conflicts that mining significantly increases the probability of conflicts. Wilson (2012) observes that mines have adverse local health effects in Zambian cities. Bazillier and Girard (2017) focus on the opening on new gold mines in Burkina Faso and show that large-scale mining activities have no backward linkages to other sectors and no effect on household consumption. Artisanal activities, on the other hand, seem to increase household consumption.

Using an approach similar to ours, Fenske and Zurimendi (2015) relate oil price shocks during adulthood to educational attainment (and other outcomes) in Nigeria. Their results suggest that individuals from the South – i. e. Nigeria's oil producing regions – who were in adolescence during times of high oil prices have higher educational attainment as adults than individuals from the same age cohort from the North.[3] This result is in contrast to our findings and may reflect the difference in amenability of gold mining and oil extraction to small scale activities. Alternatively, the different findings may be due to their focus on Nigeria while we explore the long-run effects of gold mining across 30 countries.

This paper is also related to the broader literature on the determinants of educational attainment. At the most basic level, individuals' educational attainment in equilibrium can be modeled as the outcome of a comparison between the opportunity costs of acquiring further education and its expected returns (Becker, 1964, 1965). In practice, opportunity costs or expected returns have been found to depend on the cognitive skills of a child (Bacolod and Ranjan, 2008; Sawada and Lokshin, 2009), the age of school entry (Angrist and Krueger, 1992), family or community background (Tansel, 2002), school and

[3]Similarly, Adhvaryu et al. (2014) show that high crop prices during early life improve mental health outcomes for individuals in crop-producing regions of Ghana.

class characteristics (Altonji et al., 2005; Angrist and Lavy, 1999; Dee, 2005), and government policies (Duflo, 2004; Hanushek and Woessmann, 2006). Our findings suggests that available employment opportunities for children are another important determinant of educational attainment. Even if the higher income in gold mining districts enables households to invest in the education of their children, the employment opportunities offered by gold mines seem to be sufficiently large for the substitution effect to outweigh the income effect.

2 Background

2.1 The process of gold mining

Gold is one of the world's most economically important and versatile minerals. It can be used for jewelery, for coinage, in electronics, and various other industrial applications. This broad range of uses makes gold a highly valued commodity. At the same time, its rarity ensures that gold mining can be a profitable even for small-scale operations.[4]

Gold is extracted from various ores that contain small, and often minuscule, amounts of gold particles. Depending on the characteristics of a particular gold deposit, i. e., an expanse of ores with a significant concentration of gold, different extraction methods are employed. Some gold mines are exploited predominantly with capital intensive methods. In open pit mines, for example, the ore is excavated from the hard rock with dynamite. The ore is then transported with large trucks to be processed further using chemicals such as cyanide to separate the gold particles from other materials.[5]

Gold can also be mined with more labor intensive methods. In particular, miners involved in placer mining use simple tools such as pans or sluices to extract gold from alluvial

[4]The concentration of gold in one ton of earth is about 0.005 grams (Eugene and Mujumdar, 2009).

[5]See Gasparrini (1993) for more details on the process of gold extraction and mineral processing.

deposits at, e. g., stream beds. This method relies on the fact that gold particles are heavier than the host rocks and thus can be washed out.

Given that gold can be extracted with such relatively simple methods, small-scale (artisanal) mining activities are particularly common around gold mines. In fact, even large and capital-intensive mines provide opportunities for small-scale mining. For example, lower grade ore is often discarded and used as mine fill by mining companies. The fill can be further mined by artisanal miners. The amenability of gold mines to small-scale activities is a notable feature given the importance of this form of mining in Africa and, more generally, in the developing world. It is estimated that about 13 million people are directly involved in small-scale mining globally; another 80-100 million depend in some indirect fashion on this type of mining (Hentschel et al., 2003). A significant fraction of the small-scale miners are engaged in the extraction of gold (Hilson, 2016).

2.2 The effect of gold mining on education

Gold mines, as any type of mineral resources, can have a positive effect on educational attainment by increasing household incomes. The higher incomes that can be earned in the mining sector (compared to e. g. agriculture) should enable households to keep their children in school (Weber-Fahr et al., 2002). On the other hand, gold mining can have adverse effects on educational attainment through various channels. One obvious, and as shown below, presumably the most relevant channel in our context, is that parents may prefer to send their children to work for subsistence rather than to school. The children themselves may also prefer to earn money immediately rather than to invest in their education, possibly because they perceive the returns to education to be too uncertain. Even if large mining companies do not employ children or untrained youth, the importance of (often informal) small-scale mining for the excavation of gold implies that it is reasonably easy for children to find employment in the production of gold.

Children are known to work either directly in the mines or in ancillary roles. Children as young as three are employed to wash gold; from six years onward they may break rocks; from 12 years onward they can work underground and do the same work as adults (Hentschel et al., 2003). Ancillary roles include activities such as suppling provisions and tools to the miners. These ancillary roles are assumed by both boys and girls. Thus, the mining sector is not necessarily dominated by men even if work in the mines consist of hard manual labor (ILO, 2007; Tolonen, 2014). In fact, in some countries women constitute the majority in the mining sector; for example, Hentschel et al. (2003) note that 75% of the workforce in the artisanal mining sector of Guinea are women. Young women and girls may also be have opportunities for employment in sectors that are connected to gold mining through forward or backward linkages, i. e. because of local multiplier effects of gold mines (Moretti, 2010). Thus, any negative effect of mining on education could be observable for both genders.

In addition to children and young adults working in mines and connected sectors rather than attaining education, three possibly important alternative channels through which gold mines may appear to have adverse effects on education are the following. First, the government may provide fewer educational facilities in mining districts; it may anticipate that people living in mining districts have sufficient economic opportunities anyway and therefore are less in need of educational resources. Second, any negative relationship between gold mines and education may be due to endogenous migration of less educated workers to mining districts.[6] That is, gold mining districts may have a higher share of less educated inhabitants, not because inhabitants choose to acquire less education but because less educated individuals are more likely to migrate into gold mining districts. Third, gold mines may increase the likelihood of political conflicts and violence (Collier and Hoeffler, 2004,

[6]It is, of course, also possible that migrants into mining districts are more educated than the locals (Loayza and Rigolini, 2016).

2005; Berman et al., 2014). For example, conflicts may disrupt the education of children by displacing their families. We explore these alternative channels below.

3 Data

3.1 Afrobarometer

To analyze the effect of gold mining on educational attainment, we rely on the 3rd to 5th wave of the Afrobarometer survey. The Afrobarometer is an "independent, nonpartisan research project that measures the social, political, and economic atmosphere in Africa". The third wave was conducted in 18 countries around 2005, the fourth wave was conducted in 20 countries around 2008, and the fifth wave as conducted in 34 countries around 2011-2013. Since we rely on subnational variation in the regressions, we drop four very small countries from the sample (Cape Verde , Lesotho , Mauritius , Swaziland). Our final sample thus includes 30 countries from all parts of Africa.[7] The total number of observations used in the regressions is 91,062.[8] Since the names of the district vary across waves, we always work with district-wave pairs (i. e. we treat the same district from different waves of the Afrobarometer effectively as different districts). Overall, our sample includes 4950 district-wave pairs.

To measure educational attainment, we use the following question from the Afrobarometer:

[7]The countries are: Algeria, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Egypt, Ghana, Guinea, Ivory Coast, Kenya, Liberia, Madagascar, Malawi, Mali, Morocco, Mozambique, Namibia, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

[8]This number is slightly lower than the total number of respondents in the three waves, which is 103,633. In addition to the dropping the four small countries, we also lose observations because of missing information on some respondent's educational attainment and because we are unable to obtain geocodes for some districts in the different waves of the Afrobarometer (and hence could not match these districts to the gold mines data).

What is the highest level of education you have completed?[9]

We code the different stages of educational attainment using discrete values ranging form 0 to 9.[10]

In Figure 1, we plot the distribution of the educational attainment of the 91,062 respondents included in our sample. The median respondent has some but incomplete secondary education. There is also a substantial fraction of respondents who have only primary education or no education at all. Figure 2 describes the age distribution of respondents. The age distribution is interesting because we will subsequently relate gold mines during adolescence to educational attainment. It is obvious from Figure 1 that the minimum age to be eligible for participation in the survey is 18 years. Most respondents are nevertheless quite young, thus reflecting the overall age structure in the countries in our sample. The median respondent is 33 years old. There are, however, also some respondents in the sample that are (or claim to be) very old.

The Afrobarometer surveys also provide information on the geographical location of a respondent. That is, we know her "district", which is the name for the second-level administrative tier. We use the information on the district to define the "neighborhood" of a respondent to which we match the presence of gold mines during her adolescence. One drawback of this definition is that districts can have different sizes[11] and thus gold mines that are equally far away from the actual location of a respondent may not always be classified in the same way. In our main estimations, district-wave fixed effects account for such systematic differences in district sizes.

[9]Possible answers are: no formal schooling, informal schooling only (including Koranic schooling), some primary schooling, primary school completed, some secondary school/ high school, secondary school completed/high school completed, post-secondary qualifications, other than university e.g. a diploma or degree from polytechnic or college, some university, university completed, post-graduate.

[10]We also use further questions form the Afrobarometer. We describe these in the relevant sections.

[11]The minimum land are covered by a district in our sample is 1.5 km^2 (Medina in Tunis, Tunisia) while the maximum is 334,853 km^2 (Tombouctou in Timbuktu, Mali). The median district area is 1,961 km^2. Compare this to the area of Los Angeles county, which is 12,305 km^2.

Another drawback is that administrative borders may change. Thus, mines that are classified as close according to contemporaneous borders because they are located in the same district in which a respondent currently lives may have been in a different district when the respondent was young. Related to this issue, the Afrobarometer only notes the current district of a respondent, not the district when the respondent was young.

Despite these drawbacks, a definition of neighborhood based on district is useful. First, even if districts can cover areas of different sizes, they are generally reasonably small and capture the concept of neighborhood well. Second, administrative boundaries provide a natural and objective measure of closeness. Finally, educational facilities are typically planned and operated based on administrative boundaries such as districts.

3.2 Data on gold mines

We match the Afrobarometer data with data on the location (as indicated by longitude and latitude coordinates) and dates of operation of a large share of current and historical gold mines of commercial interest in Africa. This data is from MinEx Consulting, which is a private mining consulting company. MinEx estimates that its data covers 99% of all giant-sized deposits, 95% of all major deposits, 70% of moderate deposits and 50% of minor deposits.[12]

[12] The thresholds are: Minor $\geq$ 0.03 Moz Au (millions of ounces), Moderate $\geq$ 0.32 Moz Au, Major $\geq$ 2.24 Moz Au, Giant $\geq$ 11.18 Moz Au, Supergiant $\geq$ 80.00 Moz Au.

Figure 3 shows the location of the 416 gold mines included in our dataset.[13] There is substantial variation across countries in the presence of gold mines: some have many while others have none. In countries with gold mines, there is also considerable variation at the within-country level.[14]

We project the latitude and longitude coordinates of the mines that were in operation in a given year onto a district-level map (shapefile) of the countries included in our sample.[15] We then match the mines data to the Afrobarometer data. Specifically, we calculate the year in which a particular respondent was 12 years old based on the Afrobarometer data and then match the number of operating mines (and their various characteristics) in her district in that year. We generally define an age of 12 years as adolescence of a respondent (we explore the robustness of our results to other definitions of adolescence below).

The district names in the Afrobarometer and the names used in the shapefile to project the mines coordinates are often different. Hence, to match both data sources, we use a Google Maps routine to retrieve "characteristic" (as assessed by the Google Maps) longitude and latitude coordinates for the district names in the Afrobarometer. We then project these coordinates onto the shapefile and thus match the Afrobarometer district names with the names used in the shapefiles.

[13]The original MinEx data has a larger coverage of mines. When constructing the dataset for this study, we omit mines that are in countries not in our sample (except in one robustness test; see below for details). Of all mines noted in the MinEx data for the countries in our sample, we include those that have been discovered and not yet shut down as of 2015. We include all discovered mines even if they have not formally been started up because (informal) small scale mining might take place even before formal mining activities begin. We drop mines where we do not know the discovery year (i. e. mines for which discovery year is missing in the MinEx data) and all mines where we know that they were closed as of 2015 but do not know the exact closing date (i. e. mines for which shutdown year is missing). In other words, we include all discovered mines where it is not unambiguously clear that they have been shut down as of 2015.

[14]The mines also vary considerably in their size: of the 416 mines in our sample, 11.3% are classified as minor, 29.8% as moderate, 32.6% as major, 22.6% as giant, and 3.6% as supergiant.

[15]The shapefile data is from the *GADM database (www.gadm.org), version 2.5, July 2015.*

4 Empirical framework

We estimate specifications that relate educational attainment to the presence of mines during adolescence. Our preferred specification is:

$$y_{i,T} = \beta \text{Gold mine}_{i,t} + \gamma_d + \gamma_e + \gamma_t + \epsilon_{i,T}, \quad (1)$$

where $y_{i,T}$ is educational attainment of respondent i in the year T when the Afrobarometer survey was taken.

Gold mine$_{i,t}$ is a dummy that is 1 if the district of a respondent had at least one gold mine when she was 12, and 0 else. γ_d are district-wave fixed effects (which when included encompass the country fixed effects). γ_e are ethnic group - wave fixed effects.[16] γ_t are dummies for the year of adolescence of a respondent (cohort fixed effects). Such cohort fixed effects are important to account for the systematically increasing educational attainment over time, i. e. younger respondents are more likely to be better educated due to general societal trends. $\epsilon_{i,T}$ is the error term. We rely on heteroscedasticity-robust standard errors for inference. We also cluster standard errors at the district-wave level.

With this specification, we hence identify the effect of gold mines in adolescence on contemporaneous educational attainment while holding district-wave, ethnic group - wave, and cohort effects constant. In particular, by including district-wave fixed effects, we are able to control for any geographical features that may be systematically related to educational outcomes and the presence of gold mines.[17] This is important because gold mines may be less likely to be discovered or relatively unprofitable if they are located in remote areas. At the same time, educational attainment in such districts may be lower

[16]Note that we include separate dummies for respondents with non-standard responses, e. g. for those who do not know their ethnicities, refused to answer, etc. The results are similar if we drop these observations.

[17]As the district and ethnic group fixed effects vary across waves, we also control for wave-specific effects in districts and across ethnic groups.

for other reasons, for example because countries invest less in education in districts that are remote. Similarly, ethnic group fixed effects account for any systematic correlation between the education levels of different ethnicities and the suitability of their settlement area for mineral resources or their propensity to migrate toward mining districts.

One underlying assumption in this empirical design is that respondents in districts with gold mines were more likely to work in the mining sector (and possibly in sectors connected with the mining sector through upward or downward linkages when they were young). While there is no data on employment histories in the Afrobarometer, this assumption is plausible on average. Given the high level of spatial disaggregation by which we define neighborhood and the importance of mines for the local economy in Africa, it is likely that many respondents who had a mine in their district during adolescence were either directly or indirectly affected by the mining sector.

5 Baseline results

5.1 Main effects

Table 1 collects the baseline results. In Model (I), we estimate a parsimonious specification and include only country fixed effects. In Model (II), we replace the county fixed effects with district fixed effects (which encompass the country fixed effects). Model (III) finally adds ethnic group fixed effects. All models are estimated with OLS.[18]

Overall, we find that the presence of (at least) one mine in one's district during adolescence reduces educational attainment by 0.14 to 0.18 points. The estimate is statistically significant in all models. One interpretation of the magnitude of this estimate is, for example, that the presence of a mine leads one in five respondents who would have oth-

[18]Ordered probit estimations produce qualitatively similar results.

erwise completed secondary education to drop out and end up with only some incomplete secondary education.

5.2 Extensions

5.2.1 Transition to higher educational stages

While the specifications reported in Table 1 estimate an average effect across all educational stages, gold mines presumably affect some stages more adversely than others. In particular, if the adverse effect of gold on educational attainment is due to the employment opportunities in artisanal mining, it is unlikely that the presence of gold mines dissuades someone who has already acquired secondary education from entering tertiary education or deters university graduates from pursuing post-graduate studies. The economic opportunities that gold mines offer may be more attractive for children and their parents at lower stages of education and gold mines may thus have a more adverse effect on transition probabilities at these stages.

Hence, we estimate the following variants of Equation 1. Rather than a count variable, we specify a binary dependent variable that is one if a respondent has achieved a certain level of education and 0 else. First, we construct a dummy that is 1 if a respondent has at least some informal (e. g. Koranic) schooling and 0 else and re-estimate equation 1 with this dummy as dependent variable. Next, we construct a dummy that is one if a respondent has at least some formal primary education and 0 else and again re-estimate Equation 1 with this dummy as dependent variable. We adopt this approach for all further stages of education. These models allow us to asses at which educational stages gold mining matters most.

The results are collected in Figure 4. They indicate that gold mining matters most during the period between primary and secondary education. Specifically, gold mines have the most adverse effect on the likelihood that a respondent attempts to pursue or completes secondary education: the probability is about 6 percent lower. Gold mines have, however, also large negative effects on the likelihood that primary education is completed or that post-secondary (but not university) education is taken up. On the other hand, gold mines do not affect the propensity of transitioning to university or post-graduate education, presumably because these students are from a socio-economic stratum where employment in (artisanal) gold mining is not a serious consideration. There are also no effects on acquiring informal or some formal primary education, which likely reflects the fact that there are fewer employment opportunities in gold mining for very young children.

5.2.2 Gender-specific effects of gold mines

As discussed in Section 2.2, gold mines may adversely affect the educational attainment of men and women in a similar fashion given that mining is not exclusively a male activity. On the other hand, while the gap is narrowing, educational attainment of women is generally lower in Africa. Thus, gold mining might carry a relatively smaller educational cost for women: i. e., they may receive less education anyway and working in gold mining may overall be preferable to, for example, agricultural employment.[19]

To explore possible gender-specific effects, we append Equation 1 with a dummy for female respondents and an interaction between the female dummy and the gold mines dummy. The sign and significance of the interaction effect indicates whether the education of men or women is affected more adversely by gold mines during adolescence. The results are collected in Model (I) of Table 2. We find that the dummy for female respondents is significantly negative, reflecting the fact that there still remains a gender gap in educational

[19]In fact, Tolonen (2014) finds that gold mines improve gender equality in Africa. Kotsadam and Tolonen (2016) also show that mine openings cause a shift in the employment pattern, with women switching from the agricultural to the service sector.

attainment in Africa. However, the interaction effect is insignificant, which suggests that the educational cost of gold mining affects men and women equally.

5.2.3 The size of gold mines

Another important question is whether the educational cost of gold mines is mostly confined to smaller mines. Answering this question is important because it helps us to understand further why gold mines have adverse educational effects (it is thus related to the mechanisms that are responsible for the baseline results). Specifically, given the importance of artisanal mining for the excavation of gold and the relatively low level of governmental monitoring of these activities, children and young adults may easily find employment in smaller gold mines as artisanal miners. Larger gold mines, in contrast, are likely exploited by corporations, which may be scrutinized more heavily; the corporations themselves may also prefer to hire a better trained and older workforce. If the susceptibility of gold to small-scale mining is the reason for why gold mines have adverse educational effects, this would validate the interpretation that the direct employment opportunities offered by gold mines are an important reason for their adverse effect on educational attainment.

To explore whether the educational impact of gold mining varies according to the size of a mine, we report in Model (II) of Table 2 estimates for dummy variables indicating "smaller" (mines that are classified either as minor or moderate) and "larger" gold mines (mines that are classified as either major, giant, or supergiant).[20] We generally find that the adverse effect of gold mining is particularly pronounced for smaller mines. This result suggests that the amenability of gold to artisanal small-scale mining is an important reason why gold mines affect educational attainment negatively. We also observe a negative, albeit smaller and insignificant, coefficient estimates for larger mines. This negative yet smaller effect for larger mines is consistent with the interpretation that the employment opportunities in

[20]Note that since a district can have multiple mines, both dummies can simultaneously be one for a given respondent.

gold mining are responsible for the lower educational attainment. First, artisanal mining takes place at larger mines as well, for example if discarded minefill is further exploited by artisanal miners. Moreover, there may also be indirect effects on children in districts with large gold mines due to employment opportunities in sectors that are connected to the mining sector through forward and backward linkages.

5.2.4 The price of gold, frictions in educational choices, and income and substitution effects

To further understand the relationship between gold mining and educational outcomes, we explore the impact of the price of gold on educational attainment. If the gold price is high, gold mining should become more attractive relative to going to school in mining districts. Wages in the mining sector should increase and artisanal miners should be able to sell their produce for a higher price. Yet, the income effect may also outweigh the substitution effect. That is, an increase in the price of gold may raise household income sufficiently for parents to be able to forgo the extra income from sending their children to work, allowing them instead to send their children to school. This argument is the reason why e. g. Fenske and Zurimendi (2015) focus on variation in resource prices to explore the long-run consequences of natural resource income. Alternatively, educational choices may be subject to frictions. Once parents have decided to send their children to work rather than to school, the current price of gold, and thus any variation in the returns to gold mining, may not matter much at the margin.

We explore this question by extending Equation 1 with a continuous variable measuring the price of gold when a respondent was in adolescence[21] and an interaction effect between gold mines and the price of gold. The results are collected in Model (III) of Table 2 and suggest that the contemporaneous price of gold is unimportant for educational attainment.

[21] The data is from the World Bank's Commodity Price Data Database, Feb. 04, 2016.

That is, the interaction effect between gold mines and the price of gold is insignificant. The main effect for the presence of gold mines continues to be negative and of the same order of magnitude as in the baseline regressions.[22] These results suggest that educational choices are either subject to some frictions and the income effect following an increase in gold prices does not outweigh the substitution effect.

5.2.5 Other mineral resources

To understand the baseline results further, we explore the effect of minerals other than gold on educational attainment. The discussion in Section 2 suggests that, in general, mineral resources may have either a negative or a positive effects on educational attainment: the income effect likely works to increase households' demand for the education of their children while the substitution effect incentivizes households to send their children to work in the mining sector.

For gold mines, we listed a number of reasons why the substitution effect could outweigh the income effect – in particular, that children can find employment in the gold mining sector with relative ease given the amenability of gold mining to artisanal methods. For other types of mines, the overall effect may be different. If a mineral resource is produced with capital-intensive methods and can therefore only be exploited by large corporations, children may be unable to find employment in the relevant mines.

To explore this issue, we report in Table 3 regression results similar to the baseline specifications but with three alternative dummy variables. The first dummy variable, *Only non-gold mines*, is one when a respondent had a non-gold mine but no gold mine in her district during adolescence.[23] The second variable, *At least one non-gold mine*, is one if a

[22] The significance levels on the main effect by themselves are not informative about whether gold mines have a significant effect as the marginal effect of gold mines and the associated standard errors change with the value of for the gold price.

[23] We consider the following minerals: Andalusite, Asbestos, Barium, Calcium, Chromium, Cobalt, Copper, Diamonds, Flourine, Fluorite, Gold, Graphite, Lead, Manganese, Mercury, Mineral Sands, Molyb-

respondent had at least one non-gold mine in her district at adolescence (irrespective of the number of any additional gold mines). Finally, *Exclusively gold mine* is one if a respondent only had gold mines but no other types of mines in her district during adolescence. The first two dummy variables thus allow us to explore the effect of non-gold mines on educational attainment while the third enables us to confirm that it is indeed gold rather than other mineral resources that is responsible for the baseline results.

We find that the first two dummies are positive and statistically significant. This suggests that the presence of non-gold mines during one's adolescence has no adverse effect on educational attainment, in fact such mines lead to improvements. In contrast, respondents who only had a gold mine in their district during adolescence have lower educational attainment. Overall, these results provide further evidence that the negative effect of mining is specific to gold and comes about because its production is amenable to artisanal methods.

6 Robustness

6.1 Different years of adolescence

The baseline results suggest gold mines have a negative effect on educational attainment. However, these results may be a statistical artifact due to our particular definition of adolescence, which we assumed to be at age 12. To confirm that the results are robust to different definitions of adolescence, we re-estimate Model (III) in Table 1 after matching the number of mines at age 5 to 15. That is, we explore the presence of mines at age 5, 6, ..., 15 on educational attainment at the time the corresponding wave of the Afrobarometer was conducted.

denum, Nickel, Niobium, PGE, Platinum, Rare Earths, Ruby, Sapphire, Silver, Sulphur, Tantalum, Tin, Tungsten, Uranium, Vermiculite, Zinc, Zircon.

We plot the coefficient estimates for these eleven models in Figure 5. This figure confirms that the baseline results are not an artifact of defining adolescence at the age of 12. In fact, the presence of gold mines at age 5 up to age 15 results in a similarly negative coefficient estimate. These results correspond to the findings in Figure 4 and indicate that primary and early secondary education is particularly vulnerable to the employment opportunities offered to children by the gold mining sector.[24]

6.2 Dropping countries

Another concern with the baseline estimates is that they are driven by one particular country. According to Figure 3, gold mines seem to be particularly prevalent in a few countries, for example South Africa, Botswana, and Ghana. Even though we rely on within-region variation for identification, our estimates could be driven by a particular country, limiting the external validity of our findings. To address this concern, we re-estimate our preferred model (Model (III) in Table 1) after dropping in turn each country otherwise included in the sample.

The results are collected in Figure 6. This figure collects the 30 coefficient estimates and 90% confidence interval after dropping each of the countries in turn. The coefficient estimates are remarkably stable. The only noteworthy effects are due to Burkina Faso and South Africa. Dropping these two countries results in a notable drop in the estimated coefficients. The reason is presumably that both countries have a large number of gold mines and thus a relatively large effect on the estimated coefficient. Overall, however, we can conclude that our results are not driven by any single country.

[24]Note, however, that gold mines may have existed in a district before a respondent was born and after she has completed her adulthood. Thus, we may observe adverse effects for earlier and later ages as well.

6.3 Placebo tests

One further strategy to validate that the effect of gold mines on educational attainment found in the baseline regressions is not spurious is to conduct a placebo test. In this section, we hence explore educational attainment of respondents whose districts had no gold mines when they were in adolescence but whose district bordered districts with gold mines. If the baseline estimates are biased due to omitted variables, we should observe a similarly low level of educational attainment for such respondents if any omitted variables are spatially correlated.[25]

We construct a dummy variable that is one for respondents who had no gold mines in their district when they were in adolescence but whose district bordered a gold mining district. We ignore country borders when identifying neighboring mines (i. e. we include mines in neighboring district that are in another country) and also consider mines in African countries that are otherwise not included in our sample because they are not covered by the Afrobarometer (i. e., mines just across the border).

We relate this dummy variable to educational attainment by estimating variants of Equation 1. Model (I) of Table 4 only includes the dummy for gold mines in neighboring districts during adolescence and is estimated with a sample that includes only respondents who had no gold mines in their districts during adolescence. This model thus compares the educational attainment of respondents without any mines during adolescence in their own and in neighboring districts with the attainment of respondents who had no mines in their own district but had a mine in at least one neighboring district. Model (II) includes all districts and controls both for the dummy for mines in one's own district and the dummy for mines in neighboring districts during adolescence. Model (III) replicates Model (II) but limits the sample to only respondents that had either a mine in their own or in a

[25]Note that lower educational attainment in non-mining districts that border mining districts may not necessarily be due to omitted variables. It is also possible that mines have spillovers across district boundaries.

neighboring district during their adolescence. Given the smaller sample size, we omit the district-wave fixed effects in this regression.

All models indicate that the educational attainment of respondents in non-mining districts that neighbor mining districts is not significantly different than of respondents in generic non-mining districts. This suggests that our baseline results are not due to (spatially-correlated) omitted variables.[26]

7 Further evidence on mechanisms

The results reported above suggest that mining has a negative effect on educational attainment. As argued, the most important channel is likely that respondents decide to work in the mining sector and in turn neglect their education. However, there are further channels that may also be important. In this section, we explore three alternative channels and asses to what extent they can explain the baseline findings.

7.1 Gold mines and schooling

Besides respondents preferring to work and thus dropping out of school, gold mines may have a negative effect on educational attainment because the government provides fewer schools in mining districts. The government may believe that children in mining districts can easily find employment in the mining sector and are thus less in need of an education. We explore the importance of this alternative transmission channel by relating the presence of gold mines in the year before the relevant wave of the Afrobarometer was conducted to the presence of schools in the year of the survey. If governments provide fewer schools to districts with mines, we should observe a negative correlation between whether a district

[26] A fortiori, these results also suggest that mines have no significant spillovers across district boundaries. This is in line with the results in Loayza and Rigolini (2016), who find that the effects of mines are primarily local.

had a mine in the year before the survey and the presence of schools. The results are collected in Model (I) of Table 5. Note that this model omits the district-wave fixed effects as they would be perfectly collinear with the variable capturing the presence of contemporaneous mines in a district. Overall, there is no evidence that the provision of schools is lower in districts with gold mines.

Another test for this transmission channel would be to control for the presence of schools during adolescence. However, the Afrobarometer does not provide such data and thus we cannot implement this strategy. As an alternative, we control for contemporaneous schools in a respondent's neighborhood. Contemporaneous schools may be a good proxy for schools during adolescence if there is some persistence in their provision. Thus, we include in Model (II) of Table 5 the presence of schools as a covariate and re-estimate the baseline model. However, one problematic feature of this model is that the full sample includes individuals that are very old. Contemporaneous schools may be an imperfect proxy for schools during adolescence particularly for these respondents. Therefore, we report in Model (III) estimates where we limit the sample to the set of respondents that were in adolescence after 2000, i. e. to those respondents who were still relatively young when the surveys were taken. Given the smaller sample size, we omit the district fixed effects in these regressions.

The results from these models indicate that there is a strong correlation between the presence of schools in a respondents neighborhood and her educational attainment. However, the inclusion of the schools variable does not attenuate the negative coefficient estimate for gold mines. These results suggest that the negative effect of gold mines is not due to underinvestments in schooling within mining districts by the government.

7.2 Endogenous migration

Another potentially important channel is that individuals who are in search of employment migrate to mining areas. It is possible that migrants are relatively less educated than the natives. If this would be the case, then we may observe a negative relationship between mines and the educational attainment of some respondents not because mines lead children to drop out of school, but rather because they attract relatively uneducated individuals from other regions.

The Afrobarometer provides no information on whether a respondent migrated to her district. However, we can explore this issue by matching the self-described ethnic group of a responded from the Afrobarometer to data on the native homelands of African ethnicities according to Murdock (1959). The idea is that respondents who belong to one of the native groups of the district are less likely to have migrated due to the presence of mines while respondents with a non-native ethnicity are more likely to have done so. Thus, by focusing on whether a respondent belongs to the native ethnic groups we can rule out, to some extent, this alternative interpretation.[27]

We match geocoded data on the location of ethnic groups according to Murdock (1959) to the ethnic group information in Afrobarometer using a mapping of ethnic group names provided by Deconinck and Verpoorten (2013). As the information in Deconinck and Verpoorten (2013) only pertains to the 4th wave of the Afrobarometer, we limit the sample to only this wave in the following.

Table 6 collects the regression results. Note that given the smaller sample size, we omit the district fixed effects in these regressions. In Model (I), we add to the baseline specification a dummy for whether a respondent's ethnicity matches with one of the native groups of her district (termed *ethnic homeland*). As before, we find that gold mines have a

[27]We acknowledge that this strategy does not rule out endogenous migration at very low levels of geography, i. e. that relatively uneducated natives migrate within their homeland from non-mining to mining districts.

negative effect on educational attainment. We also observe that natives are relatively less educated than respondents who are not natives to a district. In Model (II), we include an interaction of the dummy for gold mines with the one for ethnic homeland. This allows us to explore whether gold mines have a larger effect on the eduction of non-natives. Such a larger effect would be consistent with endogenous migration of less educated non-natives to mining districts. However, we observe the opposite. While the interaction effect is insignificant, it is negative. This suggest that gold mines, if at all, affect the educational attainment of natives more adversely than that of non-natives.

Model (III) and (IV) re-estimate the baseline model with subsamples of natives and non-natives. The idea is to explore whether the adverse effect of mines are higher among natives or non-natives. We find that mines reduce educational attainment by 0.402 points for natives but by only 0.285 points for non-natives. These results are consistent with those of Model (II): mines affect the educational attainment among natives more adversely. Overall, these findings indicate that endogenous migration is likely not responsible for the negative effect of mining on educational attainment.

7.3 Mineral resources, conflicts, and education

As discussed previously, a large literature argues that mineral resources facilitate civil wars and other forms of violent conflicts (Collier and Hoeffler, 2004, 2005; Berman et al., 2014). Resources may be a tempting target for predatory political groups. They may also enable rebels or the state to fund violent campaigns. In turn, it is likely that violent conflicts cause disruptions to the education of children. Hence, any negative relationship between gold mining and educational attainment may not come about because children prefer to work in sectors related to mining, but because the presence of gold deposits facilitates conflicts.

To explore this channel, we match geocoded data on violent conflicts to the Afrobarometer data. We use the 6th version of the ACLED (Armed Conflict Location and Event Data Project) dataset. This dataset provides information on "the dates and locations of all reported political violence and protest events in over 60 developing countries" from 1997 to 2015. We project all battles and the number of fatalities recorded in the dataset on a district-level shapefile covering the countries in our sample.[28] We then note whether the district of a given respondent experienced at least one battle when she was in adolescence (aged 12) as well as the total number of fatalities in that year.

We then explore the relationship between gold mining, conflicts, and educational attainment by estimating variants of Equation 1. The results are collected in Table 7. Since the ACLED data begins only in 1997, we have no information on conflicts for respondent who were in adolescence before this year. Hence, older respondents are dropped in the regressions reported in Table 7 and the final sample is substantially smaller than in the baseline regressions. Consequently, we omit the district fixed effects in these regressions.

In Model (I), we explore whether respondents where more likely to experience a conflict in their district during their adolescence when there was at this time a gold mine. The purpose of this model is to establish whether conflicts are more likely in districts with gold mines. In Model (II), we explore, as in the baseline regressions, the relationship between gold mines during adolescence and educational attainment, but additionally control for any conflicts in the year of adolescence. If the negative effect of gold mines on educational attainment is in effect due to the higher propensity of conflicts in mining districts, the effect of gold mines on education should become insignificant once we explicitly control for conflicts. In Model (III), we extend Model (II) and additionally control for the intensity of a conflict by including the number of fatalities in a respondent's year of adolescence.

[28]As noted in the description of the dataset, the ACLED also collects information on conflict-related events other than battles, for example protests, the setting up of bases by warring parties, etc. We omit these non-battle related events when defining the conflict variable.

The results indicate that there is a significantly negative correlation between gold mines and the incidence of conflicts (Model I). Conflicts are hence less likely in districts that have gold mines, which may indicate that economic opportunities on average dissuade individuals from engaging in political violence. Gold mines thus ostensibly do not lead to lower education due to a higher incidence of conflicts. In line with this conclusion, we find that the effect of gold mines on educational attainment remains negative if we control for conflicts (Model II) and their intensity (Model III). We also observe a positive and significant correlation between the incidence and educational attainment. This may indicate that conflicts are more likely in areas with more a educated and thus politically active populace (i. e. the causality likely runs from a more educated population to conflicts rather than the other way around).

8 Long-run effect of gold mines on economic outcomes

To complement our previous findings regarding educational attainment, we explore in this section whether respondents in mining-districts are economically better off in the long-run than respondents in non-mining districts even if they have lower educational attainment. If the income from gold mining is sufficiently large or persistent, working in the mining sector or related sectors rather than acquiring further education may be the financially dominant strategy even in the long-run.

In order to explore this issue, we relate the dummy for gold mines during adolescence to contemporaneous economic conditions of a respondent. Specifically, we explore how an Afrobarometer respondent who had gold mines in her district during adolescence (i) assesses her current living conditions relative to other co-nationals, (ii) how she assesses her living conditions as such, and (iii) how she assesses the present economic conditions in her country. The results are collected in Table 8. Note that we omit the district fixed effects in these regressions. Within-district comparisons of contemporaneous economic conditions are likely not meaningful given that mines change the development trajectory of the entire district.

We find that respondents with mines during adolescence do not view their living conditions as worse than that of other co-nationals (Model I). However, it is likely that respondents think of their immediate neighborhood, i. e. other inhabitants of their district, when asked to compare their living conditions to co-nationals. If mines have, as discussed above, district-wide effects, this comparison may not be informative even if the district fixed effects are omitted. Their assessment of their absolute living conditions is therefore more informative. Indeed, we find in Model (II) that respondents with mines during adolescence are more likely to assess their current living conditions as unsatisfactory; the estimate is negative and significant.

In line with this result, we also find that respondents who had mines in their districts during their adolescence perceive the current economic conditions in their country as worse than other respondents in the same country (Model III). The estimate is not significant, but has a reasonably large z-statistic. While the Afrobarometer question explored in Model (III) relates to country-level developments, the response is presumably informed by what respondents experience in their neighborhood. Overall, these results suggest that in the long-run, respondents with gold mines in their youth do not fare better economically than generic respondents. In fact, the long-run effects of gold mines may be negative. The lower level of educational attainment and any broader long-run costs that insufficient education may have is not compensated by better economic conditions during adulthood. This finding is in line with recent evidence showing that education has a positive causal effect on income in Africa (Wantchekon et al., 2015).

9 Conclusion

There is a ongoing debate on whether mineral resources help or hinder development. Skeptics tend to point toward adverse terms of trade effects and heightened political instability as potentially negative effects. More optimistic observers emphasize the ability of the mineral resource sector to generate income and thereby to lift some of the poorest countries on the globe out of poverty. This paper contributes to this debate by documenting that gold mines have adverse effects on educational attainment and do not persistently improve economic conditions.

These results suggest that while mineral resource booms may be a boon for Africa in general, there may be costs as well. Governments should hence adopt policies that mitigate the negative consequences that gold mines may have on educational attainment. It appears that child labor in the mining sector, even if it may appear to children and their parents as more useful than going to school, does not pay off in the long-run. This observation should provide further incentives to outlaw this practice.

Our results indicate furthermore that especially small-scale and artisanal mining, which is prevalent in gold production, is not an economic activity that can provide poor households with sustainable income. This is an important results given that some observers view it as a particularly promising form of mining, one that is decentralized and can ensure subsistence for low income households in developing countries (Economist, 2016; Hilson, 2016). Indeed, many African governments have recently adopted measures to discourage this type of mining. While these measures have provoked criticism and more often than not were adopted for suspect reasons, our findings indicate that such policies may have some, even if unintended, merits.

One important limitation of our study is data availability. For example, the evidence we provide for the main transmission channel, that the employment opportunities offered by gold mines incentivizes parents to neglect the education of their children, is mostly indirect and circumstantial, i. e. by ruling out competing channels. The reason why we cannot provide more direct evidence is that there is no detailed data available on educational and employment histories for Africa. One avenue for future research in this area would be to address such data limitations. In particular, collecting survey data data on how individuals progress through the various educational stages and transition to employment may lead to further important insights.

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Table 1: Gold mines during adolescence and educational outcomes, baseline results

	(I)	(II)	(III)
Dep. Var.	Education	Education	Education
Gold mine	-0.178***	-0.141**	-0.153***
	(0.068)	(0.063)	(0.058)
Estimation method	OLS	OLS	OLS
Cohort FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
District FE	No	Yes	Yes
Ethnic group FE	No	No	Yes
Countries	30	30	30
Districts	4950	4950	4950
N	91062	91062	91062

Notes: This table shows OLS regression results that relate a categorical variable measuring educational outcomes of an Afrobarometer respondent to a dummy for whether there was a gold mine in the respondent's district when she was in adolescence. Standard errors in parentheses. Standard errors are clustered at the district-wave level and robust to heteroscedasticity. Stars indicate significance levels at 10% (*), 5% (**) and 1%(***).

Table 2: GOLD MINES DURING ADOLESCENCE AND EDUCATIONAL OUTCOMES, HETEROGENEOUS EFFECTS

	(I)	(II)	(III)
Dep. Var.	Education	Education	Education
Gold mine	-0.157**		-0.256**
	(0.068)		(0.116)
Female	-0.629***		
	(0.015)		
Gold mine × Female	0.081		
	(0.063)		
Small mine		-0.196**	
		(0.084)	
At least major mine		-0.074	
		(0.058)	
Gold mine × Price			0.024
			(0.023)
Cohort FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
District FE	Yes	Yes	Yes
Ethnic group FE	Yes	Yes	Yes
Countries	30	30	30
Districts	4950	4950	4950
N	91062	91062	84898

Notes: This table shows OLS regressions that relate a categorical variable measuring educational outcomes of an Afrobarometer respondent to a dummy variable for whether there was a gold mine in the respondent's district when she was in adolescence. We allow for heterogeneous effects of mines according to whether a respondent is a woman or a man (Model I), according to the size of a mine (Model II), and according to the price of gold (Model III). Standard errors in parentheses. Standard errors are clustered at the district-wave level and robust to heteroscedasticity. Stars indicate significance levels at 10% (*), 5% (**) and 1%(***).

Table 3: GOLD MINES DURING ADOLESCENCE AND EDUCATIONAL OUTCOMES, MINERAL RESOURCES OTHER THAN GOLD

	(I)	(II)	(III)
Dep. Var.	Education	Education	Education
Only non-gold mines	0.246***		
	(0.088)		
At least one non-gold mine		0.298***	
		(0.087)	
Exclusively gold mine			-0.225***
			(0.065)
Cohort FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
District FE	Yes	Yes	Yes
Ethnic group FE	Yes	Yes	Yes
Countries	30	30	30
Districts	4950	4950	4950
N	91062	91062	91062

Notes: This table shows OLS regression results that relate a categorical variable measuring educational outcomes of an Afrobarometer respondent against a dummy for whether there was a mine for a mineral resource other than gold in the respondent's district when she was in adolescence. Model (I) includes a dummy for districts where only non-gold mines are present. Model (II) includes a dummy for districts where gold and other minerals are present at the same time. Model (III) uses a dummy that is one only for districts where gold but no other minerals are present. Standard errors are clustered at the district-wave level and robust to heteroscedasticity. Stars indicate significance levels at 10% (*), 5% (**) and 1%(***).

Table 4: Gold mines during adolescence and educational outcomes, tests with neighboring gold mine districts

	(I)	(II)	(III)
Dep. Var.	Education	Education	Education
Gold mine		-0.180***	-0.156**
		(0.063)	(0.068)
Gold mine in neighboring district	-0.050	-0.055	
	(0.046)	(0.044)	
Cohort FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
District FE	Yes	Yes	No
Ethnic group FE	Yes	Yes	Yes
Countries	30	30	22
Districts	4860	4950	1122
N	87591	91062	14166

Notes: This table shows regressions that relates gold mines during adolescence in one's own and in neighboring districts to educational outcomes. All models are estimated with OLS. The dependent variable is always educational attainment of an Afrobarometer respondent. Model (I) includes a dummy that is one for respondents that had a gold mines in neighboring districts during their adolescence. Respondents that had a gold mine in their own district are dropped in this model. Model (II) is estimated with all observations and includes dummies for both gold mines in neighboring districts and one's own district. Model (III) limits the sample to only those respondents that had a gold mine in their own or in a neighboring district during their adolescence and includes both dummies. This model omits the district fixed effects. Standard errors in parentheses. Standard errors are clustered at the district-wave level and robust to heteroscedasticity. Stars indicate significance levels at 10% (*), 5% (**) and 1%(***).

Table 5: Gold mines during adolescence and public goods

	(I)	(II)	(III)
Dep. Var.	School	Education	Education
Current gold mine	0.007		
	(0.014)		
Gold mine		-0.145**	-0.268***
		(0.057)	(0.099)
School		0.222***	0.342***
		(0.036)	(0.058)
Cohort FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
District FE	No	Yes	No
Ethnic group FE	Yes	Yes	Yes
Countries	30	30	30
Districts	4936	4936	3020
N	90896	90677	12333

Notes: This table shows two sets of OLS regressions. In Model (I), we relate dummy variables for schools against a dummy for whether there is a gold mine in the respondent's district when the relevant wave of the Afrobarometer survey was conducted. In Model (II), we relate the educational outcomes of a respondent against the standard gold mines dummy and a dummy for the presence of schools (Model II). Model (III) replicates Model (II) but limits the sample to respondents who were in adolescence after the year 2000. Standard errors in parentheses. Standard errors are clustered at the district-wave level and robust to heteroscedasticity. Stars indicate significance levels at 10% (*), 5% (**) and 1%(***).

Table 6: Gold mines during adolescence and educational outcomes, ethnic homelands

	Full		Native	Non-native
	(I)	(II)	(III)	(IV)
Dep. Var.	Education	Education	Education	
Gold mine	-0.338***	-0.316***	-0.402***	-0.285***
	(0.074)	(0.105)	(0.099)	(0.106)
Ethnic homeland	-0.437***	-0.436***		
	(0.057)	(0.058)		
Ethnic homeland × Gold mine		-0.043		
		(0.140)		
Cohort FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
District FE	No	No	No	No
Ethnic group FE	Yes	Yes	Yes	Yes
Countries	18	18	18	18
Districts	1588	1588	1271	1153
N	22562	22562	13557	9005

Notes: This table shows OLS regression results that relate a categorical variable measuring educational outcomes of an Afrobarometer Wave 4 respondent against a dummy for whether there was a gold mine in the respondent's district when she was in adolescence. We account for whether a respondent lives within the traditional homeland of her ethnic group (and thus has likely not migrated due to the presence of a mine) in these regressions. Specifically, Model (I) and (II) is estimated with the full sample. Model I includes both the ethnic homeland and gold mines dummies. Model (II) additionally includes an interaction effect between the home region and the gold mines dummy. Model (III) is estimated with a sample that only includes respondents who live in their ethnic homelands. Model (IV) is estimated with a sample that includes only respondents that do not live in their ethnic homelands. Standard errors are clustered at the district level and robust to heteroscedasticity. Stars indicate significance levels at 10% (*), 5% (**) and 1%(***).

Table 7: Gold mines during adolescence and educational outcomes, conflicts as an alternative transmission channel

	(I)	(II)	(III)
Dep. Var.	Conflict	Education	Education
Gold mine	-0.057***	-0.307***	-0.307***
	(0.014)	(0.091)	(0.091)
Conflict		0.147**	0.150***
		(0.058)	(0.058)
Fatalities			-0.125
			(0.252)
Estimation method	OLS	OLS	OLS
Cohort FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
District FE	No	No	No
Ethnic group FE	Yes	Yes	Yes
Countries	30	30	30
Districts	4161	4161	4161
N	21364	21319	21319

Notes: This table shows OLS regression results that relate the incidence of conflicts (Model I) and educational attainment of an Afrobarometer respondent (Model II-III) against a dummy for whether there was a gold mine in the respondent's district when she was in adolescence. Model (II) controls for the incidence of conflicts and Model (III) additionally for fatalities. Standard errors in parentheses. Standard errors are clustered at the district-wave level and robust to heteroscedasticity. Stars indicate significance levels at 10% (*), 5% (**) and 1%(***).

Table 8: MINERAL RESOURCES DURING ADOLESCENCE AND CONTEMPORANEOUS ECONOMIC OUTCOMES

	(I)	(II)	(III)
Dep. Var.	Relative LC	Absolute LC	Present EC
Gold mine	-0.009	-0.062*	-0.033
	(0.030)	(0.032)	(0.032)
Cohort FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
District FE	No	No	No
Ethnic group FE	Yes	Yes	Yes
Countries	30	30	30
Districts	4950	4950	4950
N	88393	90951	89701

Notes: This table shows OLS regressions that relate categorical variables for the economic conditions of a respondent against a dummy for whether there was a gold mine in the respondent's district when she was in adolescence. Specifically, we explore how a respondent perceives her own living conditions relative to other co-nationals (Model I), her own living conditions in aboslute terms (Model II), and the present economic conditions in the country (Model III). Standard errors in parentheses. Standard errors are clustered at the district-wave level and robust to heteroscedasticity. Stars indicate significance levels at 10% (*), 5% (**) and 1%(***).

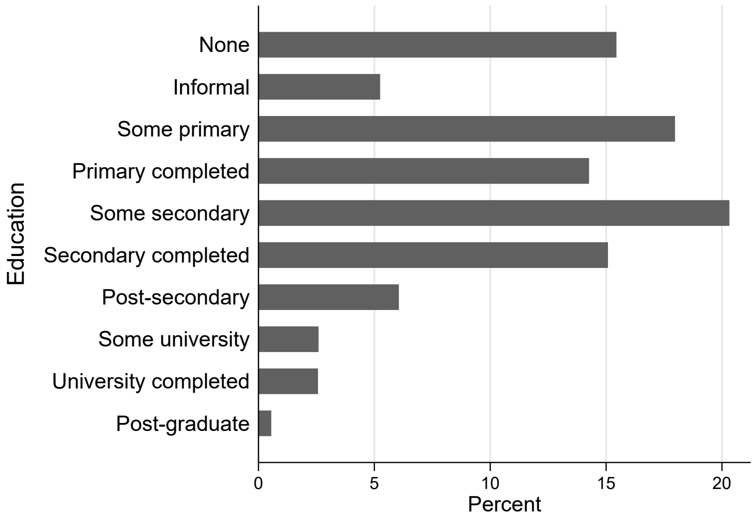

Figure 1: Educational attainment of Afrobarometer respondents

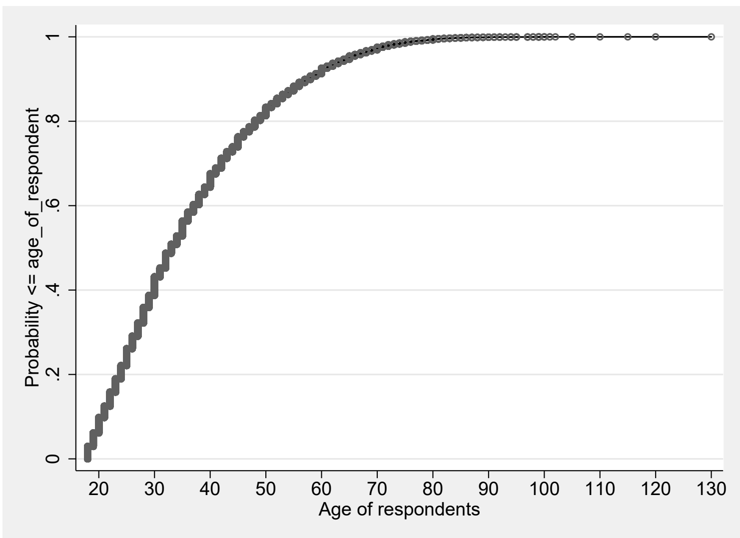

Figure 2: Age distribution of Afrobarometer respondents

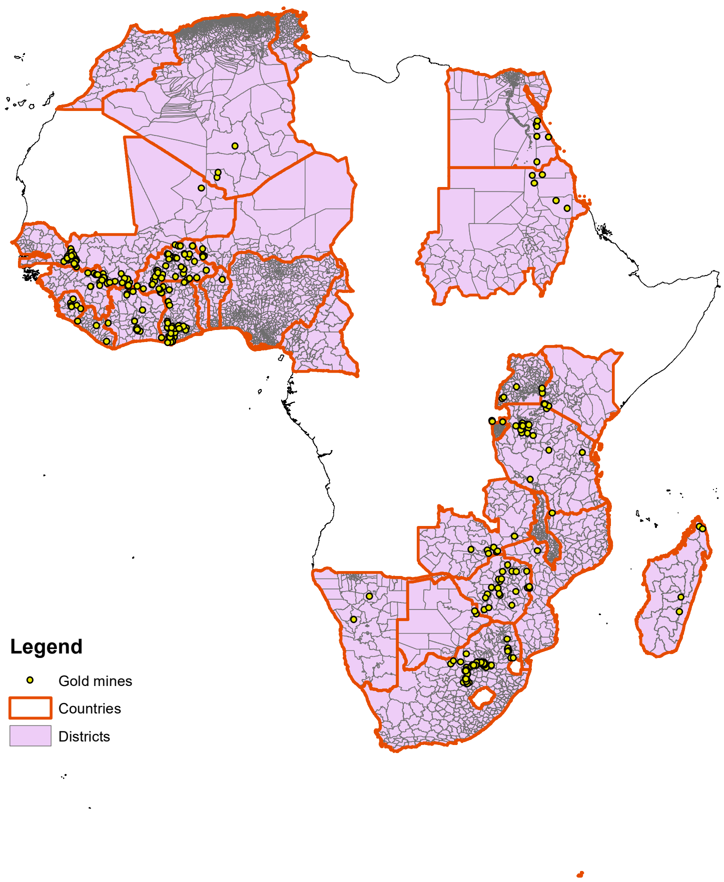

Figure 3: Location of mines in the countries included in the sample. This figure shows the location of (historical and current) mines in the countries included in our sample.

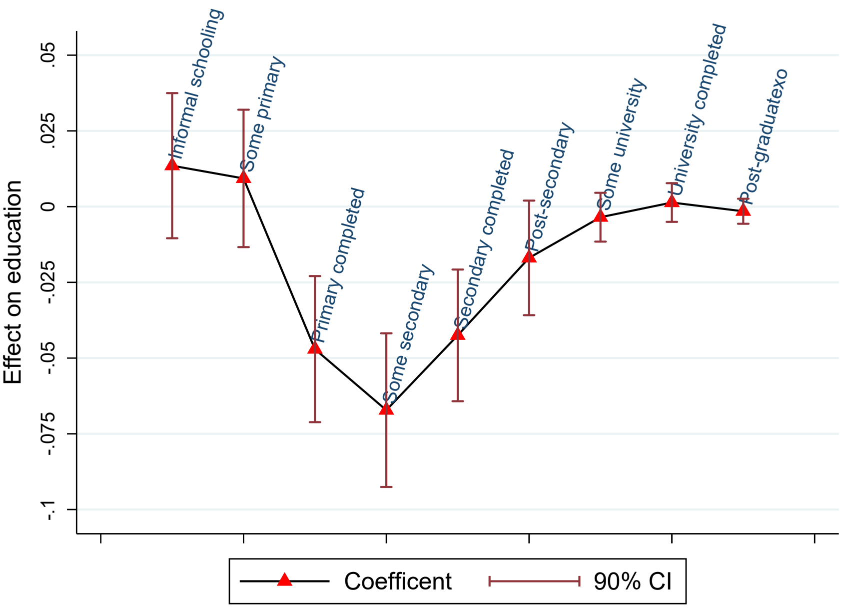

Figure 4: Effect on different educational stages. This figure shows coefficient estimates for the effect of gold mines on the probability of transition from one educational stage on the next.

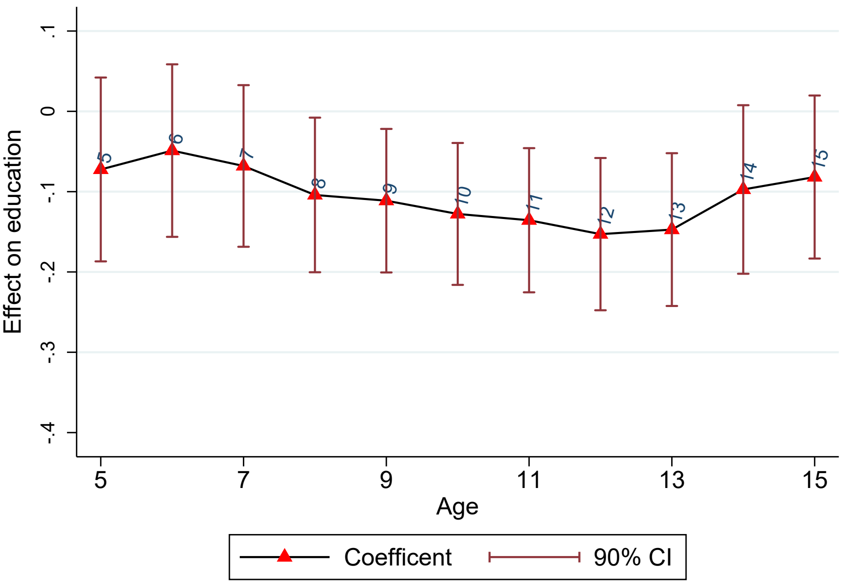

Figure 5: Coefficients at different adolescence years. This figure shows coefficient estimates for the specification in Table 1, Column (III) using different ages as thresholds for adolescence.

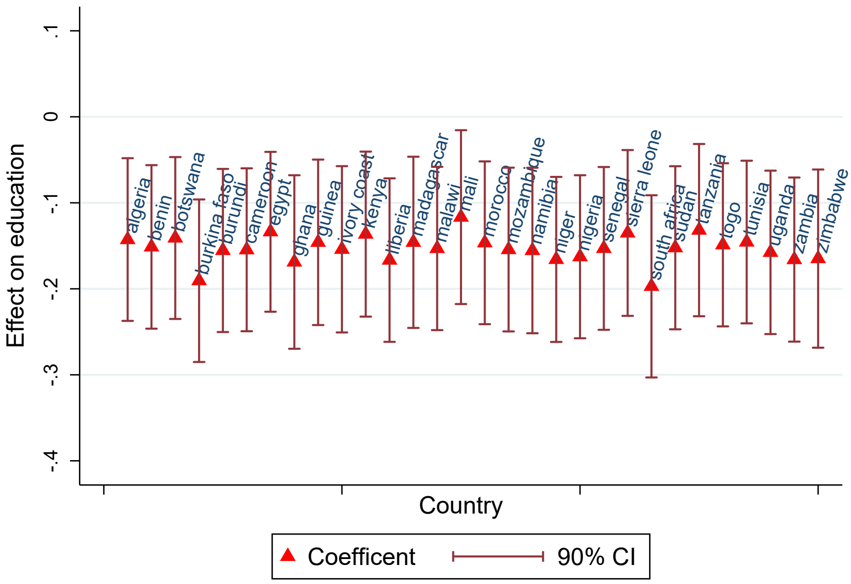

Figure 6: Coefficients without individual countries. This figure shows coefficient estimates for the specification in Table 1, Column (III) after dropping individual countries

Table A.1: DEFINITION OF VARIABLES

Label	Description	Source
Education	Educational attainment, 10 distinct stages, ranges from none (0) to post-graduate (9).	Afrobarometer 3-5th wave.
Gold mine	Dummy = 1 if least one gold mine in one's district at age 12.	Own construction based on data from MinEx.
Gold mine in neighboring district	Dummy = 1 if gold mine in at least one neighboring district at age 12 & no gold mine in one's own district.	Own construction based on data from MinEx.
Only non-gold mines	Dummy = 1 if only non-gold mines in one's district at age 12	Own construction based on data from MinEx.
At least one non-gold mine	Dummy = 1 if at least one non-gold mine in one's district at age 12	Own construction based on data from MinEx.
Exclusively gold mine	Dummy = 1 if only gold mines one's district at age 12	Own construction based on data from MinEx.
Current gold mine	Gold mine shortly before the relevant wave of the Afrobarometer survey was conducted (2004 for wave 3, 2007 for wave 4, 2010 for wave 5).	Own construction based on data from MinEx.
Small mine	Dummy=1 if gold mine is classified either as minor ($\geq$ 0.03 Moz Au) or moderate ($\geq$ 0.32 Moz Au & $<$2.24 Moz Au)	Own construction based on data form MinEx.
At least major mine	Dummy=1 if mine is at least classified as major ($\geq$ 2.24 Moz Au)	Own construction based on data form MinEx.
Gold Price	Price of gold in year t.	World Bank commodity price data (The Pink Sheet, February 2016).
Female	Dummy=1 if female respondent.	Afrobarometer 3-5th wave.
Ethnic homeland	Dummy=1 if district of a respondent overlaps with the traditional settlement area of the respondent's ethnic group.	Own construction using data from Afrobarometer 4th wave, Murdock (1959), Nunn and Wantchekon (2011), and Deconinck and Verpoorten (2013).
School	Dummy=1 if there is a school in the sampling unit / enumeration area of a respondent.	Afrobarometer 3-5th wave.

Table A.2: Summary statistics

Variable	**Obs**	**Mean**	**SD**	**Min**	**Max**
Education	91062	3.202	2.082	0.000	9.000
Gold mine	91062	0.038	0.191	0.000	1.000
Gold mine in neighboring district	91062	0.117	0.322	0.000	1.000
Only non-gold mines	91062	0.054	0.225	0.000	1.000
At least one non-gold mine	91062	0.063	0.243	0.000	1.000
Exclusively gold mine	91062	0.029	0.167	0.000	1.000
Current gold mine	91062	0.063	0.244	0.000	1.000
Small mine	91062	0.017	0.130	0.000	1.000
At least major mine	91062	0.024	0.153	0.000	1.000
Gold Price	84898	0.159	0.849	0.000	9.320
Female	91062	0.498	0.500	0.000	1.000
Ethnic homeland	24382	0.556	0.497	0.000	1.000
School	90677	0.867	0.340	0.000	1.000

This table provixodes summary statistics on the Afrobarometer respondents included in the sample.