MISUM
WORKING PAPER SERIES

NO. 2023-14, NOV 2023

ECONOMIC OPPORTUNITIES AND HUMAN CAPITAL INVESTMENTS: EVIDENCE FROM ARTISANAL GOLD MINING IN AFRICA

Avenia Ghazarian
Mistra Center for Sustainable Markets (Misum)
Stockholm School of Economics

Akib Khan
Uppsala University

Mistra Center for Sustainable Markets (Misum) | Sveavägen 65, floor 4, 113 59 Stockholm

Economic Opportunities and Human Capital Investments: Evidence from Artisanal Gold Mining in Africa*

Avenia Ghazarian†   Akib Khan‡

November 27, 2023

Abstract

How does human capital investment respond to local economic opportunities? Income gains can increase the demand for schooling while new jobs raise the opportunity costs. We investigate this question in the context of rapid growth in artisanal gold mining in sub-Saharan Africa. We compile 45 waves of Demographic and Health Surveys covering 1.3 million individuals from 14 countries in this region. Identification comes from two sources of variation: one in the global gold price and the other in the exposure of households to places that are geologically suitable for artisanal gold mining. We find that a near-tripling of the global gold price – reflecting changes between 2005 and 2010 – leads to a decline in school attendance: by 3.1 pp for 11 to 15-year-olds and by 2.3 pp for 16 to 20-year-olds who live near gold-suitable areas. These reductions are higher for boys. Taken together, these results highlight the potential costs of economic development driven by natural resources.

JEL codes: J24, O15, Q32

*We thank Niklas Bengtsson, Martina Björkman Nyqvist, Victoire Girard, Andreas Madestam, Torben Mideksa, Niklas Moneke, Abhijeet Singh, Leonard Wantchekon, Céline Zipfel, Olof Åslund, Björn Öckert, and seminar participants at Stockholm School of Economics and Uppsala University for valuable comments and helpful discussions. We are grateful to Mistra Center for Sustainable Markets (Misum) for financial support.

†Stockholm School of Economics, avenia.ghazarian@phdstudent.hhs.se

‡Uppsala University, akib.khan@nek.uu.se

1 Introduction

How do positive labor demand shocks affect human capital accumulation in low-income countries? With higher income, parents are more likely to keep children in school. However, as returns to labor increase, so does the opportunity cost of schooling. Which effect dominates is an empirical question, and the effects may vary across contexts [Atkin, 2016, Adukia et al., 2020]. We study this question leveraging one of the largest local labor market shocks in sub-Saharan Africa (SSA) over the last two decades: the rise in artisanal and small-scale gold mining.

Artisanal and small-scale mining (ASM) is a labor-intensive, low-tech mineral extraction and processing industry. This is a thriving industry in Africa that directly employs at least 60 million people, including children, and indirectly supports an additional 130 million [WorldBank, 2019].[1] Artisanal gold mining, which generates 20% of the global gold supply, is considered the predominant employer in the African ASM industry [Girard et al., 2022]. Moreover, the surge in gold prices over the last two decades has further fueled the growth of this sector. Between 2000 and 2020, the price of gold increased by about 530%, from USD 279 to 1,769 per ounce. During the same period, direct employment in artisanal gold mining more than tripled.

How does schooling investment respond to these changes in local economic opportunities? While a small and growing body of studies has investigated the effects of ASM on local economic activity, household wealth as well as on the environment [Girard et al., 2022, Poignant, 2022, Bazillier and Girard, 2020], there is limited evidence of its impact on children's schooling outcomes.

In this paper, we study whether the emergence of job opportunities in artisanal and small-scale mining, induced by the rise in the global gold price, affects the schooling decisions of children and young individuals in sub-Saharan Africa. New jobs in the local mining sites, typically labor intensive, raise the opportunity cost of staying in school. On the other hand, higher parental earnings from mining can increase the demand for schooling.[2] This is particularly relevant for parents who are credit or liquidity-constrained,

[1] For an overview of the use of child labor in ASM, see O'Driscoll [2017].

[2] There could be other mechanisms through which ASM can affect schooling outcomes such as conflict over

which characterizes the majority of the households in the region with widespread poverty and imperfect credit markets. The direction of net effects, therefore, is theoretically ambiguous and an empirical question.

Addressing this question, however, poses multiple challenges. First, most countries lack a database of artisanal mining sites as many of these sites operate informally. Second, the timing of the opening of mining sites and their location could depend on characteristics that are also correlated with schooling outcomes. For instance, remote areas with low access to schools and hence a larger out-of-school population might make it more profitable to start a mining site given the relative abundance of cheap labor. We address these challenges by combining temporal variations in international gold prices with spatial differences in household exposure to areas that are geologically suitable for small-scale gold mining.

Our empirical strategy uses two sources of plausibly exogenous variation. Instead of the location of realized mining sites, we use data on the *suitability* of a particular location for artisanal gold mining. This provides spatial variation in the households' access to potential mining opportunities. Furthermore, since artisanal gold miners are mostly price takers, we combine this spatial variation with temporal fluctuations in the global gold price, which directly determines ASM revenues. Intuitively, this is similar to a difference-in-differences design where one difference corresponds to comparisons of households across regions with high and low gold-suitability whereas the second difference entails comparing periods of (unexpectedly) high and low gold prices.[3] We also control for a host of predetermined individual and household characteristics as well as allow for time-invariant sub-national differences and country-specific time trends by means of fixed effects.

We combine three datasets. For gold suitability, we use a recent pan-African database constructed by Girard et al. [2022] on the geological suitability of the bedrock for gold

---

the control and use of natural resources [Berman et al., 2017]. Such conflict can also stem from competitions between artisanal and industrial miners [Rigterink et al., 2023]. In Section 5.2, we show that our results are not driven by areas hosting industrial gold mines.

[3] Notable examples of combining heterogeneous geographical suitability and temporal variation include Girard et al. [2022], Nunn and Qian [2011], and Sviatschi [2022].

mining.[4] This database leverages recent mapping of the contours, age, and chemical composition of geological bedrock and shows that 18% of the continental surface is suitable for artisanal gold mining. Second, for schooling and demographic information, we pool 45 waves of Demographic and Health Surveys (DHS) covering close to 1.4 million individuals across 14 countries in SSA and spanning the period 2000-2018. These surveys collect GPS coordinates of the household clusters, which allows us to measure a household's potential access to mining opportunities by calculating their distance to the nearest gold-suitable location. Lastly, we use the time series of global gold prices.

Overall, higher international gold prices adversely affect school attendance of children living near gold-suitable areas. These effects are higher for individuals aged 11-20 years. For instance, if the gold price nearly triples[5], reflecting the change between the years 2005 and 2010, individuals aged 11-15 years are 3.1 percentage points less likely to attend school ($p < 0.01$; 4% of the corresponding sample mean). The corresponding estimates for age groups 16-20 and 21-25 are 2.3 percentage points ($p < 0.01$; 5.1% of the sample mean) and 0.8 percentage points ($p < 0.10$; 7.3% of the sample mean), respectively.

These effects are generally larger for boys. For instance, while the average effect for children aged 6-10 years is statistically indistinguishable from zero, boys of this age living in gold-suitable areas show a 1.6 percentage points decline in attendance in years with higher gold prices ($p < 0.05$; 2.3% of the sample mean). A potential explanation is that the boys may have a comparative advantage in brawn-intensive jobs such as those available in the mining sector [Pitt et al., 2012].

These results are robust to multiple sensitivity checks. Estimates are similar when using alternative definitions of exposure to gold suitability. Neither migration nor access to industrial mining opportunities drive our results. Finally, inference based on permutation tests supports our main conclusions.

As a secondary analysis, using a sample of young adults, we assess the long-term effects of gold price shocks during the different phases of childhood and adolescence. Identification comes from the differences in gold price trajectories across the different

[4] We are immensely grateful to Girard et al. [2022] for kindly sharing this data.
[5] An increase of 172%, to be precise, which corresponds to an increase of one log point.

cohorts combined with their exposure to gold-suitable locations. We find that higher prices during primary schooling age leads to lower completed schooling for individuals growing up in gold-suitable areas.

Taken together, these results suggest that higher labor demand for jobs that are labor-intensive and offer low returns to education – such as those in artisanal gold mining – can have a negative impact on the human capital accumulation of children and young individuals.

Our findings contribute to three strands of literature. First, we add to the literature on how changes in employment opportunities shape human capital investments. Consistent with our results, Atkin [2016] finds an increase in school dropouts in response to the rapid expansion of the export manufacturing sectors in Mexico. In contrast, Adukia et al. [2020] finds that new roads connecting villages with urban labor markets increase middle-school enrolment in India. Given the different *and* counteracting mechanisms at play for a positive labor demand shock, such as a higher opportunity cost of schooling and a positive income effect, these mixed results point toward the importance of the contextual specifics in determining the net effects [Bau et al., 2020, Shah and Steinberg, 2017]. Jobs in artisanal gold mining are typically low-tech and labor-intensive, hence widely accessible for school-age individuals, especially in the absence of effective child labor restrictions [O'Driscoll, 2017]. On the other hand, the positive income effects might be rather weak given the potentially low returns to secondary schooling in the region [Duflo et al., 2021].

We also add to the literature on the impact of natural resources on the process of development (see Sachs and Warner [2001] for a review). Our results highlight an important mechanism through which natural endowments can impede growth – by reducing human capital investments. Lastly, our findings add to the growing literature on artisanal mining and its socioeconomic effects [Girard et al., 2022, Poignant, 2022, Bazillier and Girard, 2020, Guenther, 2018, Kotsadam and Tolonen, 2016, Geenen et al., 2021].[6]

The remainder of the paper is organized as follows. Section 2 provides background

[6] We are aware of an ongoing study on the effects of ASM on schooling in Burkina Faso by Guirkinger and Stoeffler, but there is no working paper that we can find online as of this date.

information on artisanal and small-scale mining in sub-Saharan Africa. We describe the data in Section 3 and the empirical strategy in Section 4. Section 5 presents the results and robustness checks. Section 6 concludes.

2 Background : Artisanal gold mining in sub-Saharan Africa

Artisanal and small-scale mining (ASM) refers to small-scale, low-tech, labor-intensive mining activities typically carried out by individuals or small groups of miners [Hilson and Maconachie, 2020]. ASM can be differentiated from industrial and large-scale mining, which is typically licensed, capital-intensive, and uses advanced technology.

For geological reasons, ASM is particularly prevalent in sub-Saharan Africa. The livelihoods of at least 60 million people are directly dependent on the revenues of ASM, and 130 million people indirectly rely on the sector to earn livelihoods [WorldBank, 2019].

Both men and women participate in ASM activities. Women's direct participation in such mining varies across the world. In Asia, less than 10% of miners are women, whereas the corresponding figure for Latin America is higher, approximately 10-20%. In Africa, the share of female artisanal miners is the highest, ranging from 40 to 50% [Hinton et al., 2003]. There are also children actively working in the sector. The more remote or informal the activity, the more likely children are to be involved [Hilson, 2003]. The informality of the sector, however, makes it hard to estimate the total number of children involved. In 2006, ILO estimated that about 1 million children work in the ASM sector. In Burkina Faso, for instance, estimates suggest that children constitute up to 30 to 50% of the entire ASM workforce [ILO, 2021].

There are four key steps involved in the process of artisanal gold mining. First, gold ore is excavated from the soil, rock, and surrounding water tributaries. The gold ore is then processed and concentrated[7] by gravity methods (sluice, shaking table[8], etc.). It is then combined with elemental mercury, which forms a gold–mercury amalgamation.

[7] A method used for increasing the amount of gold in ore, by selectively removing lighter particles.
[8] A shear flow process equipment that separates particle grains of its feed material based on the differences in their specific gravity, density, size, and shape.

This amalgam is subsequently burned, removing the mercury as vapor and leaving a relatively pure gold alloy, which can be further refined [Allan-Blitz et al., 2022].

The market for ASM products is not well-organized, with the majority of miners[9] selling to individual collectors at a negotiated price [Chupezi et al., 2009]. In Cameroon, for example, the majority of the miners sell their gold to individual collectors, with only a small share selling to agents that set prices based on factors such as the carat of the gold and the percentage of gold lost during smelting [Funoh, 2014]. The payment methods to artisanal miners differ based on factors such as ownership of the mining site and whether they work independently or as part of a group. Typically, mining sites operate under individual ownership. Individual miners who own the mining site may employ family labor and/or hire wage laborers. Wage payments are often based on informal or verbal agreements and are paid in cash or kind (a percentage of their produced gold) or a combination of both. Miners who work in groups split their earnings among the members according to each member's contribution [Funoh, 2014].

ASM activities are mainly driven by poverty and have been shown to have implications for poverty alleviation through income and consumption gains [Guenther, 2018, Bazillier and Girard, 2020]. On the other hand, ASM can have detrimental effects on the environment through increasing deforestation and adversely affecting vegetation health [Girard et al., 2022, Morgane et al., 2018]. Moreover, poor working conditions (e.g., risk of collapse due to the absence of proper structural support, exposure to toxins such as mercury or arsenic, etc.) pose serious threats to the physical health and safety of the miners [Hentschel, 2003].

The industry may continue to exist, buoyed by persistently high gold prices, and not the least because there is still widespread poverty in the region [Hentschel, 2003]. Making a comprehensive assessment of the impacts of ASM, however, is challenging since, in most countries, the sector is highly informal with significant bureaucratic barriers to formalization [Morgane et al., 2018]. Consequently, ASM activities are frequently associated with child labor and exploitation that might put children's health, safety, and future at risk [ILO, 2019]. Therefore, it is critical that we investigate how these mining activities

[9] 66.67% in Cameroon and 93.75% in the Central African Republic

affect children's outcomes such as schooling, which plays an important role in the development of their human capital and in addressing the intergenerational transmission of poverty [Jensen, 2000].

2.1 ASM and schooling

Human capital investments are critical for long-run economic growth [Mankiw et al., 1992, Edmonds and Pavcnik, 2006, Lucas Jr, 1988]. Artisanal mining activities, like any other source of income, can improve schooling outcomes by enabling households to send their children to school, especially in contexts with binding liquidity or credit constraints. On the other hand, in the presence of child labor, these mining opportunities increase the opportunity cost of staying in school. Hence, the theoretical prediction for the net effects is ambiguous and depends on the relative strength of these two different mechanisms.

There are other channels through which ASM may affect schooling outcomes. Considering the hazardous working conditions and the pay structure that is often tied to gold production, children may still indirectly experience adverse effects due to the insufficient time and energy that parents can invest in them while working in the mines.

Developing countries have made remarkable progress in school enrolment rates in the last two decades. In sub-Saharan Africa, where the progress lags behind other regions, primary school enrollment has risen from 73% in 1990 to 99% in 2019. Secondary enrollment has increased as well, from 23% in 1990 to 44% in 2019 (UNESCO Institute for Statistics). Nevertheless, positive labor demand shocks may threaten school enrolment rates by raising the opportunity cost of schooling.

Schooling responses to the arrival of job opportunities depend on the prevalence of child labor [Bau et al., 2020] as well as the nature of the jobs in terms of the returns they offer to education [Adukia et al., 2020]. Job opportunities in the ASM sector do not offer higher returns to schooling, and most of the tasks or occupations in this industry are relatively low-skilled and labor-intensive. Hence, specific age or gender may not confer a substantial comparative advantage. However, there could be, for instance, gendered specialization across occupations or tasks within the industry depending on the task-specific relative intensity of physical labor. For instance, men might specialize in extraction, whereas women could be more involved in tasks entailing sorting.

3 Data description

3.1 Gold-suitable locations

To determine the extent to which households are exposed to ASM job opportunities, we measure the distance from where a household lives to the nearest gold-suitable location. The suitability of the land is exogenously determined by geological features. Certain geological properties can indicate the likelihood of gold deposits within a particular bedrock. In the African continent, primary and alluvial gold deposits are found almost exclusively in certain geological formations [Goldfarb et al., 2017].

By leveraging recent mapping of the contours, age, and chemical composition of African geological bedrocks, Girard et al. [2022] construct a dataset to identify areas where artisanal gold mining may take place. We rely on this dataset to determine the potential exposure of households to artisanal gold mining opportunities. The left panel in Figure 1 shows the map of the geological gold-suitability of bedrock across Africa.

3.2 Schooling and demographic characteristics of households

The Demographic and Health Surveys (DHS) provide data on schooling and other demographic information at both individual and household levels. A subset of these surveys also provides GPS coordinates for clusters[10], which allows us to determine the (linear) distance from the location of the cluster where a household lives to the nearest location that is geologically suitable for artisanal gold mining.[11] This provides us with variations in the extent to which households are exposed to the potential emergence of ASM job opportunities. Presumably, traveling to places where ASM activities take place incurs costs that are likely to increase with distance. Thus, the closer a household resides to

[10] Defined as groupings of household participants in the survey living in one or several close villages or in an urban neighborhood.

[11] Geospatial calculations are performed in ArcGIS.

gold-suitable locations, the more likely they are to take advantage of the job opportunities in the ASM sector. We restrict our sample to the surveys conducted between 2000 and 2018 as some preceding survey rounds do not collect geo-coordinates. The rise in the gold price accelerated in 2007. To account for this, we further restrict the sample to countries that have at least one DHS wave available before 2007 and at least one afterward, which results in a sample of 45 DHS waves from 14 countries in sub-Saharan Africa [Boyle et al., 2022]. The blue dots in the right panel of Figure 1 present the distribution of the DHS clusters from the latest round of DHS for each of the countries in the sample.

As discussed earlier, the schooling responses to the arrival of new job opportunities may vary by age as the cost of dropping out of school might differ across the age distribution. We primarily focus on four age groups; 6-10, 11-15, 16-20, and 21-25 years to capture the potential heterogeneity. Figure 2 shows the share attending school by age for males and females. As shown in the figure, by the age of 25, both men and women have mostly completed their education. Therefore, the age group of 26-30 can serve as another comparison group as the labor market shocks are unlikely to change their schooling outcomes.[12]

The primary outcome of our analysis is school attendance, which is a *flow* variable and captures contemporaneous schooling decisions. To assess long-term effects, we also use completed years of schooling, which is the corresponding *stock* variable. In the main analysis, we take 10 kilometers as the threshold for exposure, i.e., households living within 10 km of the nearest gold-suitable locations are considered to have access to potential ASM activities, whereas households living further away constitute the comparison group. On average, it takes less than 2 hours to walk for 10 km and around 30 minutes to cycle, so it is not too costly to do on a daily basis. Table 1 presents some descriptive statistics by age groups. Table A1 in the Appendix describes the sample size divided by country and survey year.

[12] Figure A2 shows the same pattern by using completed years of schooling.

3.3 Global gold price

The global gold price is a direct determinant of the revenues of ASM activities. As presented in Figure 3, over the past two decades, the global gold price has experienced a sharp increase, by about 530% from 2000 to 2020. This has led to a surge in public and private interest in the ASM sector. The estimated number of people directly involved in the activity increased from 13 million in 1999 to 40.5 million in 2017 [Morgane et al., 2018]. Given the small-scale and decentralized nature of the sector, artisanal miners are considered to be price takers in the international gold market. Hence, changes in global prices may impact artisanal mining, both on the extensive margin, in terms of the number of people who work in the mines, and on the intensive margin, on the level of effort they put into mining activities [Girard et al., 2022].

4 Empirical Strategy

4.1 School attendance

To investigate if the emergence of job opportunities in artisanal gold mining affects school enrolment, we exploit two sources of variation. One is the temporal variation in the global gold price, with the underlying assumption that the local ASM transactions do not have an effect on the international price. The second source of variation is spatial: the differential exposure of the households to these job opportunities as measured by their proximity to the nearest gold-suitable location. For our preferred specification, we take 10 kilometers to dichotomize this exposure.[13][14]

We estimate the following model for the *flow* measure of schooling, namely school

[13] In other words, households who live within 10 kilometers of the closest gold-suitable location constitute the treatment group while those who live further away are considered the comparison group. We relax this definition by gradually increasing the threshold. We also use an alternative measure of exposure: distance to the nearest gold-suitable location. We report and discuss the results below in 5.2.

[14] Note that this is similar in spirit to the reduced form of a shift-share design with potentially endogenous shares and exogenous shocks [Borusyak et al., 2022].

attendance:

$$Y_{icgt} = \sum_{g=1}^{4} \alpha_g \text{ Gold}_c \times \text{Price}_{t-1} \times \text{Age}_g + \sum_{g=1}^{4} \gamma_g \text{ Price}_{t-1} \times \text{Age}_g +$$
$$\nu \text{ Gold}_c \times \text{ Price}_{t-1} + \sum_{g=1}^{4} \lambda_g \text{ Gold}_c \times \text{Age}_g + \sum_{g=1}^{4} \theta_g \text{ Age}_g + X_i + FE_{region} + FE_{t \times country} + \epsilon_{ict}, \tag{1}$$

where Y_{icgt} is the outcome of individual i who lives in cluster c, belongs to the age group g, and responds to the survey in year t. The outcome is a binary variable indicating whether an individual is attending a school in year t. Age_g represents one of the age groups 6-10, 11-15, 15-20, and 21-25 years. The omitted age group is 26-30 as their schooling investments are unlikely to be affected by any price shock and thereby serve as a within-cluster comparison group.[15] Gold_c indicates if cluster c is located within 10 km from the closest gold-suitable location. Price_{t-1} is the one-year-lagged international gold price in US dollars (in log terms). X_i is a vector of predetermined covariates at the individual and household levels: whether individual i is female, household size, whether household head is female, and whether the household lives in a rural area. Fixed effects for regions or sub-national units, FE_{region}, account for time-invariant differences between regions.[16] Country-year fixed effects, $FE_{t \times country}$, allow for differential trends across the different countries that might originate from varying schooling or labor market policies. ϵ_{ict} is the error term clustered at the DHS-cluster level. A cluster often represents a village or a similar agglomeration of households, which is a reasonable proxy for a local labor market. Clustering the standard error at this level, therefore, allows us to account for local labor market shocks coinciding with the changes in gold price.

The parameters of interest are α_g, which capture the age-specific effects of living near gold-suitable locations in periods with higher international gold prices. This is important as both access and returns to schooling might differ across these age groups.

[15] Note that using this within-cluster comparison group makes this specification similar to a triple difference estimation.

[16] For any given country, all regions are represented across all survey rounds.

4.2 Years of schooling

For the stock measure, namely completed years of schooling, we are interested in the long-run effects of labor market shocks from childhood through adolescence. Hence, we restrict our sample to individuals aged 21-30 years. Combining price variation across cohorts with differential gold-suitability of a location, we estimate the following specification[17]:

$$\begin{aligned} Y_{ict} = \sum_{k=1}^{3} \beta_k \text{ Gold}_c \times \text{Price\_at\_Age}_k + \\ \mu \text{ Gold}_c + \sum_{k=1}^{3} \pi_k \text{ Price\_at\_Age}_k + X_i + FE_{region} + FE_{t\times country} + \epsilon_{ict}, \end{aligned} \tag{2}$$

where Y_{ict} represents the total years of schooling completed by individual i living in cluster c and surveyed in year t. Price_at_Age_k represents the log average price of gold when an individual is 6-10, 11-15, or 16-20 years old. Gold_c indicates if cluster c is located within 10 km from the closest gold-suitable location. X_i is a vector of predetermined covariates at the individual and household levels: whether individual i is female, household size, whether household head is female, and whether the household lives in a rural area. Finally, FE_{region} and $FE_{t\times country}$ are region and country-by-year fixed effects, respectively. ϵ_{ict} is the error term clustered at the DHS-cluster level.

The parameters of interest are β_k, which captures the long-term schooling effects of price shocks that individuals in gold-suitable areas experience when they are 6-10, 11-15, or 16-20 years old. Identification comes from the differences in gold price trajectories across the different cohorts combined with their exposure to gold-suitable locations. For instance, β_1, the coefficient on $\text{Gold}_c \times \text{Price\_at\_Age}_{6\_10}$, uses two comparison groups: individuals who belong to the same cohort but are not exposed to gold-suitable areas and individuals from other cohorts living in gold-suitable areas who do not experience a gold price shock when they are 6-10 years old.

It is important to note that, in both cases, our estimates potentially provide intention-to-treat effects of ASM on schooling since our definition of exposure is based on the

[17] This is akin to the model that Sviatschi [2022] uses to estimate the long-term effects of shocks to coca prices during different schooling ages on adult incarceration.

suitability of a location for mining activities but not on the realized mining opportunities.[18]

5 Results

5.1 Effect on school attendance

Table 2 reports the main results on school attendance. Column 1 uses country-by-year fixed effects; column 2 instead introduces region-by-year fixed effects; and column 3, our preferred specification, uses region and country-by-year fixed effects (as detailed in equation1).

Overall, higher international gold price adversely affects school attendance of young individuals living in gold-suitable areas. These effects are higher for individuals aged 11-20 years. For instance, if the gold price nearly triples[19], reflecting the change between the years 2005 and 2010, individuals aged 11-15 years are 3.1 percentage points less likely to be attending school ($p < 0.01$; 4% of the sample mean for this age group). The corresponding estimates for age groups 16-20 and 21-25 are 2.3 percentage points ($p < 0.01$; 5.1% of the sample mean) and 0.8 percentage points ($p < 0.10$; 7.3% of the sample mean), respectively. While the estimate for the 6 to 10-year-olds is negative (1 percentage point), it is not statistically significant at conventional levels. These effects are stable across the different specifications in Columns 1-3.[20]

Using the same structure as above, Table 3 investigates gender heterogeneity in the effects of gold price shocks. Broadly, the decline in school attendance in years with high gold prices is more pronounced for boys living in gold-suitable areas. The differential effects are economically and statistically significant for the age groups 6-10 and 16-20. For instance, while 6-10-year-old girls in gold-suitable areas exhibit no significant

[18] For privacy protection, DHS randomly displaces the clusters in a mean-zero way. This can introduce classical measurement error in our definition of exposure to gold-suitable areas and, in turn, may attenuate our estimates toward zero.

[19] An increase of 172%, to be precise, which corresponds to an increase of one log point.

[20] Table A3 presents results with clustering at a higher administrative unit that is larger than the clusters but smaller than the regions. Table A2 reports the average size of these units (as well as those for clusters and regions). These units generally correspond to the GADM-3 level. Reassuringly, our results retain their statistical significance.

reduction in school attendance in response to a positive price shock, boys of the same age are 1.6 percentage points less likely to be in school ($p < 0.05$; 2.3% of the sample mean).[21]

5.2 Robustness

In what follows, we subject our results to a battery of sensitivity and robustness checks.

5.2.1 Alternative definitions of exposure to gold-suitable areas

First, we gradually increase the distance threshold in defining household exposure to gold-suitable areas, from 5 km up to 50 km in steps of 5. Figure 4 reports the corresponding estimates for school attendance. Reassuringly, the estimates for the two age groups of 11-15 and 16-20 years get smaller in magnitude as the households living further away from the gold-suitable locations are considered to be exposed to gold-suitable areas. The same pattern of dissipating estimates over higher distance thresholds holds for other age groups. As an alternative measure of exposure to gold-suitable areas, we estimate our preferred specification (equation 1) replacing the indicator variable, Gold_c, with distance to the nearest gold-suitable region (in log terms). The estimates, reported in Table A5, are consistent with our main results, both in terms of relative magnitude across the different age groups and statistical significance.

Second, similar in spirit to a spatial regression-discontinuity design, we make a narrower comparison. We create buffers of 20 kilometers centered on the edge of each gold-suitable region. In other words, we only include clusters that lie within 20 kilometers of the edge of any gold-suitable zone. Any cluster located in the intersection of the buffer and the gold-suitable zones is considered to be living in a gold-suitable area. On the other hand, clusters that are outside this intersection (but still in the buffer) constitute the comparison group. Figure A3 elaborates this exercise in detail. Table A6 shows that

[21] DHS does not collect labor market information on individuals younger than 15 years, which limits the scope for looking at labor market outcomes. Using the sample of 16-30 years old, Table A4 estimates equation 1 with employment as an outcome. We find an increase in employment in years with higher gold prices among individuals aged 16-20 years who live in gold-suitable areas – by 3.3 percentage points ($p < 0.01$; 15.7% of this age-group's sample mean).

the resultant sample makes the individuals living in gold-suitable areas vs those living just outside more comparable on predetermined characteristics (compared to the main sample as summarized in Table 1). We then replicate our main analysis in Table 5.1 using this sample and report the results in Table 4.[22] The estimates are similar to the benchmark results. Interestingly, the estimates grow in both practical and economic significance.[23]

Lastly, we redefine distance to the nearest gold-suitable location by allowing for within-country commutes only as it may not be feasible to cross borders frequently in some of the countries. This changes the *treatment* status of a few clusters that are close to borders (see Figures A4 and A5). However, results from this exercise (see Table A9) are broadly similar to the benchmark estimates.

5.2.2 Migration

A concern for identification is endogenous migration. For instance, individuals, especially those with low schooling, may migrate to the gold-suitable areas to participate in mining. Such selective migration, in turn, would introduce a downward bias in our estimates[24]. To investigate this possibility, we proceed in two steps. First, we check whether there is a differential rate of migration into the gold-suitable areas. Table 5 reports the relevant results, using a slightly modified equation 1. The sample in Column 1 includes all individuals from the main sample where we have non-missing migration information for at least one member of the household. The sample in Column 2, on the other hand, includes individuals if we have migration data on their household-head. In both cases, we have 8 countries and 24 survey rounds (compared to 14 countries and 45 waves in the full sample). The outcome is a binary variable indicating whether an individual has migrated to the current location within the last five years. We consider all members of a household to be migrants if any of these members is a migrant (Column 1) or if the household-head is a migrant (Column 2). The estimate in Column 1, which adopts a

[22] With one modification to equation 1: using buffer fixed-effects instead of region fixed-effects.
[23] Table A8 repeats this exercise using buffers of 10 kilometers. The conclusions remain the same. Table A7 reports the summary statistics for the corresponding sample.
[24] I.e., we would overestimate the adverse effects on school attendance.

broad definition of migration, suggests a small and marginally significant increase in migration into the gold-suitable areas when gold prices are high. There is no such effect when we assign migration status based on the migration history of the household head.[25]

Next, we replicate our main analysis (equation 1) excluding the migrants using the two definitions above. The results are reported in Table 6. Column 1 estimates equation 1 with the sample of individuals with available migration information for at least one household member. Column 2 excludes individuals who have at least a migrant member from their household.[26] Column 3 excludes individuals with migrant household-head (from the sample used in Column 2, Table 5 with non-missing migration information on household-heads). Overall, the results from this exercise are consistent with the original estimates. In fact, in some cases, the estimated effects on attendance become larger after excluding migrants from the sample.

5.2.3 Permutation tests

Fifth, we perform two different placebo tests to assess the robustness of our inference. First, we randomly assign 'gold-suitability' status to 40%[27] of the clusters and estimate the main specification 1,000 times. Figure 5 reports the distribution of the coefficients for the different age groups from this exercise as well as the original estimates from column (3) of Table 2. In a second exercise, for each of a total of 100 random allocations of suitability, we permute the vector of gold prices 10 times, yielding a total of 1,000 iterations. Figure 6 reports the relevant results. These alternative attempts at inference yield the same conclusions. The original estimates retain their statistical significance.

[25] Moreover, if we define migrants based on whether they have migrated into the current location within the last ten years instead of five, we do not find any evidence of differential migration. These results are reported in Table A10

[26] Note that this broad definition of assigning migrant status to everyone in the household as long as one member has a migration history leads to a substantial decline in the sample size. We consider this approach to be conservative.

[27] To preserve the original proportion of clusters that are considered to be gold-suitable or otherwise in the sample.

5.2.4 Industrial mining

To address the concern that the effects may be driven by industrial mining, we use the dataset from Berman et al. [2017] with location information on industrial mines operating in a given year for the period 2000-10. In Column 1, Table 7, we estimate the benchmark model using the DHS survey rounds available during this period. In Column 2, for each survey round, we exclude clusters that have an active industrial gold mine operating within 100 kilometers. In Column 3, we exclude all clusters that have such mines operating nearby in *any* year over this period. The results broadly support our main results.

5.2.5 Canonical Difference-in-Differences

Sixth, given the persistently high gold price in the latter part of the study period, we estimate a canonical two-period difference-in-differences model, splitting the time periods into low-price (before 2007) and high-price (2007 and onward). Table A11 reports the key estimates, which are broadly similar to those from our preferred specification. [28]

5.3 Long-run impacts on completed schooling

What are the long-term effects of labor-market shocks during childhood and adolescence? Using equation 2, we address this question using young adults aged 21-30 years living in gold-suitable areas who experience different trajectories of gold prices during their childhood. Note that, this age restriction, while necessary, excludes individuals from the younger generations who experience the acceleration in gold price around 2010 but are not old enough to be included in this analysis. This also limits the scope for comparing these results with those for school attendance. We acknowledge this limitation.[29]

Table 8 reports the relevant results. Column 1 uses the full sample whereas Columns

[28] In Table A12, we estimate the benchmark specification using higher lags of gold price. The results are broadly similar. In another robustness exercise, we exclude the regions hosting the capital for any country. The results are reported in Table A13 and support the main conclusions.

[29] Another important caveat relates to migration. Migration rates are higher for this age group compared to their younger counterparts. However, we do not have sufficiently granular information on the origin of these young adults. This may introduce noise to our measures of their exposure to gold-suitable areas when they were growing up.

2 and 3 use the male and female sub-samples, respectively. Price shocks earlier in childhood appear to have higher long-term effects. One log point higher gold price when an individual living in a gold-suitable area was 6-10 years old leads to a decline in completed years of schooling by over half a year ($p < 0.05$; 9.5% of the sample mean). The corresponding estimate for shocks during ages 11-15 is a reduction of 0.22 years ($p < 0.05$; % of the sample mean). While the estimate is negative for shocks during ages 16-20, it is imprecise and not significant at conventional levels. Moreover, in gold-suitable areas, boys exhibit a higher decline in completed schooling for higher prices when they are 6-10 years old. In contrast, the schooling penalty is more pronounced for girls if the gold prices are high when they are 11-15 years old.

Taken together, these results suggest that the contemporaneous declines in attendance in response to higher prices that we observe in Section 5.1 may translate into long-term losses in completed years of schooling.[30]

6 Conclusion

This paper investigates how local labor market conditions shape human capital investments in the context of artisanal and small-scale gold mining in sub-Saharan Africa. Thanks to rapidly rising gold prices over the last two decades, this industry has grown in prominence, employing over 60 million people and supporting another 130. While the earning gains from these jobs can increase the parental demand for schooling, the rise in labor demand may raise the opportunity costs as well. The direction of the net effects, therefore, is an empirical question.

We find adverse effects of potential artisanal mining activities on the schooling outcomes of children and young adults. This suggests that the positive income effect of ASM that other studies have highlighted [Girard et al., 2022] may not increase the demand for schooling enough to offset the higher opportunity costs. The lack of formalization and the absence of effective laws regulating child labor may also have contributed to the

[30] Using the same sample and outcome, Figure A7 reports results from a canonical event study where we assume that the individuals born in 1990, who are 17 in 2007 when the rise in gold price accelerates, are the first relevant cohort to experience relatively higher prices over the study period. The results are similar and show a decline in completed education for the younger cohorts born after 1990.

decline in children's human capital investments.

Our results also shed light on the gendered effects of labor demand shocks. The decline in attendance we document appears to be higher for boys, potentially due to their comparative advantage at brawn-intensive work, which is common in the mining industry.

Our findings may inform the design of policies to increase school attendance, such as lowering the opportunity cost of schooling by means of conditional cash transfers or regulating and enforcing child labor laws. Future research should investigate the mechanisms underlying the gendered effects as well as potential intra-household considerations in schooling choices.

References

Anjali Adukia, Sam Asher, and Paul Novosad. Educational investment responses to economic opportunity: evidence from indian road construction. *American Economic Journal: Applied Economics*, 12(1):348–76, 2020.

Lao-Tzu Allan-Blitz, Charlotte Goldfine, and Timothy B Erickson. Environmental and health risks posed to children by artisanal gold mining: A systematic review. *SAGE Open Medicine*, 10:20503121221076934, 2022.

David Atkin. Endogenous skill acquisition and export manufacturing in mexico. *American Economic Review*, 106(8):2046–2085, 2016.

Natalie Bau, Martin Rotemberg, Manisha Shah, and Bryce Steinberg. Human capital investment in the presence of child labor. 2020.

Remi Bazillier and Victoire Girard. The gold digger and the machine. evidence on the distributive effect of the artisanal and industrial gold rushes in burkina faso. *Journal of Development Economics*, 143:102411, 2020.

Nicolas Berman, Mathieu Couttenier, Dominic Rohner, and Mathias Thoenig. This mine is mine! how minerals fuel conflicts in africa. *American Economic Review*, 107(6):1564–1610, 2017.

Kirill Borusyak, Peter Hull, and Xavier Jaravel. Quasi-experimental shift-share research designs. *The Review of Economic Studies*, 89(1):181–213, 2022.

Elizabeth Heger Boyle, Miriam King, and Matthew Sobek. Ipums-demographic and health surveys: Version 9, 2022.

Tieguhong Julius Chupezi, Verina Ingram, and Jolien Schure. *Impacts of artisanal gold and diamond mining on livelihoods and the environment in the Sangha Tri-National Park landscape.* CIFOR, 2009.

Esther Duflo, Pascaline Dupas, and Michael Kremer. The impact of free secondary education: Experimental evidence from ghana. Technical report, National Bureau of Economic Research, 2021.

Eric V Edmonds and Nina Pavcnik. International trade and child labor: cross-country evidence. *Journal of international Economics*, 68(1):115–140, 2006.

Kevin N Funoh. *The impacts of artisanal gold mining on local livelihoods and the environment in the forested areas of Cameroon*, volume 150. CIFOR, 2014.

Sara Geenen, Nik Stoop, and Marijke Verpoorten. How much do artisanal miners earn? an inquiry among congolese gold miners. *Resources Policy*, 70:101893, 2021.

Victoire Girard, Teresa Molina-Millán, Guillaume Vic, et al. Artisanal mining in africa. Technical report, Universidade Nova de Lisboa, Nova School of Business and Economics, NOVAFRICA, 2022.

Richard J Goldfarb, Anne-Sylvie André-Mayer, Simon M Jowitt, and Gavin M Mudd. West africa: The world's premier paleoproterozoic gold province. *Economic Geology*, 112(1): 123–143, 2017.

Martin Guenther. Local effects of artisanal mining: Empirical evidence from ghana. In *Presentation at the international conference'environmental economics: a focus on natural ressources', orléans*, 2018.

Thomas Hentschel. Artisanal and small-scale mining: challenges and opportunities. 2003.

Gavin Hilson and Roy Maconachie. Artisanal and small-scale mining and the sustainable development goals: Opportunities and new directions for sub-saharan africa. *Geoforum*, 111:125–141, 2020.

Gavin M Hilson. *The socio-economic impacts of artisanal and small-scale mining in developing countries*. CRC Press, 2003.

Jennifer Hinton, Marcello M Veiga, and Christian Beinhoff. Women and artisanal mining: Gender roles and the road ahead. *The socio-economic impacts of artisanal and small-scale mining in developing countries*, pages 149–188, 2003.

ILO. Child labor in mining and global supply chains. 2019.

ILO. Children's work in the artisanal and small-scale gold mining sector in timor-leste: Baseline research report, 2021.

Robert Jensen. Agricultural volatility and investments in children. *American Economic Review*, 90(2):399–404, 2000.

Andreas Kotsadam and Anja Tolonen. African mining, gender, and local employment. *World Development*, 83:325–339, 2016.

Robert E Lucas Jr. On the mechanics of economic development. *Journal of monetary economics*, 22(1):3–42, 1988.

N Gregory Mankiw, David Romer, and David N Weil. A contribution to the empirics of economic growth. *The quarterly journal of economics*, 107(2):407–437, 1992.

Fritz Morgane, James McQuilken, Nina Collins, and Fitsum S Weldegiorgis. Global trends in artisanal and small-scale mining: A review of key numbers and issues. 2018.

Nathan Nunn and Nancy Qian. The potato's contribution to population and urbanization: evidence from a historical experiment. *The quarterly journal of economics*, 126(2):593–650, 2011.

Dylan O'Driscoll. Overview of child labour in the artisanal and small-scale mining sector in asia and africa. 2017.

Mark M Pitt, Mark R Rosenzweig, and Mohammad Nazmul Hassan. Human capital investment and the gender division of labor in a brawn-based economy. *American economic review*, 102(7):3531–3560, 2012.

Adrian Poignant. Small-scale mining and agricultural development: Evidence from northwestern tanzania. *Available at SSRN 4082121*, 2022.

Anouk S Rigterink, Tarek Ghani, Juan Sebastian Lozano, and Jacob N Shapiro. Mining competition and violent conflict in africa: Pitting against each other. Technical report, Empirical Studies of Conflict Project, 2023.

Jeffrey D Sachs and Andrew M Warner. The curse of natural resources. *European economic review*, 45(4-6):827–838, 2001.

Manisha Shah and Bryce Millett Steinberg. Drought of opportunities: Contemporaneous and long-term impacts of rainfall shocks on human capital. *Journal of Political Economy*, 125(2):527–561, 2017.

Maria Micaela Sviatschi. Making a narco: Childhood exposure to illegal labor markets and criminal life paths. *Econometrica*, 90(4):1835–1878, 2022.

WorldBank. Shining a light on a hidden sector. *World Bank*, 2019.

Tables

Table 1: Summary Statistics

	Sample	Distance to Gold-Suitable Area		Sample	Distance to Gold-suitable Area	
		<=10 km	>10 km		<=10 km	>10 km
	age group: 6-10			age group: 16-20		
N	443,724	185,942	257,782	282,946	115,142	167,804
Female (%)	49.49	49.55	49.44	52	51.49	52.35
Rural (%)	74.87	76.37	73.78	66.09	68.08	64.73
HH-head female (%)	23.02	24.01	22.30	26.93	27.45	26.57
HH size	7.93	7.31	8.37	7.39	6.73	7.84
	age group: 11-15			age group: 21-25		
N	352,114	147,404	204,710	222,083	91,667	130,418
Female (%)	49.67	49.65	49.68	55.92	55.84	55.98
Rural (%)	72.15	74.23	70.65	62.39	64.19	61.12
HH-head female (%)	26.48	27.44	25.79	22.54	22.48	22.59
HH size	7.93	7.35	8.36	6.36	5.62	6.88

Note: Summary statistics for the different age groups stratified by exposure to the suitability of the land for artisanal mining. The sample comprises 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA. See Table A1 for details.

Table 2: ASM and school attendance

	Dependent variable:		
	school attendance		
	(1)	(2)	(3)
gold×price×age_6_10	−0.009	−0.011	−0.010
	(0.010)	(0.010)	(0.010)
gold×price×age_11_15	−0.031***	−0.032***	−0.031***
	(0.009)	(0.009)	(0.009)
gold×price×age_16_20	−0.022***	−0.024***	−0.023***
	(0.008)	(0.008)	(0.008)
gold×price×age_21_25	−0.009*	−0.009**	−0.008*
	(0.005)	(0.005)	(0.005)
country × year FE	✓		✓
region FE			✓
region × year FE		✓	
Observations	1,385,524	1,385,524	1,385,524

	School attendance by age groups			
	age: 6-10	age: 11-15	age: 16-20	age: 21-25
mean	0.69	0.77	0.45	0.11
(sd)	(0.46)	(0.41)	(0.49)	(0.32)

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The sample includes individuals aged 6 to 30 years who are surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The 'gold' variable indicates whether a cluster is located within 10 km of the nearest gold-suitable location. The standard errors are clustered at the DHS cluster level and are reported in parentheses.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table 3: ASM and school attendance: Gender heterogeneity

	Dependent variable:		
	school attendance		
	(1)	(2)	(3)
gold×price×age_6_10	−0.002	−0.004	−0.003
	(0.011)	(0.010)	(0.010)
gold×price×age_11_15	−0.029***	−0.029***	−0.027***
	(0.010)	(0.010)	(0.010)
gold×price×age_16_20	−0.012	−0.014	−0.012
	(0.009)	(0.009)	(0.009)
gold×price×age_21_25	−0.006	−0.005	−0.005
	(0.005)	(0.005)	(0.005)
gold×price×age_6_10×male	−0.015**	−0.016**	−0.016**
	(0.007)	(0.007)	(0.007)
gold×price×age_11_15×male	−0.006	−0.007	−0.008
	(0.007)	(0.007)	(0.007)
gold×price×age_16_20×male	−0.022**	−0.023***	−0.024***
	(0.009)	(0.009)	(0.009)
gold×price×age_21_25×male	−0.006	−0.009	−0.009
	(0.007)	(0.007)	(0.007)
country × year FE	✓		✓
region FE			✓
region × year FE		✓	
Observations	1,385,524	1,385,524	1,385,524

	School attendance by age groups			
	age: 6-10	age: 11-15	age: 16-20	age: 21-25
mean	0.69	0.77	0.45	0.11
(sd)	(0.46)	(0.41)	(0.49)	(0.32)

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The sample includes individuals aged 6 to 30 years who are surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. The 'gold' variable indicates whether a cluster is located within 10 km of the nearest gold-suitable location. The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The specification is identical to Equation (X), with the addition of 'male' interaction terms. The standard errors are clustered at the DHS cluster level and are reported in parentheses.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table 4: Robustness: Using individuals living within 20km of the boundary of gold-suitable areas

	Dependent variable:		
	school attendance		
	(1)	(2)	(3)
inside×price×age_6_10	−0.059***	−0.047***	−0.051***
	(0.014)	(0.014)	(0.014)
inside×price×age_11_15	−0.065***	−0.058***	−0.060***
	(0.013)	(0.013)	(0.013)
inside×price×age_16_20	−0.034***	−0.029***	−0.030***
	(0.011)	(0.011)	(0.011)
inside×price×age_21_25	−0.012*	−0.010	−0.012*
	(0.007)	(0.007)	(0.007)
country × year FE	✓		✓
buffer FE			✓
buffer × year FE		✓	
Observations	633,749	633,749	633,749

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The sample includes all households surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018 who were living in clusters located within the 20 km buffer around the gold-suitability boundaries. The 'inside' variable indicates whether a cluster is located at the intersection of the 20km buffer with gold-suitable land. The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The standard errors are clustered at the DHS cluster level and are reported in parentheses.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table 5: Robustness: ASM and migration

	Dependent variable:	
	Respondent is a migrant	Respondent is a migrant
	(1)	(2)
gold×price	0.011*	0.003
	(0.006)	(0.009)
country × year FE	✓	✓
region FE	✓	✓
age group FE	✓	✓
Observations	710,131	191,089

Note: Estimates based on OLS regressions. The sample in Column 1 includes all individuals from the main sample where we have non-missing migration information for at least one member of the household. The sample in Column 2, on the other hand, includes individuals if we have migration data on their household-head. In both cases, we have 8 countries and 24 survey rounds (compared to 14 countries and 45 waves in the full sample). The outcome is a binary variable indicating whether an individual has migrated to the current location within the last five years. We consider all members of a household to be migrants if any of these members is a migrant (Column 1) or if the household-head is a migrant (Column 2). The standard errors are clustered at the DHS cluster level and are reported in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table 6: Robustness: Excluding Migrants

	Dependent variable:		
	School attendance		
Excluding households with:	-	Any migrant member	Migrant HH-head
	(1)	(2)	(3)
gold×price×age_6_10	-0.088^{***}	-0.114^{***}	-0.128^{***}
	(0.011)	(0.012)	(0.013)
gold×price×age_11_15	-0.096^{***}	-0.089^{***}	-0.090^{***}
	(0.009)	(0.010)	(0.012)
gold×price×age_16_20	-0.035^{***}	-0.035^{***}	-0.038^{**}
	(0.010)	(0.012)	(0.015)
gold×price×age_21_25	0.002	0.007	0.013
	(0.006)	(0.009)	(0.011)
country × year FE	✓	✓	✓
region FE	✓	✓	✓
Observations	710,131	312,468	153,037

	School attendance by age groups			
	age: 6-10	age: 11-15	age: 16-20	age: 21-25
mean	0.74	0.82	0.48	0.10
(sd)	(0.43)	(0.37)	(0.49)	(0.31)

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The 'gold' variable indicates whether a cluster is located within 10 km of the nearest gold-suitable location. The sample in column (1) includes individuals aged 6 to 30 years living in households with available data on migration status who are surveyed across 24 waves of Demographic and Health Surveys (DHS) covering 8 countries in SSA and spanning the period 2000-2018. Households with at least one migrant member have been excluded in column (2), and households with a migrant head have been excluded in column (3). The standard errors are clustered at the DHS cluster level and are reported in parentheses.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table 7: Robustness: Excluding clusters with industrial mines (2000-2010)

	Dependent variable:		
	school attendance		
Excluding clusters with:	-	active mine	active mine ever
	(1)	(2)	(3)
gold×price×age_6_10	-0.043^{***}	-0.040^{***}	-0.049^{***}
	(0.015)	(0.015)	(0.015)
gold×price×age_11_15	-0.038^{***}	-0.030^{**}	-0.039^{***}
	(0.014)	(0.015)	(0.014)
gold×price×age_16_20	-0.010	-0.005	-0.008
	(0.013)	(0.013)	(0.013)
gold×price×age_21_25	-0.015^{**}	-0.013^{*}	-0.013^{*}
	(0.008)	(0.008)	(0.008)
country × year FE	✓	✓	✓
region FE	✓	✓	✓
Observations	716,843	704,101	698,050

	School attendance by age groups			
	age: 6-10	age: 11-15	age: 16-20	age: 21-25
mean	0.63	0.73	0.42	0.10
(sd)	(0.48)	(0.44)	(0.49)	(0.30)

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The 'gold' variable indicates whether a cluster is located within 10 km of the nearest gold-suitable location. The sample in column (1) includes individuals aged 6 to 30 years who are surveyed across 26 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2010. In Column 2, for each survey round, we exclude clusters that have an active industrial gold mine operating within 100 kilometers. In Column 3, we exclude all clusters that have such mines operating nearby in any year over this period. The standard errors are clustered at the DHS cluster level and are reported in parentheses.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table 8: ASM and long-run effects on completed schooling

	Dependent variable:		
	Years of schooling		
	All	Male	Female
	(1)	(2)	(3)
gold×ln_avgprice_6_10	−0.592**	−0.534	−0.487
	(0.274)	(0.391)	(0.319)
gold×ln_avgprice_11_15	−0.220**	−0.066	−0.366***
	(0.104)	(0.144)	(0.122)
gold×ln_avgprice_16_20	−0.137	−0.161	−0.075
	(0.085)	(0.112)	(0.094)
country × year FE	✓	✓	✓
region FE	✓	✓	✓
Observations	427,467	188,593	238,874

Note: Estimates based on OLS regressions (equation 2). The sample in column (1) includes individuals aged 21 to 30 years who are surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018, while column 2 (3) includes males (females) only. The dependent variable is completed years of schooling. The 'gold' variable indicates whether a cluster is located within 10 km of the nearest gold-suitable location. The 'ln_avgprice_6_10', variable for example, captures the average of the global gold price in US dollars in logs when these individuals were 6-10 years old. The standard errors are clustered at the DHS cluster level and are reported in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Figures

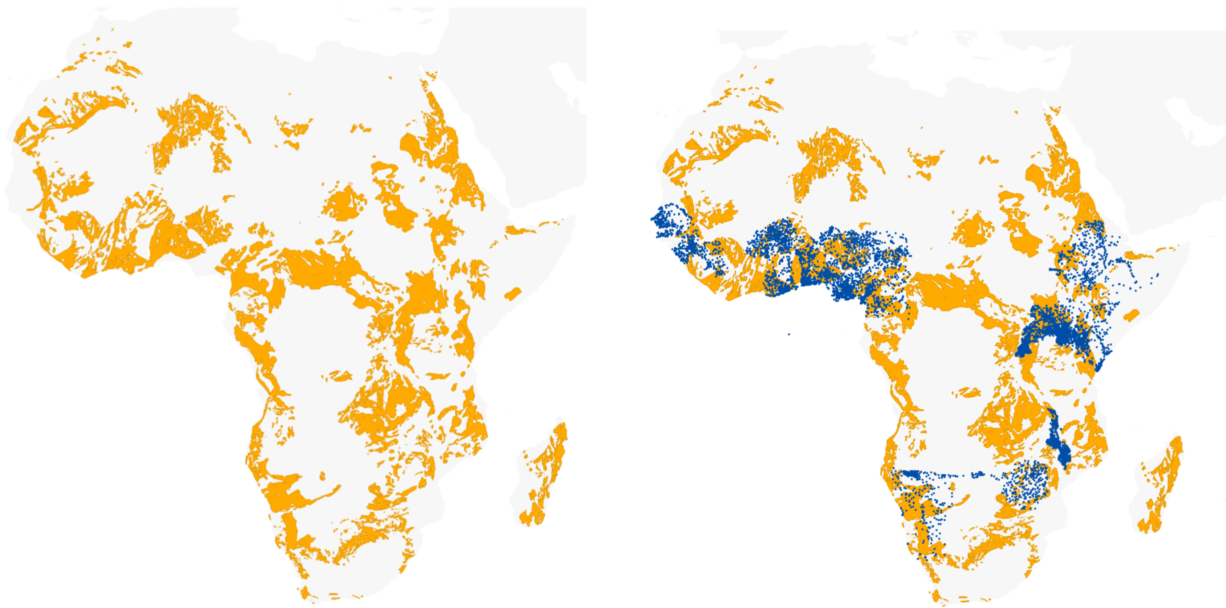


Figure 1: Geological suitability for artisanal gold mining and DHS clusters

Note: The left panel shows the map of the bedrock that is geologically suitable for artisanal gold mining in Africa. The right panel shows the GPS coordinates of DHS clusters of the countries included in the sample.

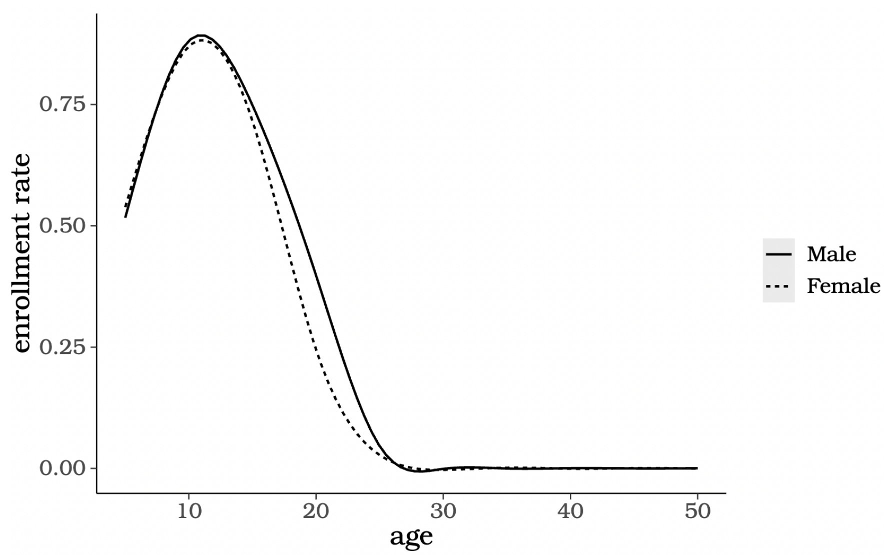


Figure 2: Attendance rates across age by gender

Note: The figure shows the school attendance rates by age, separately for males and females. The solid (dotted) line shows the age profile for males (females). The sample comprises the latest available waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA.

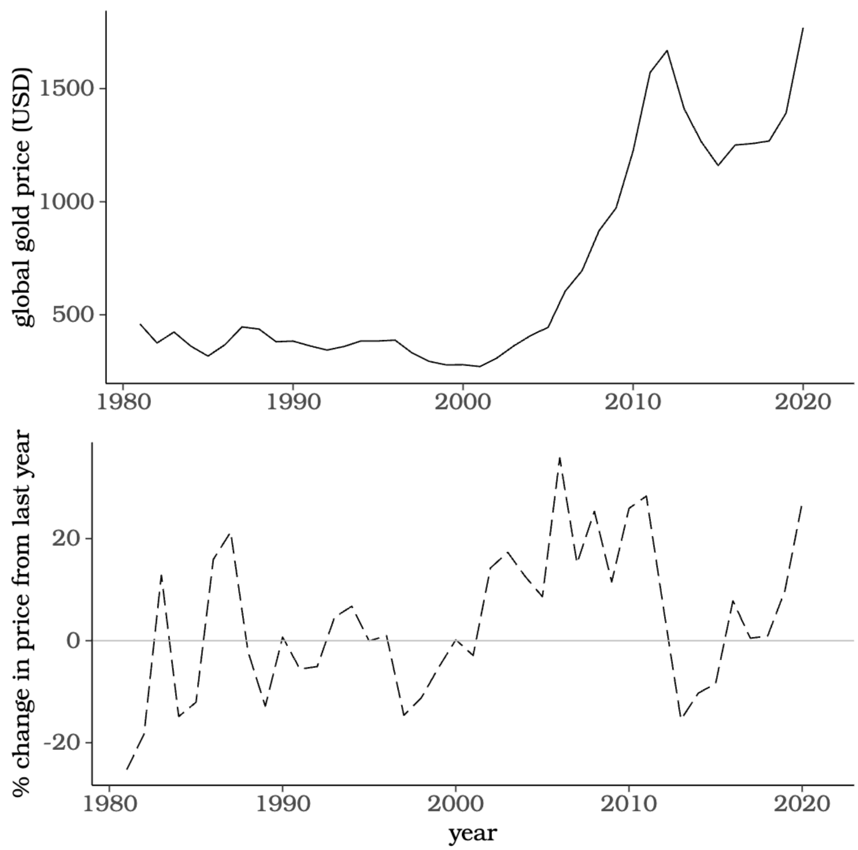


Figure 3: Global gold price and its annual growth over the period 1980-2020

Note: *Source:* www.gold.org

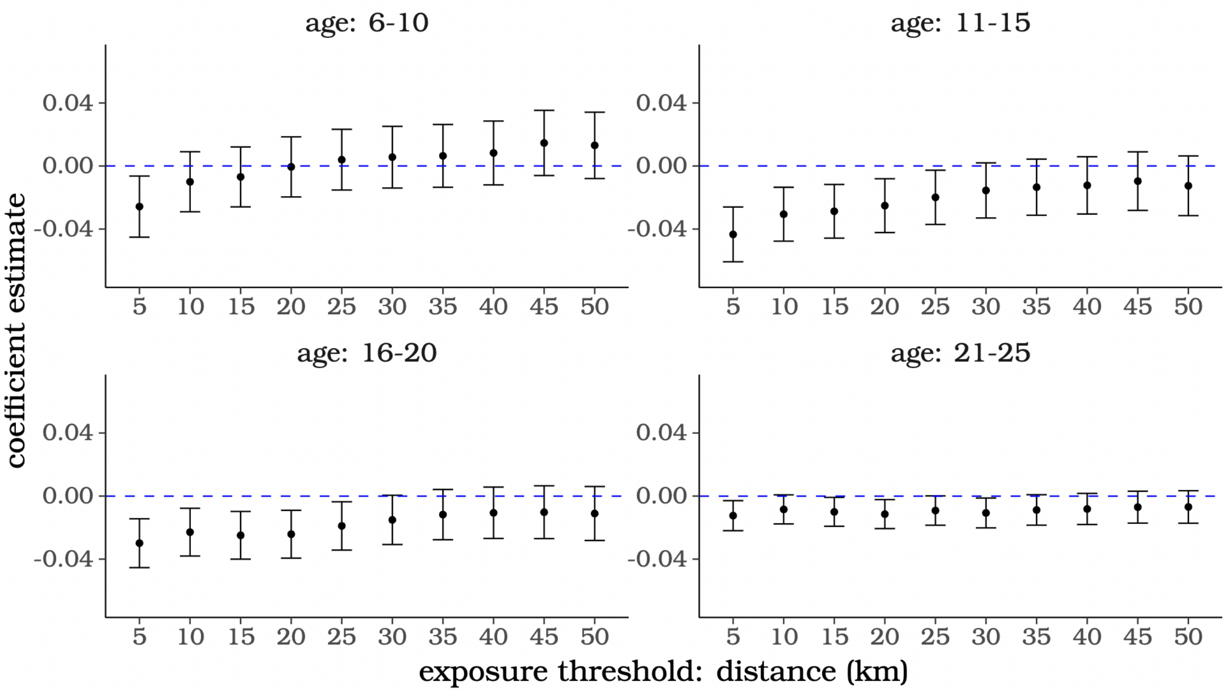


Figure 4: Sensitivity of estimates to using different distance thresholds to define exposure (school attendance)

Note: With school attendance as the dependent variable, the figure reports point estimates and 95% confidence intervals across varying distance thresholds to define exposure. E.g., results for '30' correspond to the case where households who live within 30 km of the nearest gold-suitable location are considered to be potentially exposed to ASM opportunities. All estimates use the specification with region and country-by-year fixed effects.

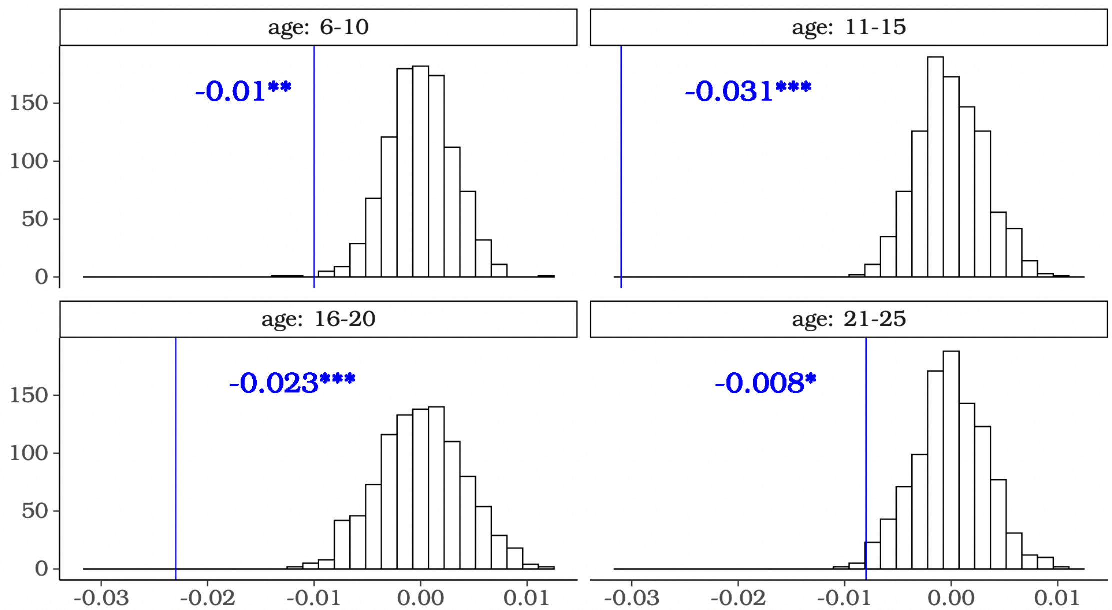


Figure 5: Suitability permutation test results for school attendance

Note: The figure depicts the distribution of the coefficients on gold*price*age from 1,000 regressions with the suitability exposure randomly assigned to 40% of the clusters in each iteration. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. All specifications also include price*age, gold*age, and age-group fixed effects, as well as the aforementioned individual and household controls. The vertical blue lines indicate the coefficients from the original analysis, i.e., column (3) in Table 2.

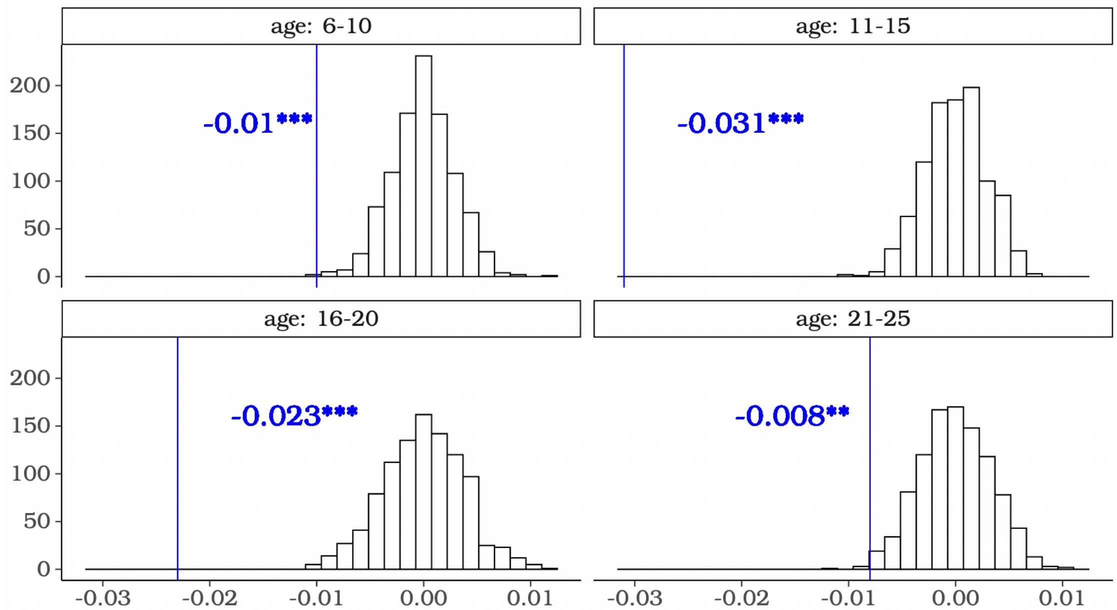


Figure 6: Suitability and price permutation test results for school attendance

Note: The figure depicts the distribution of the coefficients on gold*price*age from 1,000 regressions using the following approach: for each of a total of 100 random allocations of suitability, we permute the vector of the gold-price 10 times, yielding a total of 1,000 iterations. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. All specifications also include price*age, gold*age, and age-group fixed effects, as well as the aforementioned individual and household controls. The vertical blue lines indicate the coefficients from the original analysis, i.e., column (3) in Table 2.

Appendix

Table A1: Sample size by DHS wave

country	year	observations	country	year	observations
Senegal	2005	56,513	Nigeria	2003	29,394
	2010	62,889		2008	124,184
	2015	34,094		2013	143,542
	2016	33,928		2018	149,363
	2017	64,858			
			Malawi	2000	52,195
Ethiopia	2000	58,029		2004	49,678
	2005	37,531		2010	96,829
	2011	65,578		2016	101,177
	2016	63,944			
			Uganda	2001	30,338
Kenya	2003	31,409		2006	36,417
	2008	31,934		2011	36,329
	2014	131,063		2016	73,890
Ghana	2003	22,459	Guinea	2005	32,533
	2008	39,984		2012	37,583
	2014	37,508		2018	41,015
Rwanda	2005	39,352	Namibia	2000	27,116
	2010	47,386		2006	36,153
	2014	46,878		2013	35,349
Zimbabwe	2005	37,814	Benin	2001	24,471
	2010	35,082		2011	69,920
	2015	36,716			
			Burkina Faso	2003	50,316
Cameroon	2004	42,738		2010	67,335
	2011	59,132			

Note: The table shows the sample size for individuals aged 6 to 30 who are surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018.

Table A2: Sample description for the different aggregation units

country	region-I	region-II	clusters	N	N (per region-I)	N (per region-II)	N (per cluster)
Benin	12	78	991	59,814	4,984	767	60
Burkina Faso	13	45	937	71,762	5,520	1,595	77
Cameroon	10	58	1,040	64,080	6,408	1,105	62
Ethiopia	11	75	2,251	156,499	14,227	2,087	70
Ghana	16	253	1,228	58,381	3,649	231	48
Guinea	8	34	983	61,004	7,626	1,794	62
Kenya	47	297	2,373	123,486	2,627	416	52
Malawi	28	235	2,745	170,550	6,091	726	62
Namibia	13	107	1,291	58,236	4,480	544	45
Nigeria	37	741	3,510	271,156	7,329	366	77
Rwanda	5	30	1,438	85,848	17,170	2,862	60
Senegal	14	45	1,566	157,708	11,265	3,505	101
Uganda	58	163	1,685	113,193	1,952	694	67
Zimbabwe	10	91	1,185	54,534	5,453	599	46

Note: The table presents the number of administrative regions, categorized into two distinct geographical levels as well as the number of DHS clusters and the average number of residents per each of these units in each country.

Table A3: Robustness: Clustering standard errors at the sub-region level

	Dependent variable:		
	school attendance		
	(1)	(2)	(3)
gold×price×age_6_10	−0.009	−0.011	−0.010
	(0.013)	(0.013)	(0.013)
gold×price×age_11_15	−0.031***	−0.032***	−0.031***
	(0.012)	(0.012)	(0.012)
gold×price×age_16_20	−0.022**	−0.024**	−0.023**
	(0.010)	(0.010)	(0.010)
gold×price×age_21_25	−0.009	−0.009	−0.008
	(0.006)	(0.006)	(0.006)
country × year FE	✓		✓
region FE			✓
region × year FE		✓	
Observations	1,385,524	1,385,524	1,385,524

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The sample includes individuals aged 6 to 30 years who are surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The 'gold' variable indicates whether a cluster is located within 10 km of the nearest gold-suitable location. The standard errors are clustered at the sub-region or region-II level and are reported in parentheses. Please see Table A2 for the average sample size for these sub-regional units.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table A4: ASM and employment of individuals aged 16-25

	Dependent variable:		
	Employment		
	(1)	(2)	(3)
gold×price×age_16_20	0.033***	0.031***	0.033***
	(0.007)	(0.007)	(0.007)
gold×price×age_21_25	0.003	0.002	0.003
	(0.006)	(0.006)	(0.006)
country × year FE	✓		✓
region × year FE		✓	
region FE			✓
Observations	263,130	263,130	263,130

	Employment rate by age groups	
	age: 16-20	age: 21-25
mean	0.21	0.34
(sd)	(0.41)	(0.47)

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The sample includes individuals aged 16-30 years surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018. The outcome variable indicates whether an individual has been employed in the last 12 months (excluding household labor). The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The standard errors are clustered at the DHS cluster level and are reported in parentheses.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table A5: Robustness: Distance to the nearest gold-suitable location)

	Dependent variable:		
	school attendance		
	(1)	(2)	(3)
distance×price×age_6_10	0.0001	0.001	0.001
	(0.002)	(0.002)	(0.002)
distance×price×age_11_15	0.007***	0.008***	0.008***
	(0.002)	(0.002)	(0.002)
distance×price×age_16_20	0.006***	0.007***	0.006***
	(0.002)	(0.002)	(0.002)
distance×price×age_21_25	0.003***	0.004***	0.003***
	(0.001)	(0.001)	(0.001)
country × year FE	✓		✓
region FE			✓
region × year FE		✓	
Observations	1,385,524	1,385,524	1,385,524

*Note: Estimates based on OLS regressions. All specifications also include price*age, distance*age, and age-group fixed effects. The sample includes individuals aged 6 to 30 years who are surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. The 'distance' variable is the distance of a cluster from the nearest gold-suitable location + 1 in logs, i.e. $log(distance + 1)$. The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The standard errors are clustered at the DHS cluster level and are reported in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.*

Table A6: Summary statistics: Individuals living within 20km of the boundary of gold-suitable areas

	Sample	Inside_20	Outside_20	Sample	Inside_20	Outside_20
	age group: 6-10			age group: 16-20		
N	200,738	89,362	111,376	125,990	55,929	70,061
Female (%)	49.57	49.59	49.55	51.61	51.95	51.34
Rural (%)	76.61	74.52	78.29	68.53	65.80	70.71
HH-head female (%)	23.51	23.66	23.40	27.37	27.20	27.51
HH size	7.29	7.30	7.27	6.68	6.67	6.69
	age group: 11-15			age group: 21-25		
N	159,611	70,427	89,184	100,120	45,278	54,842
Female (%)	49.72	49.93	49.56	56.15	56.05	56.23
Rural (%)	74.43	72	76.35	65.08	61.50	68.04
HH-head female (%)	27.03	27.13	26.95	22.21	22.73	21.78
HH size	7.31	7.31	7.30	5.59	5.58	5.60

Note: Summary statistics for the different age groups stratified by location inside or outside the borders of gold-suitable regions. The Inside_20 group includes households living within 20km inside the boundaries of areas suitable for artisanal gold mining while the outside_20 group includes households living within 20km outside the boundaries of gold-suitable areas. The sample comprises 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA. See Figure A3 for a visual representation of the sample and the associated stratification.

Table A7: Summary statistics: Individuals living within 10km of the boundary of gold-suitable areas

	Sample	Inside_10	Outside_10	Sample	Inside_10	Outside_10
	age group: 6-10			age group: 16-20		
N	126,360	59,128	67,232	79,508	37,069	42,439
Female (%)	49.57	49.64	49.51	51.77	52.24	51.37
Rural (%)	77.01	76.05	77.86	68.84	67.39	70.10
HH-head female (%)	23.44	23.37	23.51	27.02	26.81	27.20
HH size	7.28	7.34	7.24	6.67	6.69	6.66
	age group: 11-15			age group: 21-25		
N	100,414	46,556	53,858	63,122	29,818	33,304
Female (%)	49.71	49.71	51.37	56.15	56.26	56.05
Rural (%)	74.74	73.52	70.10	65.59	63.38	67.56
HH-head female (%)	27.02	26.98	27.20	22.31	22.60	22.06
HH size	7.29	7.31	6.66	5.58	5.61	5.56

Note: Summary statistics for the different age groups stratified by location inside or outside the borders of gold-suitable regions. The Inside_10 group includes households living within 10km inside the boundaries of areas suitable for artisanal gold mining while the outside_10 group includes households living within 10km outside the boundaries of gold-suitable areas. The sample comprises 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA. See Figure A3 for a visual representation of the sample and the associated stratification.

Table A8: Robustness: Using individuals living within 10km of the boundary of gold-suitable areas

	Dependent variable:		
	school attendance		
	(1)	(2)	(3)
inside_10×price×age_6_10	−0.039**	−0.027	−0.033*
	(0.018)	(0.018)	(0.018)
inside_10×price×age_11_15	−0.043***	−0.039**	−0.041**
	(0.016)	(0.016)	(0.016)
inside_10×price×age_16_20	−0.025*	−0.022	−0.022
	(0.014)	(0.014)	(0.014)
inside_10×price×age_21_25	−0.024***	−0.022***	−0.024***
	(0.008)	(0.008)	(0.008)
country × year FE	✓		✓
buffer FE			✓
buffer × year FE		✓	
Observations	398,861	398,861	398,861

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The sample includes all households surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018 who were living in clusters located within the 10 km buffer around the gold-suitability boundaries. The 'inside_10' variable indicates whether a cluster is located at the intersection of the 10 km buffer with gold-suitable land. The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The standard errors are clustered at the DHS cluster level and are reported in parentheses.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table A9: Robustness: Distance to the nearest gold-suitable location within the country

	Dependent variable:		
	school attendance		
	(1)	(2)	(3)
gold×price×age_6_10	−0.011	−0.011	−0.011
	(0.010)	(0.010)	(0.010)
gold×price×age_11_15	−0.031***	−0.030***	−0.030***
	(0.009)	(0.009)	(0.009)
gold×price×age_16_20	−0.020**	−0.021***	−0.021***
	(0.008)	(0.008)	(0.008)
gold×price×age_21_25	−0.005	−0.006	−0.006
	(0.005)	(0.005)	(0.005)
country × year FE	✓		✓
region FE			✓
region × year FE		✓	
Observations	1,373,017	1,373,017	1,373,017

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The sample includes individuals aged 6 to 30 years who are surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The 'gold' variable indicates whether a cluster is located within 10 km of the nearest gold-suitable location within the borders of the country where the cluster is located. The standard errors are clustered at the DHS cluster level and are reported in parentheses.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table A10: Robustness: Migration (using alternative reference periods)

	Dependent variable: Respondent is a migrant			
	(1)	(2)	(3)	(4)
gold× price	0.011*	0.010	0.006	0.005
	(0.006)	(0.006)	(0.005)	(0.011)
country × year FE	✓	✓	✓	✓
region FE	✓	✓	✓	✓
age group FE	✓	✓	✓	✓
Observations	710,131	710,131	191,089	191,089

Note: Estimates based on OLS regressions. The sample in columns 1 and 2 includes all individuals from the main sample where we have non-missing migration information for at least one member of the household. The sample in columns 3 and 4, on the other hand, includes individuals if we have migration data on their household-head. In both cases, we have 8 countries and 24 survey rounds (compared to 14 countries and 45 waves in the full sample). The outcome in columns 1 and 2 (3 and 4) is a binary variable indicating whether an individual has migrated to the current location within the last 2 (10) years. We consider all members of a household to be migrants if any of these members is a migrant (columns 1 and 2) or if the household-head is a migrant (columns 3 and 4). The standard errors are clustered at the DHS cluster level and are reported in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table A11: Robustness: Canonical Difference in Differences

	Dependent variable:
	school attendance
gold×high_price×age_6_10	-0.027^{**}
	(0.012)
gold×high_price×age_11_15	-0.045^{***}
	(0.011)
gold×high_price×age_16_20	-0.023^{**}
	(0.010)
gold×high_price×age_21_25	-0.014^{**}
	(0.006)
country × year FE	✓
region FE	✓
Observations	1,385,524

Note: Estimates based on OLS regressions. All specifications also include the aforementioned individual and household controls as well as high_price*age, gold*age, and age-group fixed effects. The sample includes individuals aged 6 to 30 years who are surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018. The dependent variable in column (1) is school attendance, and in column (2), years of schooling. The high_price variable is a dummy that takes the value 1 for the years after 2007 and 0 otherwise. The standard errors are clustered at the DHS cluster level and are reported in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table A12: Robustness: Different lags for gold price

	Dependent variable:		
	school attendance		
	(1)	(2)	(3)
gold×price×age_6_10	−0.009		
	(0.010)		
gold×price×age_11_15	−0.031***		
	(0.009)		
gold×price×age_16_20	−0.022***		
	(0.008)		
gold×price×age_21_25	−0.009*		
	(0.005)		
gold×price_lagged_2×age_6_10		−0.010	
		(0.009)	
gold×price_lagged_2×age_11_15		−0.030***	
		(0.008)	
gold×price_lagged_2×age_16_20		−0.027***	
		(0.007)	
gold×price_lagged_2×age_21_25		−0.008*	
		(0.004)	
gold×price_lagged_3×age_6_10			0.002
			(0.008)
gold×price_lagged_3×age_11_15			−0.022***
			(0.007)
gold×price_lagged_3×age_16_20			−0.025***
			(0.007)
gold×price_lagged_3×age_21_25			−0.010**
			(0.004)
country × year FE	✓	✓	✓
region FE	✓	✓	✓
Observations	1,385,524	1,385,524	1,385,524

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The sample includes individuals aged 6 to 30 years who are surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. The 'gold' variable indicates whether a cluster is located within 10 km of the nearest gold-suitable location. In column (1), the 'price' variable is the global gold price in US dollars in logs, lagging by a year. In columns (2)-(3), this variable is lagging by 2 and 3 years, respectively. The standard errors are clustered at the DHS cluster level and are reported in parentheses.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table A13: Robustness: Excluding regions hosting country capitals

	Dependent variable:	
	school attendance	
	Benchmark	Dropping capital regions
	(1)	(2)
gold×price×age_6_10	−0.010	0.0004
	(0.010)	(0.010)
gold×price×age_11_15	-0.031^{***}	-0.021^{**}
	(0.009)	(0.009)
gold×price×age_16_20	-0.023^{***}	-0.014^{*}
	(0.008)	(0.008)
gold×price×age_21_25	-0.008^{*}	-0.010^{**}
	(0.005)	(0.005)
country × year FE	✓	✓
region FE	✓	✓
Observations	1,385,524	1,290,861

*Note: Estimates based on OLS regressions. All specifications also include price*age, gold*age, and age-group fixed effects. The dependent variable is school attendance i.e., whether an individual is attending school in the year of the survey. The 'price' variable is the global gold price in US dollars in logs, lagging by a year. The 'gold' variable indicates whether a cluster is located within 10 km of the nearest gold-suitable location. In column (1), the sample includes individuals aged 6 to 30 years who are surveyed across 45 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA and spanning the period 2000-2018. Individuals living in capital regions are excluded from the sample in column (2). The standard errors are clustered at the DHS cluster level and are reported in parentheses.* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Figure A1: Countries included in the sample (dashed)

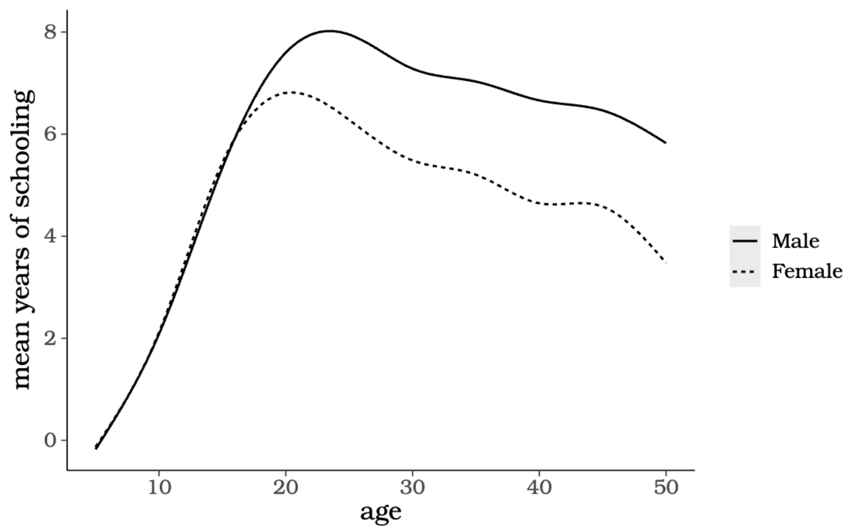


Figure A2: Mean years of schooling across ages by gender

Note: The figure shows the mean years of schooling by age separately for males and females. The solid (dotted) line shows the age profile for males (females). The averages are taken using the latest waves available for each country in the sample. The sample comprises 14 waves of Demographic and Health Surveys (DHS) covering 14 countries in SSA.

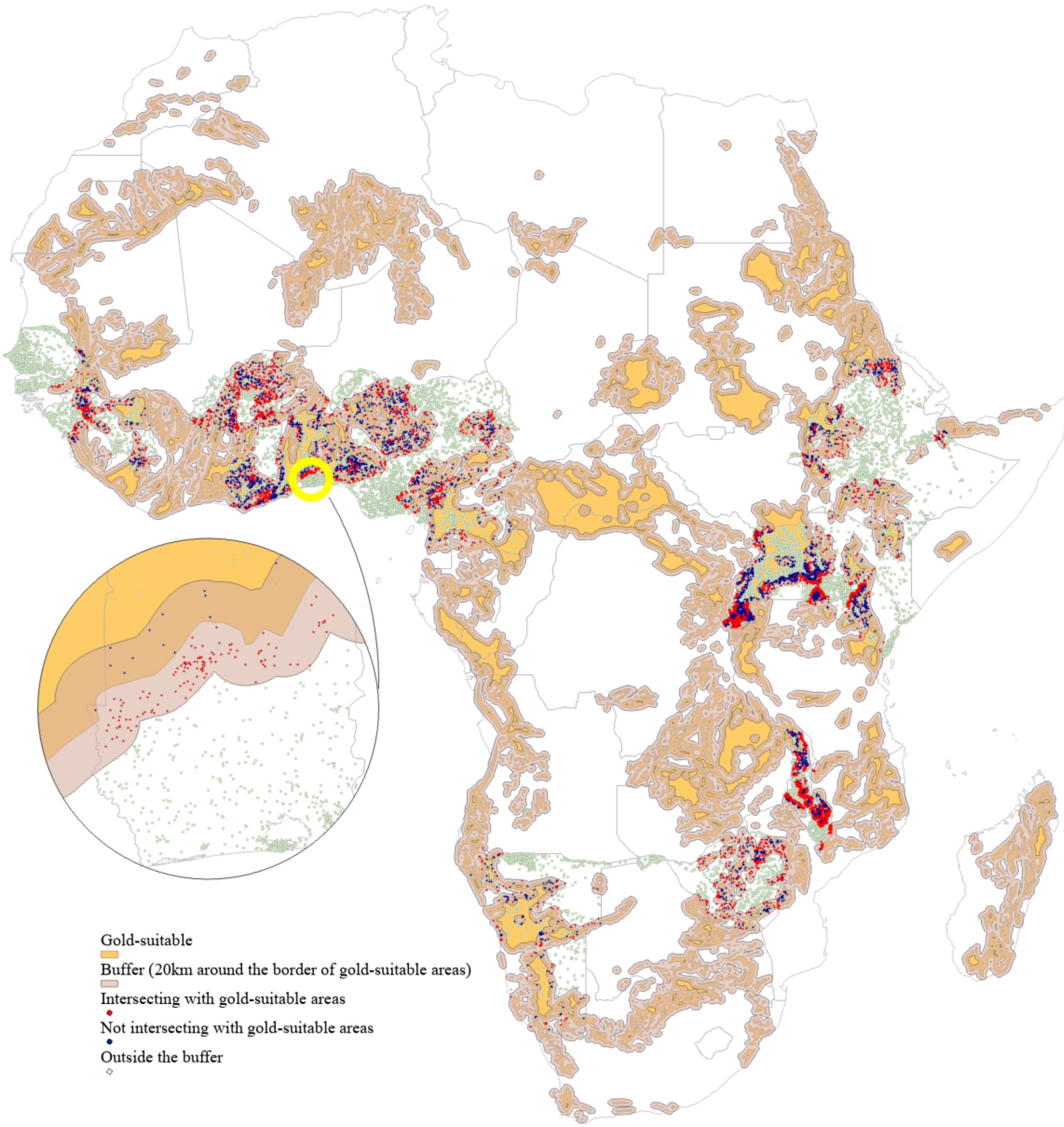
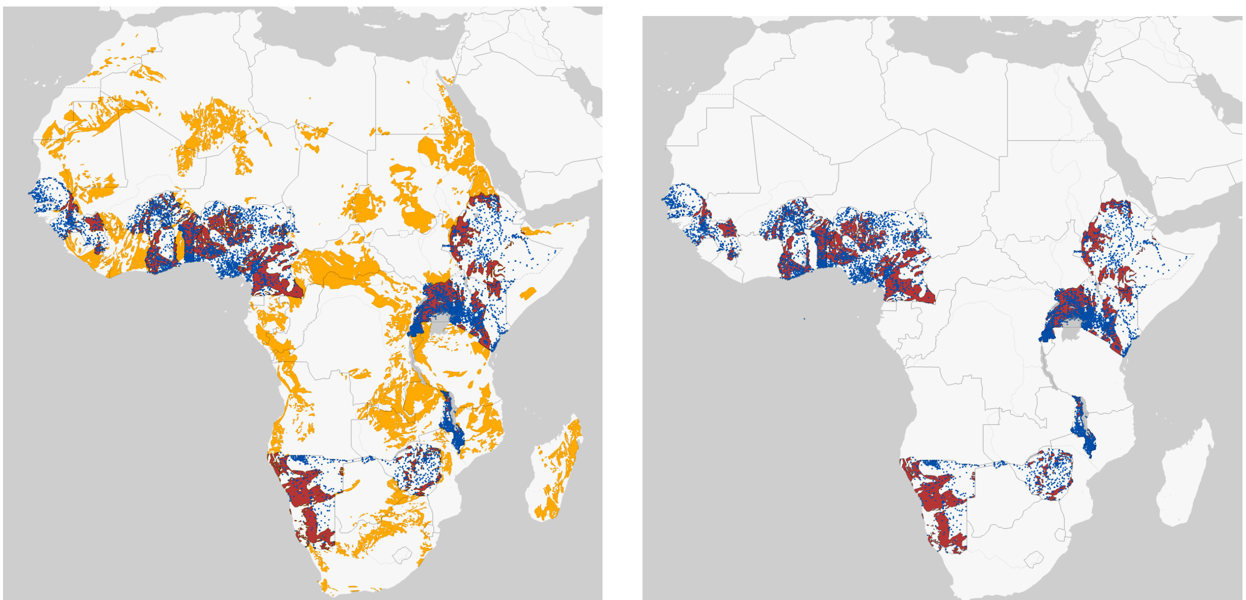


Figure A3: 20 km buffers centered on the boundaries of gold-suitable areas

Note: The map shows areas suitable for gold mining, overlapped with a 20km buffer around the edges of each suitability polygon. Blue clusters are located where this buffer intersects with gold-suitable land. Red clusters are within the buffer but outside gold-suitable areas. Green clusters are entirely outside the buffer and hence not included in the analysis presented in Section 5.2.1 and Table 4.

Figure A4: Intersection of gold-suitability and country borders



Note: The yellow polygons indicate the layer of gold-suitability across Africa. The red polygons indicate the surfaces of the gold-suitability layer that are contained within the borders of the countries included in the sample. The blue dots represent the DHS clusters of the latest wave available for each country.

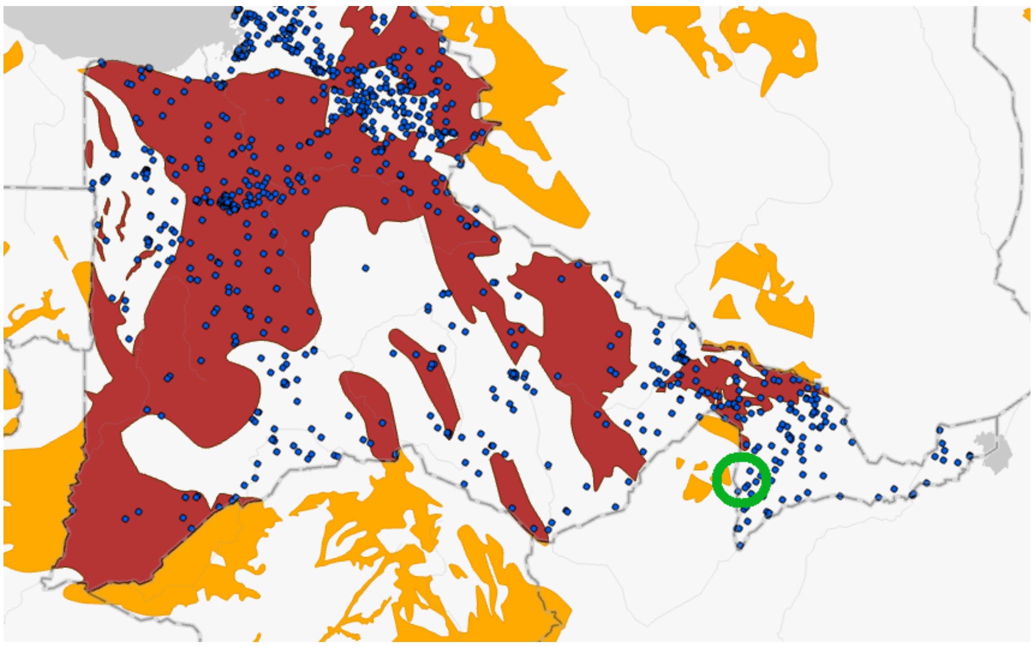


Figure A5: Illustrative example of accounting for country borders: Cameroon (rotated)

Note: The figure shows the map of Cameroon rotated 90 degrees. The blue dots represent the DHS clusters. The red areas are the gold-suitable locations within Cameroon whereas the yellow areas are those outside Cameroon. The clusters that are located within the green circle are considered to be in the Treatment group in the original analysis as they are within 10 km from the closest gold-suitable location. Taking the country's borders into account, these clusters are considered controls.

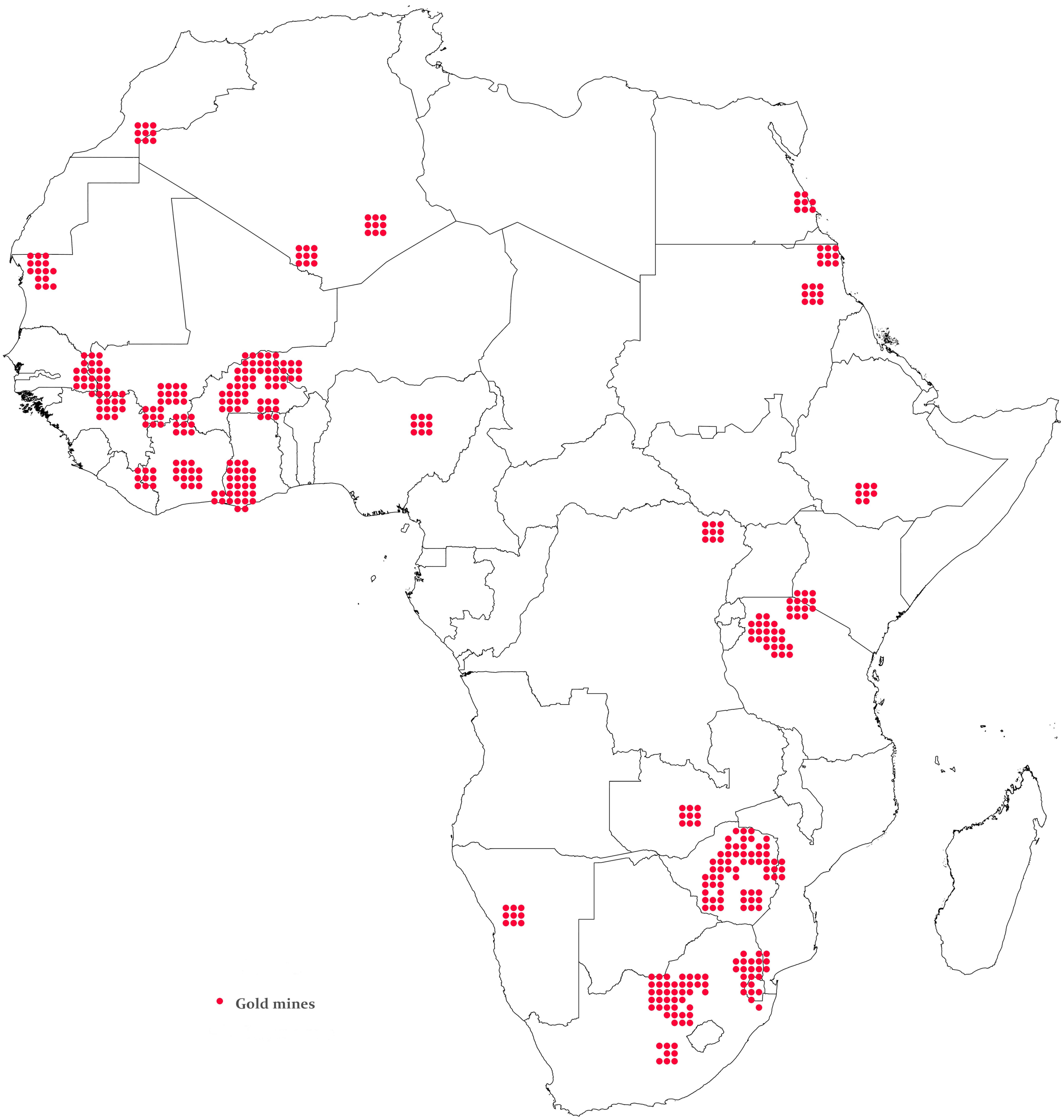


Figure A6: Location of industrial gold mines (2000-2010)

Note: The map shows the locations of industrial gold mines that are active between 2000 and 2010. Source: Berman et al. [2017].

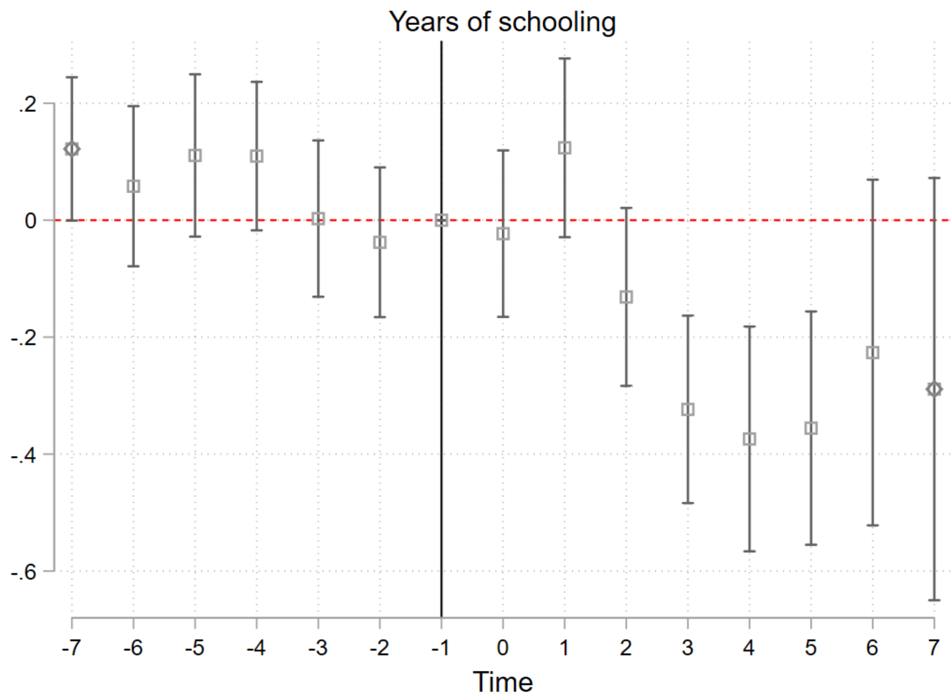


Figure A7: Event study estimates for completed years of schooling

Note: N=427,452; Sample: 21-30 years old born between 1970 and 1997. To supplement the analysis on the long-term effects in Section 5.3, this Figure presents the event-study estimates using the following specification:
$y_{ict} = \alpha + \sum_{t\in(-7,+7),\ t\neq-1} \theta_t Gold_c + \boldsymbol{\tau X}_i + \boldsymbol{\mu}_c + \boldsymbol{\lambda}_t + \boldsymbol{\zeta}_{country} + \epsilon_{ict}$,
where we normalize the periods relative to the cohort born in 1990 ($t = 0$), with the cohort born in 1989 $t = -1$ as the reference point. We assume that the individuals born in 1990, who are 17 in 2007 when the rise in gold price accelerates, are the first relevant cohort to experience relatively higher prices over the study period. y_{ict} is completed years of schooling for individuals born in year t and living in cluster c. $Gold_c$ is a binary variable indicating whether an individual is living within 10 km of a gold-suitable area. μ_c and $\zeta_{country}$ stand for cluster and country fixed effects, respectively, and λ_t represents birthyear/cohort fixed effects. X_i comprises the same set of covariates used in the main analysis as well as age-at-survey fixed effects. The vector of coefficients plotted are $\boldsymbol{\theta}_t$ $[t \in (-7, +7),\ t \neq -1]$.