RESEARCH

The impact of fluctuations in the price of gold on education in Tanzania

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Abstract

This paper evaluates the impact of fluctuations in the price of gold on enrollment and household expenditure in Tanzania. Using a difference-in-differences strategy that compares households that vary in their proximity to a gold mine, I find that a sixty-two percent increase in the price of gold leads to an 18.6 percentage point decline in enrollment among individuals fourteen to seventeen years old living within thirty kilometers of an artisanal gold mine. I also find that wealth increases for households living within thirty kilometers of a gold mine.

Keywords: Education; gold; mining; artisanal; industrial; Tanzania

Abbreviations: ASM: Artisanal and small-scale mining

1. Introduction

Nations with an abundance of natural resources may find it difficult to develop because of the "the perverse effects [such natural resources have on a nation's] economic, social, or political well-being" (Ross, 2013). Additionally, wild swings in the price of a key export commodity like gold can depress economic growth (Labys, 1993). Beyond large macroeconomic trends, price fluctuations can cause individuals to shift work either away or towards a particular sector (Kebede, 2021). These individual decisions may have a significant impact on a nation's economic well-being. For a country like Tanzania, where much of its population works in agriculture, an increase in the price of gold may cause many to move away from agriculture toward mining. The consequences of such a sectoral shift on individual and household outcomes remain unknown.

Gold's role and importance in Tanzania's economy have never been greater. It accounts for more than forty percent of the nation's nontraditional exports (Reuters, 2019). In 2020, the country exported 2.6 billion dollars worth of gold, making it the thirty-second largest gold exporter in the world (OEC, 2022). As of 2021, it stood as the fourth-largest gold producer in Africa (ITA, 2021).

This paper aims to understand the consequences of fluctuations in the price of gold on schooling and household well-being in Tanzania. To do this, I compare households that vary in their proximity to gold mines. I consider two different types of gold mines, artisanal and industrial. Unlike industrial mines, artisanal mines are smaller and informal, requiring little to no formal training for individuals to work in them. Additionally, there is little to no government oversight over these mines. Using data on the location of artisanal and industrial mines and data on individual and household outcomes from three waves of the Tanzanian National Panel Survey, I find a negative effect of increases in the price of gold and proximity to an artisanal mine on enrollment. I find that a sixty-two percent increase in the price of gold leads to a 18.6 percentage point decline in enrollment among individuals fourteen to seventeen years old living within thirty kilometers of an artisanal mine (see Table 3). The effect is similar for those living near industrial mines. However, this effect likely comes from spillover from artisanal mines. When controlling for proximity to an artisanal mine, the statistical significance of the effect goes away. These declines in enrollment occur despite families growing wealthier. Household wealth, measured as log per capita real expenditure, increases for households living within thirty kilometers of an artisanal mine. Increased wealth often enables households to send their children to school. The reason for this decline in enrollment might be that high gold prices raise the opportunity cost of schooling. If the opportunity cost of schooling is high, households will spend less of their income on education. These findings contributeto the literature by providing greater insight into the short run effects of relative price changes onhuman capital attainment.

The rest of the paper is as follows. Section 2 discusses the literature and theoretical framework. Section 3 presents a history of gold mining in Tanzania. Section 4 describes the data. In section 5, I outline the empirical methodology. Section 6 describes the main results of changes in the price of gold on enrollment. Section 7 investigates the mechanism behind the results seen in section 6. Section 8 concludes.

2. Theoretical Background

Several empirical studies have focused on the impact of price fluctuations in commodities on human capital attainment. Cogneau et Jedwab (2012) find that a fall in commodity prices leads to counter cyclical human capital investment. They find that reductions in cocoa-prices in Cote D'Ivoire led to a decline in enrollment and increase in child labor. Other studies seem to suggest that human capital investment when looking at shocks to agricultural production caused by natural events like droughts is pro cyclical (Beegle et al., 2008; Yamano et al., 2005). In Tanzania, Beegle, Dehejia, and Gatti (2006) find that negative shocks to household income increases the number of hours children work.

The link between prices and human capital investment comes from several channels. An increase in prices raises the cost of schooling due to a rise in the cost of leisure. Meaning, household consumption of schooling falls. However, higher prices also provide households with more money to spend. With more money to spend, households may use the extra income to send their kids to school (Basu and Pham, 1998; Baland and Robinson, 2000).

Recent work on human capital attainment from natural resource extraction looks at an individual, household, and communities proximity to a mine on several individual, household, and community well-being measures (Ahlreup et al., 2020; Hoedoafia et al., 2014; Kotsadam and Tolonen, 2016; Muslihundin et al., 2017; Zabsonré et al., 2007). For the most part, the literature is focused on understanding the larger social, political, and economic implications of having large endowments of natural resources (Auty, 2001; Gylfason, 2001; Ploeg, 2011; Sachs and Warner, 1997, 2001). Though these studies provide valuable insights into the outcomes of individual and house-hold human capital decisions, it remains unclear what drives these decisions. This paper attempts to contribute to the literature by providing greater insight into the short run impact of changes in a key export commodity on human capital attainment and the driving factors behind individual and household human capital decisions.

3. Background

Although it is rather hard to define artisanal and small-scale mining, artisanal and small-scale mining (ASM) generally involves using rudimentary tools like shovels, buckets, and pans on shallow ore deposits (Schwartz et al., 2021). These ore deposits are typically placer deposits. A placer deposit is a mineral deposit where minerals like gold and other precious metals and gemstones are mixed with sand and deposited by a river or glacier (USGS, 2017). ASM is a labor-intensive process with serious health risks and even death (Burki, 2019). Yet, even with these risks, it is estimated that nearly forty million people in eighty countries participate in ASM, far exceeding the seven million people working in the industrial mining sector (IISD, 2017). ASM activities contribute twenty percent of the world's annual production of gold, that is, 4.77 metric tonnes of gold. And according to the world bank, ASM is "indisposable [and] the most important nonfarm activity in the developing world" that can help reduce poverty in rural communities (World Bank, 2019).

In Tanzania, gold had an important yet limited role in the nation's early history. In the early fourteenth and fifteenth centuries, the island of Kilwa Kisiwani, located in the southern half of the country, stood as the epicenter of the medieval century gold trade. In the ports of this island, gold extracted from Zimbabwe and Manicaland was loaded and shipped to the Middle East and India (Pearson, 1998). As a result of the gold trade, the island flourished. However, the city's fortunes soon deteriorated with the emergence of the Black Death, which caused a sharp decline in the price of gold (Bryceson et al., 2012).

Gold production did not take place until 1898, when gold was discovered by Koncession für Edelmineralien, a German company (Chachage, 1995). However, due to the low price of gold, limited production took place (Lemelle, 1986). Production increased in the 1920s and 1930s due to a decline in agricultural prices and a sudden rise in gold prices (Brycenson et al., 2012). Mining at this time was dominated by alluvial mining (Roberts 1986). Artisanal and small-scale miners primarily perform this type of mining. Early estimates of the mining sector in 1938 found that of the 32,000 individuals working in the mining sector, seventy-three percent worked as small-scale miners (Lemelle, 1986). Gold production would fall again in the 1940s and 50s. The government in 1967 nationalized most of the country's mines (Brycenson et al., 2012). In 1979, the government passed the Mining Act, which led to the privatization of the mining sector. The act gave more established rights to artisanal and small-scale mining activities (Brycenson et al., 2012). Under the act, individuals could post-mining claims to certain areas and "engage in mining activities that did not require large expenditures and specialized equipment" (Brycenson et al., 2012). The government went further with the Small-Scale Mining Policy Paper of 1983, which encouraged individuals to participate in mining to supplement their incomes (Chachage, 1995). In short, artisanal, and small-scale mining in Tanzania, unlike in other countries, is seen as a viable alternative to agriculture.

4. Data

4.1 Education data

My analysis uses data from three rounds of the Tanzanian National Panel Survey (NPS). The Tanzanian Bureau of statistics conducted all three rounds of the survey with technical support from the World Bank. The three rounds of the survey ran from 2008 to 2009, 2010 to 2011, and 2012 to 2013. Each survey round provides detailed information on various household-level socioeconomic factors, like whether an individual was enrolled in the year of the survey interview. The NPS also includes geolocation data on households interviewed in the survey. To ensure the anonymity of each household, households' geolocation data is offset by a few kilometers. For example, in urban areas, the offset is 0-2km, while in rural areas, the offset is 0-5km, with an additional 0-10km offset used for 1 percent of rural clusters (Tanzania Bureau of Statistics).

I construct an unbalanced panel of 2,990 households interviewed in the first wave. The original survey consisted of 3,265 households; however, households with no geolocation data or interview date were dropped from the panel. My key measure of enrollment is constructed based on an individual's enrollment status at the time of the interview. Individuals that had no recorded response on their current enrollment status but responded to never attending school were recorded as not being enrolled. Individuals with missing responses on their current enrollment status but who responded to having attended school at some point in their life were dropped from the analysis. Figure 3 plots the mean enrollment of individuals seven to seventeen years old. Individuals begin primary school at around age seven. Figure 3 shows that enrollment is highest from age ten to twelve, peaking at age eleven. From age fourteen to seventeen, there is a sharp decline in enrollment. I measure household wealth as the log of total household real expenditure, which is the expenditure on all goods purchased by the household measured in Tanzanian shillings. Importantly, because I know the precise latitude and longitude coordinates of a household in each wave, I can observe whether a household migrates and, therefore, control for endogenous migration.

4.2 Mine data

Data on mine locations come from the International Peace Information Service (IPIS), Mindat, and the University of Glasgow. IPIS provides data on four hundred and fifty mines, of which two hundred and thirty-five are artisanal gold mines. Mindat provides data on the location of eleven industrial mines. The University of Glasgow provides data on the location of one hundred and twenty-one small-scale mines. Eighty-six are gold mines. An additional seventy-six mines that were discovered between 1920 to 1990 were dropped. These mines may have seen high usage during previous gold booms, and therefore there is likely to be no activity at them. The final count of artisanal and industrial mines is two hundred and fifty-six. Figure 1 plots the location of all mines. One caveat of the mine data is that the IPIS data does not represent mines spotted within the survey year. The IPIS data is on the location of mines observed in 2017 and 2019, several years after the NPS. Therefore, I cannot say whether those mines were active during the survey years. I assume that those mines present potential mining opportunities within the area. Therefore, the estimates may suffer from attenuation bias. They may be a lower bound of the actual effect. Data on gold prices come from the World Gold Council (see Figure 2).

5. Methods

I begin the analysis by estimating the effect of fluctuations in the price of gold and proximity to a mine on enrollment for individuals fourteen to seventeen years old. As seen in Figure 2, there is a large decline in enrollment from ages fourteen to seventeen. Individuals at this age must make critical decisions on whether to continue schooling or pursue other opportunities, often resorting to child labor (Human Rights Watch, 2017). I estimate the following model below.

$$(1)\ Enrollment_{ijkt} = \beta_0 + \beta_1 Proximity_{jkt} * P_t + \delta_j + \delta_t + \chi_{ijkt} + \epsilon_{ijkt}$$

The dependent variable $Enrollment_{ijkt}$ is a dummy 1 if individual i in household j living in village k is enrolled in school at year t. $Proximity_{jkt}$ is a dummy 1 if a household is within 30km of a known artisanal mine. P_t is the log price of gold in year t. It should be noted that the coefficient of interest β_1 likely suffers from attenuation bias because the treatment measures a household's distance to a potential artisanal mine. δ_j and δ_t are household and year fixed effects. χ_{ijkt} is a set of controls such as age, gender, age and gender interaction, whether or not an individual lives in an urban or rural area, the annual mean precipitation and annual mean temperature, and whether or not a household moved. Lastly, ϵ_{ijkt} is the error term. The regression is estimated using robust standard errors clustered at the village and year level.

6. Results

Table 1 and Table 2 provide summary statistics for all variables of interest. The summary statisticsin Table 1 show only households with individuals fourteen to seventeen years old across all three rounds. Table 2 shows the summary statistics of the full sample of households pooled across all three rounds. Figure 4 plots the mean enrollment for those living within thirty kilometers of a artisanal gold mine and those not. The figure shows that enrollment started off higher in round 1 for those living within thirty kilometers of an artisanal gold mine. Lastly, Figure 5 plots the mean per capita real expenditure for the full panel of households. Per capita expenditure for households within thirty kilometers of an artisanal mine remained below that of households not within thirty kilometers inall three rounds.

6.1 The impact of gold price on enrollment

Table 3 shows the impact of gold price on enrollment. Column (1) represents the impact of variation in the price of gold on the enrollment of individuals fourteen to seventeen years old living within thirty kilometers of a known artisanal gold mine. This column suggests that a one percent increase in the log price of gold leads to a -0.339-percentage point decline in enrollment for those living within thirty kilometers of an artisanal mine versus those not. During the survey period, the price of gold increased by sixty-two percent (Figure 2). Therefore, a sixty-two percent increase in the price of gold is associated with a 21.01 percentage point decline in enrollment. In column (2), the treatment changes from proximity to an artisanal gold mine to proximity to an industrial gold mine. The magnitude of the estimate is essentially the same. A one percent increase in the log price of gold leads to a 20.46 percentage point decline in enrollment for those living within thirty kilometers of an industrial mine versus those not. This effect is likely biased due to spillover from artisanal mines. In column (3), when controlling for proximity to an artisanal mine, the impact of proximity to an industrial mine is smaller and not statistically significant. Likewise, when controlling for proximity to an industrial mine, an increase in the price of gold leads to an 18.6 percentage point decline in enrollment for those living within thirty kilometers of an artisanal gold mine.

Figures 6 and 7 show the impact of price fluctuations at various distances from artisanal and industrial mines. Figure 6 shows that an increase in the price of gold leads to a decline in enrollment for those living within ten to twenty kilometers and twenty to thirty kilometers of an artisanal gold mine. An increase in the price of gold leads to higher enrollment for those living within thirty to forty kilometers of an artisanal mine versus those not. The reason for this uptick in enrollment at these distances remains unclear. However, at more considerable distances, forty to fifty kilometers and fifty to sixty kilometers, an increase in the price of gold has no statistically significant effect on enrollment. The findings show that a high price of gold has a negative local effect. This local effect of prices on enrollment is not seen when looking at industrial mines. The coefficients in Figure 7 show that regardless of the distance from an industrial mine, higher prices do not significantly affect enrollment. One potential reason is that Tanzanian law prevents children under the age of eighteen from employment in mining (Employment and Labour Relations Act, 2004).

7. Mechanisms

The findings in Table 3 show that increases in the price of gold and proximity to a gold mine led to significant declines in enrollment among secondary school-aged children. This section tests several potential mechanisms that could be driving this decline. I begin by looking at household wealth for households with secondary school aged children. I then look to at household wealth for all households surveyed across all three rounds. From there, I look at the labor force participation of secondary school-aged children and adults.

7.1 The impact of gold price on per capita real expenditure

High gold prices may improve household well-being through higher wages. Higher wages raise the opportunity cost of schooling. If the substitution effect dominates, enrollment declines. However, if the income effect dominates, enrollment will increase—table 4 tests whether household wealth measured as per capita real expenditure increases. The sample contains only households with children fourteen to seventeen years old. The results suggest that an increase in the price of gold leads to an increase in log per capita real expenditure for households within thirty kilometers of an artisanal mine versus those not (see Table 4, column 3). A one percent increase in the price of gold leads to a 0.301 percent increase in log per capita expenditure, which means that the substitution effect potentially dominates the income effect. Figure 8 further shows that log per capita real expenditure falls at greater distances. However, the coefficients are not statistically significant.

7.2 The impact of gold price on per capita real expenditure (full sample)

The findings in Table 4 only show how wealth changed for a subset of households. To compare the full sample of households surveyed across all three rounds, I estimate the following model below.

$$(2)\ \textit{Log per capita expenditure}_{jkt} = \beta_0 + \beta_1 \textit{Proximity}_{jkt} * P_t + \delta_j + \delta_t + \mu_{jkt} + \epsilon_{jkt}$$

The dependent variable *Log per capita expenditure*$_{jkt}$ measures the log of household real expenditure. *Proximity*$_{jkt}$ is a dummy 1 if a household is within thirty kilometers of an artisanal mine and 0 otherwise. P_t is the log price of gold in year t. δ_j and δ_t are household and year fixed effects. μ_{jkt} is a set of time variant controls such as percentage of children male, percentage of children female, the marital status of the household head, the gender and age of the household head, whether the household owns their home, whether a household lives in an urban or rural area, the quality of the wall, roof, floor, toilet, and lighting of a household's home, and whether the household moved. The regression is estimated using robust standard errors clustered at the village and year level.

Figure 9 shows that an increase in the price of gold leads to an increase in log per capita real expenditure for households with an artisanal mine within twenty to thirty kilometers of their home compared to those without. This result is statistically significant at the five percent level. And although these gains in wealth do not lead to higher enrollment among children fourteen to seventeen years old, enrollment among children eight to twelve years old does increase (see Table 5). The implications of this finding show that households may invest more in younger children, which is consistent with much of the literature on household human capital investment (Akresh et al., 2012). Figure 10 shows that having more artisanal mines near a household has no statistically significant effect on a household's wealth.

7.3 The impact of gold price on hours worked

Though individuals fourteen to seventeen years old consume less education, it is unclear if the decline in enrollment is due to substitution towards mining or other activities like agriculture. Figures 11 and 12 attempt to test whether individuals work more in agricultural or non-agriculture activities. I measure labor force participation in each sector based on the total number of reported hours worked during the past seven days of the interview date. The results in Figures 11 and 12 suggest that for secondary school-aged children, an increase in the price of gold and proximity to an artisanal mine has no statistically significant effect on farm and non-farm hours worked. However, for adults and individuals aged eighteen to fifty-five years old, an increase in the price of gold leads to a 6.917 percentage point decline in farm hours worked for those living within thirty kilometers of an artisanal gold mine versus those not (see Table 6). This finding suggests that high gold prices induce adults near artisanal mines to substitute away from agriculture for other activities like mining. Therefore, the increase in household wealth could come from increased participation by adults in mining-related activities. Though I do not observe an increase in farm hours worked among secondary school-aged children, the decline in enrollment could come from them filling in at the home as their parents work more outside the home.

8. Conclusion

This paper analyzed the impact of fluctuations in the price of gold and proximity to a gold mine on education and household outcomes in Tanzania. My results show that an increase in the price of gold leads to a decrease in enrollment and an increase in per capita real expenditure for households living near a gold mine. Importantly, these findings show the short-run consequences of increasing gold prices. There may be persistent long-run consequences to individual, household, and community well-being. Future research should investigate these long-run effects.

From a policy standpoint, my findings provide some insight. They suggest that small-scale mining could allow households to accumulate wealth and diversify their income stream. With that being said, the government's current position toward the mining sector limits the opportunity for small-scale miners. The government's policy effectively excludes many small-scale miners from selling their extracted resources in formal markets (Reuters, 2019). This exclusion, in turn, empowers pit owners and other intermediaries whom these miners must go through (Reuters, 2019). If the government wishes to empower small-scale miners, it must lower entry barriers into the formal marketplace.

Appendix 1. Graphs, Figures, and Tables

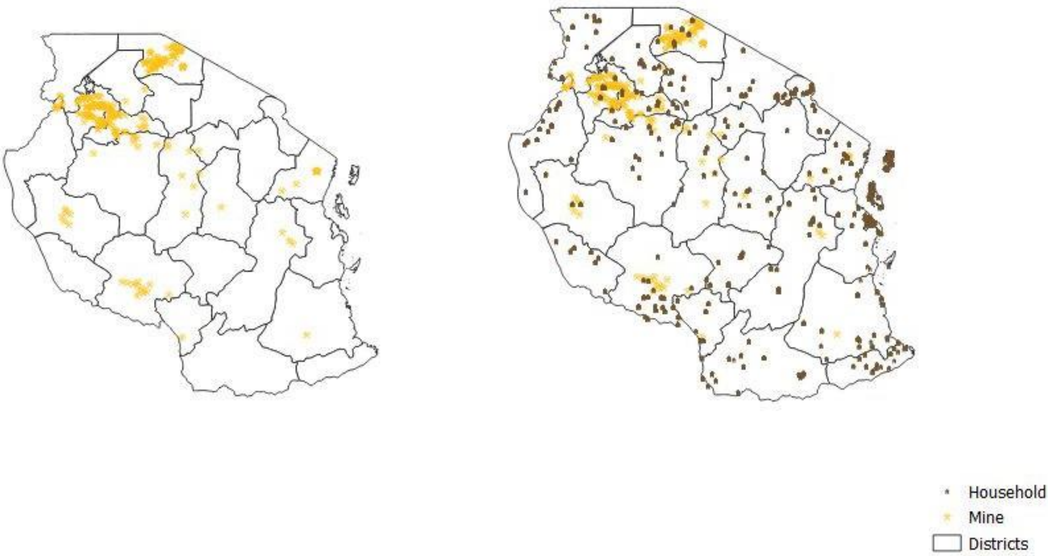

Figure 1. Mine location map

Sources: Mindat, IPIS, University of Glasgow

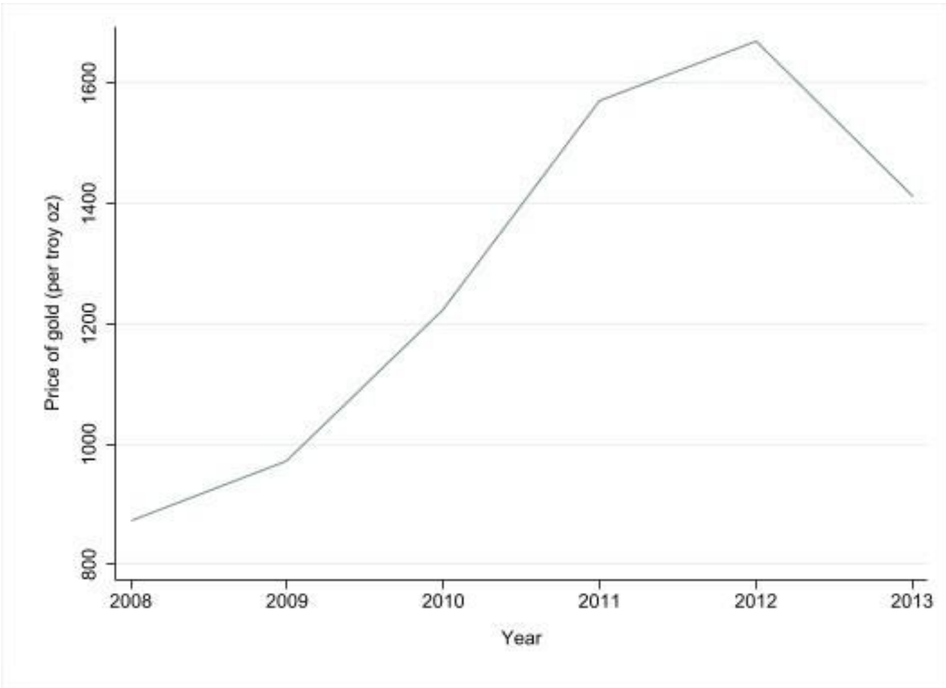

Figure 2. Price of gold

Notes: The graph above represents the per troy ounce dollar price of gold. Sources: World Gold Council. Survey rounds 2008/2009, 2010/2011, 2012/2013.

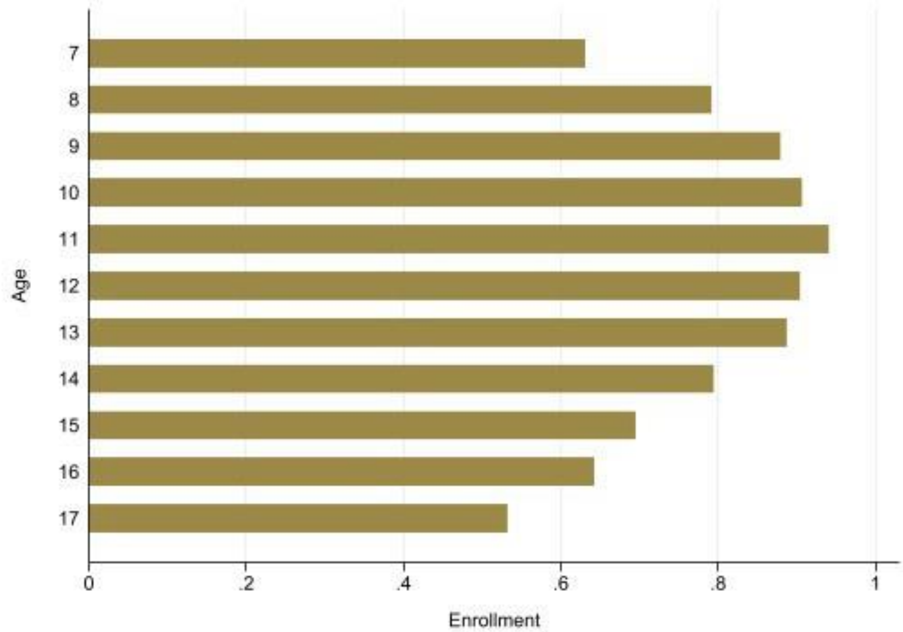

Figure 3. Mean enrollment by age

Notes: The graph above represents the mean enrollment among individuals 8 to 17 years old. The treatment is 1 if an individual lives within thirty kilometers of an artisanal mine and zero otherwise. Survey rounds are 2008/2009, 2010/2011, 2012/2013.

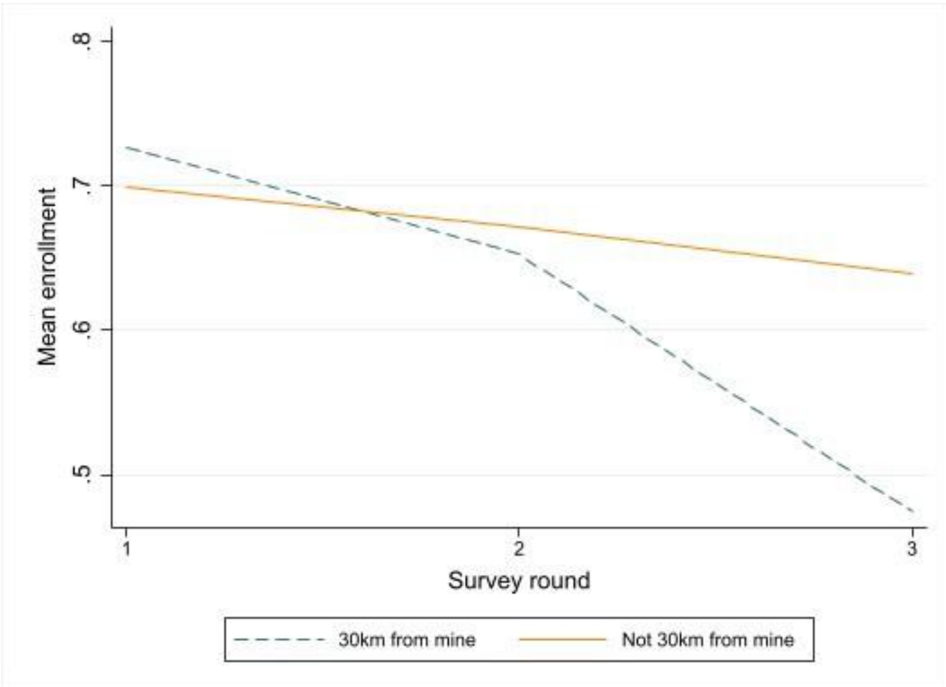

Figure 4. Mean enrollment artisanal mine

Notes: The graph above represents the mean enrollment rate among individuals 14 to 17 years old. Survey rounds are 2009/2009, 2010/2011, 2012/2013.

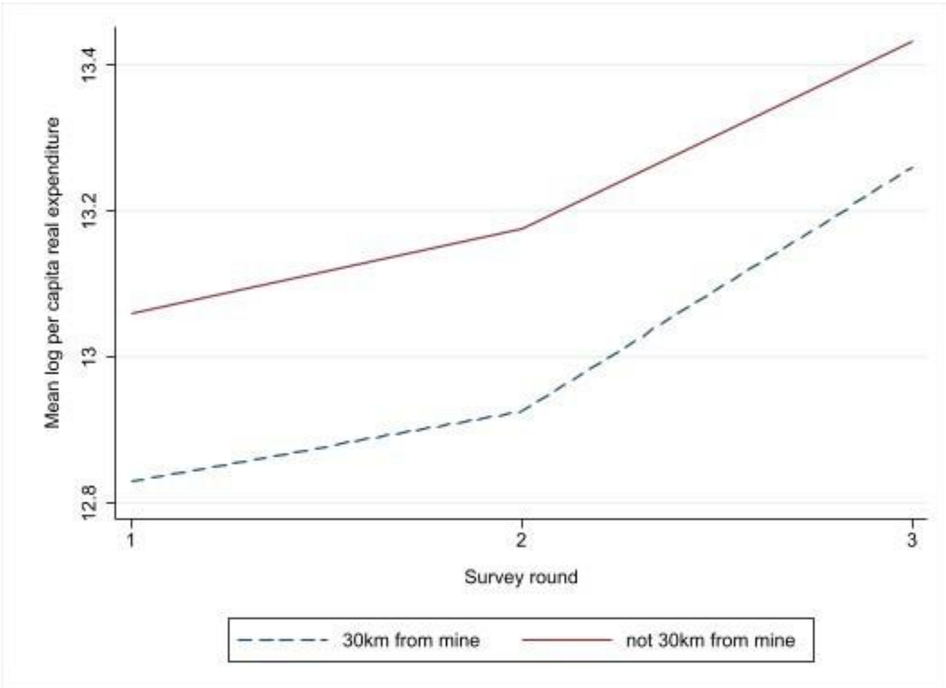

Figure 5. Log per capita real expenditure

Notes: The graph above represents the mean log per capita real expenditure. Survey rounds are 2008/2009, 2010/2011, 2012/2013.

Table 1

Summary statistics (14- to 17-year-olds)

Variable	Obs	Mean	SD
Enrolled	4,555	0.6329	0.4821
Mine (10km)	4,555	0.0570	0.2318
Mine (20km)	4,555	0.0989	0.2986
Mine (30km)	4,555	0.1519	0.3589
Mine (40km)	4,555	0.1792	0.3835
Mine (50km)	4,555	0.2263	0.4185
Mine (60km)	4,555	0.2746	0.4464
Industrial mine (30km)	4,555	0.0765	0.2659
Monopsony mine (30km)	4,555	0.0454	0.2081
age	4,555	15.4850	1.1120
Female	4,555	0.4969	0.5000
Rural	4,555	0.7752	0.4175
Annual mean total rainfall (mm)	4,555	787.7947	228.9715
Annual Mean Temperature (°C * 10)	4,555	222.4235	25.8081
Married household	4,555	0.6332	0.4820
Household head works in agriculture	4,555	0.7155	0.4512
Migrated	4,555	0.0267	0.1613

Notes: The summary statistics are weighted using household weights. The sample contains households with an individual that is fourteen to seventeen years old across all three rounds. Source: Tanzania NPS, IPIS, Mindat, University of Glasgow, World Gold Council.

Table 2

Summary statistics full panel

Variable	Obs	Mean	SD
Log per capita real expenditure	8,692	13.13025	0.7350
Percentage of children male	8,692	15.3158	15.3895
Percentage of children female	8,692	8.2837	11.0396
Married household	8,692	0.5808	0.4934
Male household head	8,692	0.7294	0.4442
Household head age	8,692	46.9391	15.8443
Household head works in agriculture	8,692	0.6622	0.4729
Owner occupies home	8,692	0.7924	0.4055
Good wall quality	8,692	0.3917	0.4881
Good roof quality	8,692	0.6265	0.4837
Good floor quality	8,692	0.3360	0.4723
Flush toilet	8,692	0.1016	0.3021
Modern lighting	8,692	0.1620	0.3684
Migrated	8,692	0.0340	0.1814
Rural	8,692	0.7219	0.4480

Notes: The summary statistics are weighted using household weights. The sample contains the full sample of households pooled across all three rounds. Sources: Tanzania NPS, IPIS, Mindat, University of Glasgow, World Gold Council.

Table 3

Impact of gold price on enrollment (14- to 17-year-olds)

VARIABLES	(1) Enrollment	(2) Enrollment	(3) Enrollment
Artisanal mine (30km) * Log price of gold	-0.339***		-0.306*
	(0.129)		(0.178)
Artisanal mine (30km)	2.688***		2.376*
	(0.930)		(1.273)
Industrial mine (30km) * Log price of gold		-0.330*	-0.0789
		(0.169)	(0.234)
Industrial mine (30km)		2.844**	0.929
		(1.234)	(1.687)
Constant	0.781	0.789	0.704
	(0.694)	(0.690)	(0.702)
Observations	4,555	4,555	4,555
Adjusted R-squared	0.330	0.329	0.330
Household FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Season controls	Yes	Yes	Yes
Age dummies	Yes	Yes	Yes
Sampling weights	Yes	Yes	Yes
Clusters	1883	1883	1883

Notes: The sample contains individuals fourteen to seventeen years old. Each column includes householdand year fixed effects. Controls include gender, household migration status, household heads marital status, whether the household head works in agriculture, and whether the household lives in a rural area. Season controls control for the annual mean precipitation and annual mean temperature in the region the household is located. Age dummies contains dummies for age as well as an interaction of age and gender. Robust standard errors clustered at the village and year level are reported in parentheses. *significant at 10% **significant at 5% ***significant at 1%. Sources: Tanzania NPS, Mindat, University of Glasgow, World Gold Council.

Table 4

Impact of gold price on log per capita real expenditure (14- to 17-year-olds)

VARIABLES	(1) Log per capita real expenditure	(2) Log per capita real expenditure	(3) Log per capita real expenditure
Artisanal mine (30km) * Log price of gold	0.0764		0.301*
	(0.130)		(0.160)
Industrial mine (30km) * Log price of gold		-0.274	-0.522**
		(0.182)	(0.225)
Artisanal mine (30km)	-0.776		-2.439*
	(1.008)		(1.275)
Industrial mine (30km)		2.136	4.095**
		(1.330)	(1.682)
Constant	13.41***	13.22***	13.34***
	(1.064)	(1.056)	(1.063)
Observations	4,553	4,553	4,553
Adjusted R-squared	0.716	0.716	0.717
Household FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Season controls	Yes	Yes	Yes
Age dummies	Yes	Yes	Yes
Sampling weights	Yes	Yes	Yes
Clusters	1883	1883	1883

Notes: The sample contains individuals fourteen to seventeen years old. Each column includes household and year fixed effects. Controls include gender, household migration status, household heads marital status, whether or not the household head works in agriculture, and whether the household lives in a rural area. Season controls control for the annual mean precipitation and annual mean temperature in the region the household is located. Age dummies contains dummies for age as well as an interaction of age and gender. Robust standard errors clustered at the village and year level are reported in parentheses. *significant at 10%
**significant at 5% ***significant at 1%. Sources: Tanzania NPS, Mindat, University of Glasgow, World Gold Council.

Table 5

Impact of gold prices on enrollment (8- to 12-year-olds)

VARIABLES	(1) Enrollment
Artisanal mine (30km) * Log price of gold	0.104*
	(0.0626)
Industrial mine (30km) * Log price of gold	-0.0111
	(0.0689)
Artisanal mine (30km)	-0.643
	(0.465)
Industrial mine (30km)	0.0103
	(0.508)
Constant	0.291
	(0.615)
Observations	6,252
Adjusted R-squared	0.386
Household FE	Yes
Controls	Yes
Season controls	Yes
Age dummies	Yes
Sampling weights	Yes
Clusters	2105

Notes: The sample contains individuals eight to twelve years old. Each column includes household and year fixed effects. Controls include gender, household migration status, household heads marital status, whether the household head works in agriculture, and whether the household lives in a rural area. Season controls control for the annual mean precipitation and annual mean temperature in the region the household is located. Age dummies contains dummies for age as well as an interaction of age and gender. Robust standard errors clustered at the village and year level are reported in parentheses. *significant at 10% **significant at 5% ***significant at 1%. Sources: Tanzania NPS, Mindat, University of Glasgow, World Gold Council.

Table 6

Impact of gold price on hours worked

VARIABLES	(1) Farm work (hours)	(2) Non-farm work (hours)
Artisanal mine (30km) * Log price of gold	-6.917**	-2.357
	(2.915)	(2.127)
Industrial mine (30km) * Log price of gold	5.622	-6.058**
	(4.791)	(2.489)
Artisanal mine (30km)	50.24**	15.37
	(21.21)	(15.11)
Industrial mine (30km)	-39.73	45.27**
	(34.22)	(17.71)
Constant	28.89***	6.192
	(8.214)	(7.437)
Observations	13,053	13,053
Adjusted R-squared	0.378	0.411
Household FE	Yes	Yes
Controls	Yes	Yes
Season controls	Yes	Yes
Age dummies	Yes	Yes
Sampling weights	Yes	Yes
Clusters	2491	2491

Notes: The sample contains individuals eighteen to fifty-five years old. Each column includes household and year fixed effects. Controls include gender, household migration status, household heads marital status, whether the household head works in agriculture, and whether the household lives in an rural area. Season controls control for the annual mean precipitation and annual mean temperature in the region the household is located. Age dummies contains dummies for age as well as an interaction of age and gender. Robust standard errors clustered at the village and year level are reported in parentheses. *significant at 10%
**significant at 5% ***significant at 1%. Sources: Tanzania NPS, Mindat, University of Glasgow, World Gold Council.

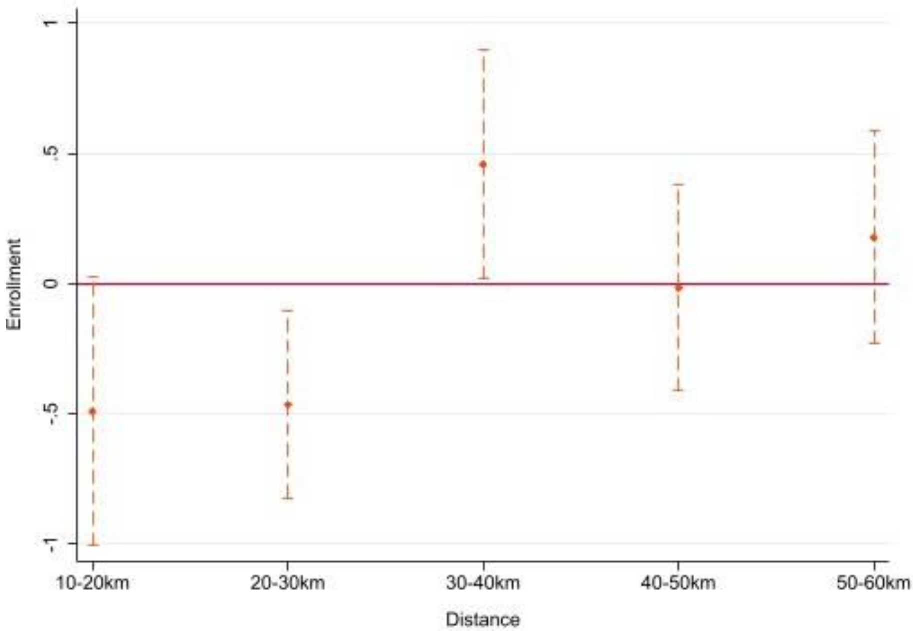

Figure 6. The impact of gold price on enrollment artisanal mines

Notes: The sample contains individuals fourteen to seventeen years old. The treated group includes individuals with an artisanal mine between 10 to 20km, 20 to 20km, 30 to 40km, 40 to 50km, and 50 to 60km of their home. Each estimate includes household and year-fixed effects. Controls include gender, household migration status, household head marital status, whether the household head works in agriculture, and whether the household lives in a rural area. Additional Season controls, which control for the annual mean precipitation and annual mean temperature in the region the household is located, and age dummies and an interaction of age and gender, are also included—robust standard errors clustered at the village and year level.

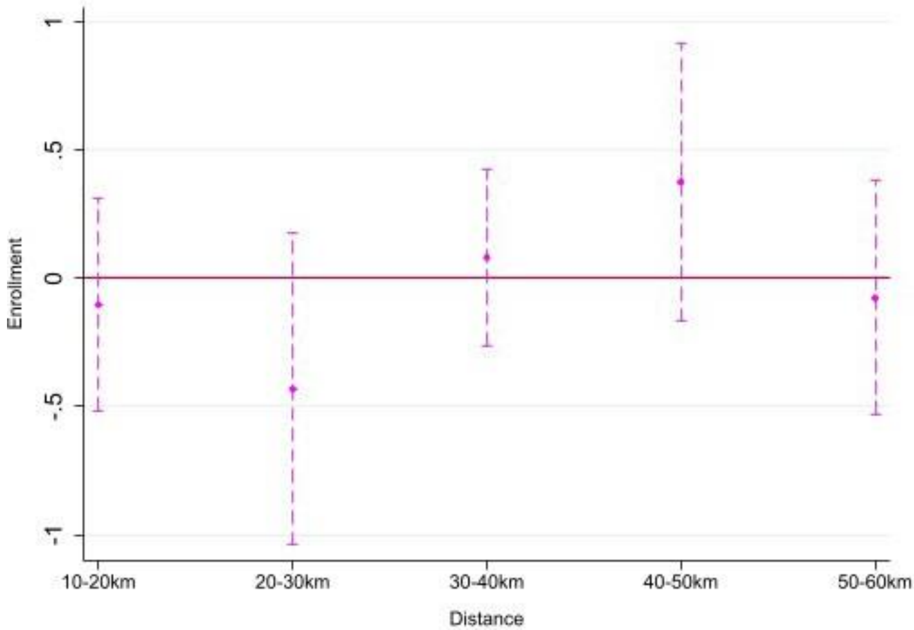

Figure 7. The impact of gold price on enrollment industrial mines

Notes: The sample contains individuals fourteen to seventeen years old. The treated group includes individuals with an industrial mine between 10 to 20km, 20 to 20km, 30 to 40km, 40 to 50km, and 50 to 60km of their home. Each estimate includes household and year-fixed effects. Controls include gender, household migration status, household head marital status, whether the household head works in agriculture, and whether the household lives in a rural area. Additional Season controls, which control for the annual mean precipitation and annual mean temperature in the region the household is located, and age dummies and an interaction of age and gender, are also included—robust standard errors clustered at the village and year level.

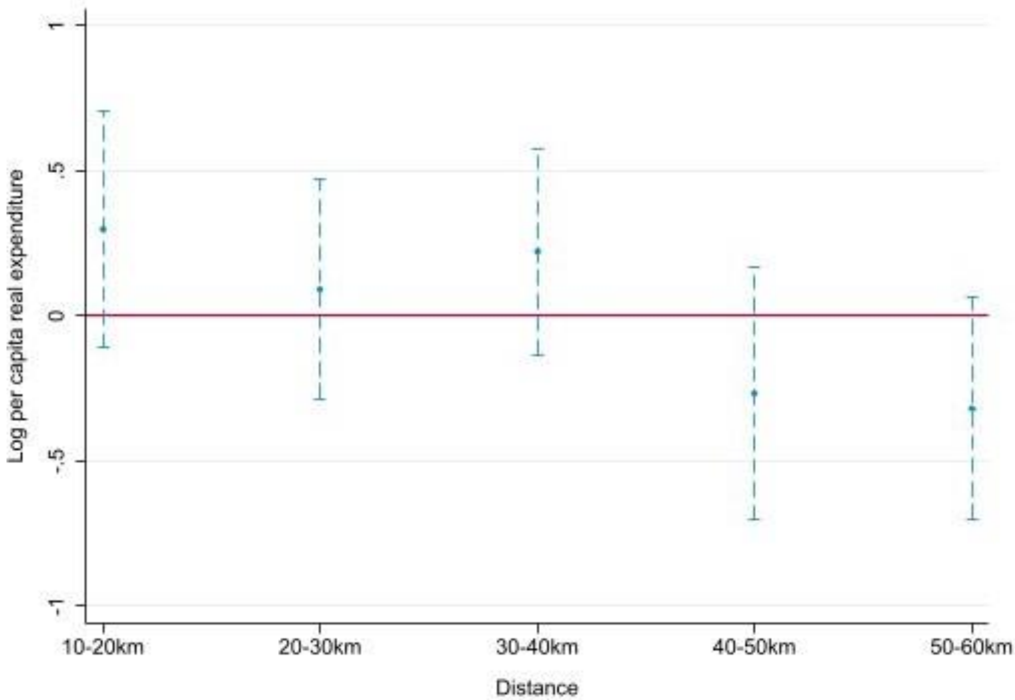

Figure 8. The impact of gold price on household expenditure (14- to 17-year-olds)

The sample contains individuals fourteen to seventeen years old. The treatment group includes households with a mine between 10 to 20km, 20 to 20km, 30 to 40km, 40 to 50km, and 50 to 60km of their home. Log per capita real expenditure measures in shillings total expenditure in each household. Each estimate includes household and year-fixed effects. Controls include gender, household migration status, household head marital status, whether the household head works in agriculture, and whether the household lives in a rural area. Additional Season controls, which control for the annual mean precipitation and annual mean temperature in the region the household is located, and age dummies and an interaction of age and gender, are also included—robust standard errors clustered at the village and year level.

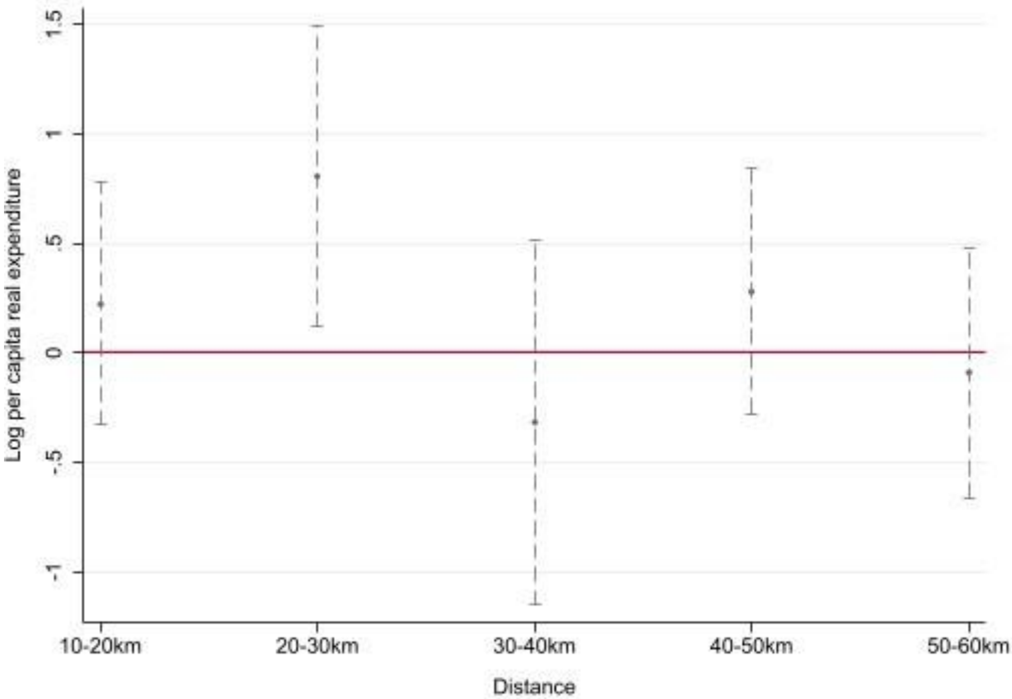

Figure 9. The impact of gold price on household expenditure (full sample)

The sample contains all households pooled across the three rounds of the survey. The treatment group includes households with a mine between 10 to 20km, 20 to 20km, 30 to 40km, 40 to 50km, and 50 to 60km of their home. Log per capita real expenditure measures in shillings total expenditure in each household. Each estimate includes household and year-fixed effects. Controls include gender, household migration status, household head marital status, whether the household head works in agriculture, and whether the household lives in a rural area. Additional Season controls, which control for the annual mean precipitation and annual mean temperature in the region the household is located, and age dummies and an interaction of age and gender, are also included. —robust standard errors clustered at the village and year level.

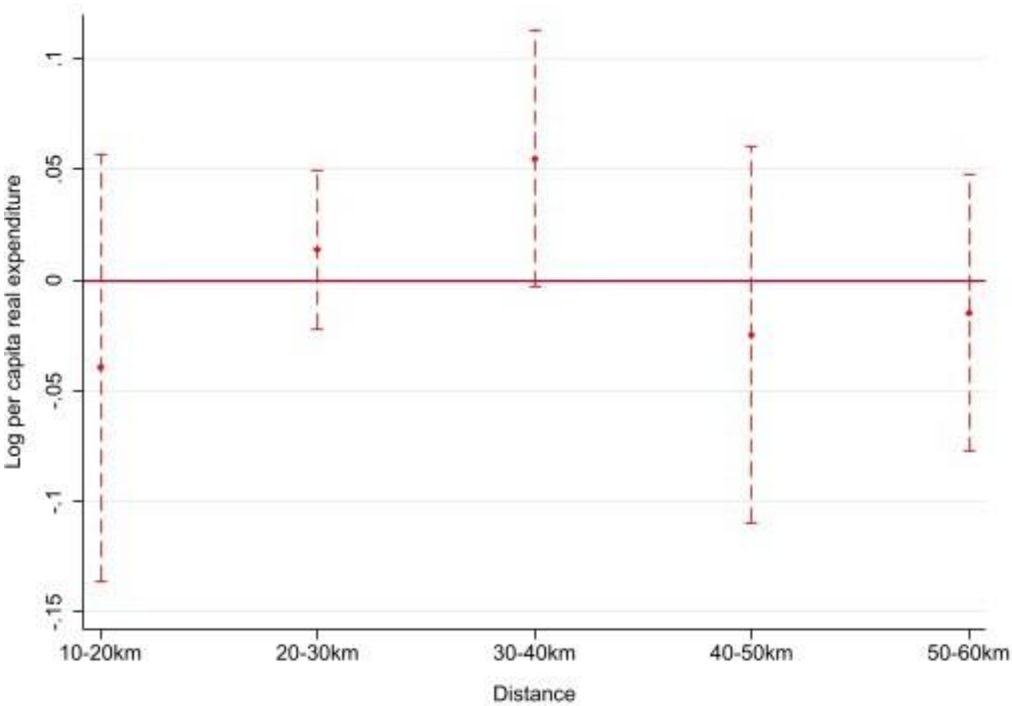

Figure 10. The impact of gold price on household expenditure (full sample)

The sample contains all households pooled across the three rounds of the survey. Distance measures the total number of mines between 10 to 20km, 20 to 20km, 30 to 40km, 40 to 50km, and 50 to 60km of a individual's home. Each estimate includes household and year-fixed effects. Controls include gender, household migration status, household head marital status, whether the household head works in agriculture, and whether the household lives in a rural area. Additional Season controls, which control for the annual mean precipitation and annual mean temperature in the region the household is located, and age dummies and an interaction of age and gender, are also included. —robust standard errors clustered at the village and year level.

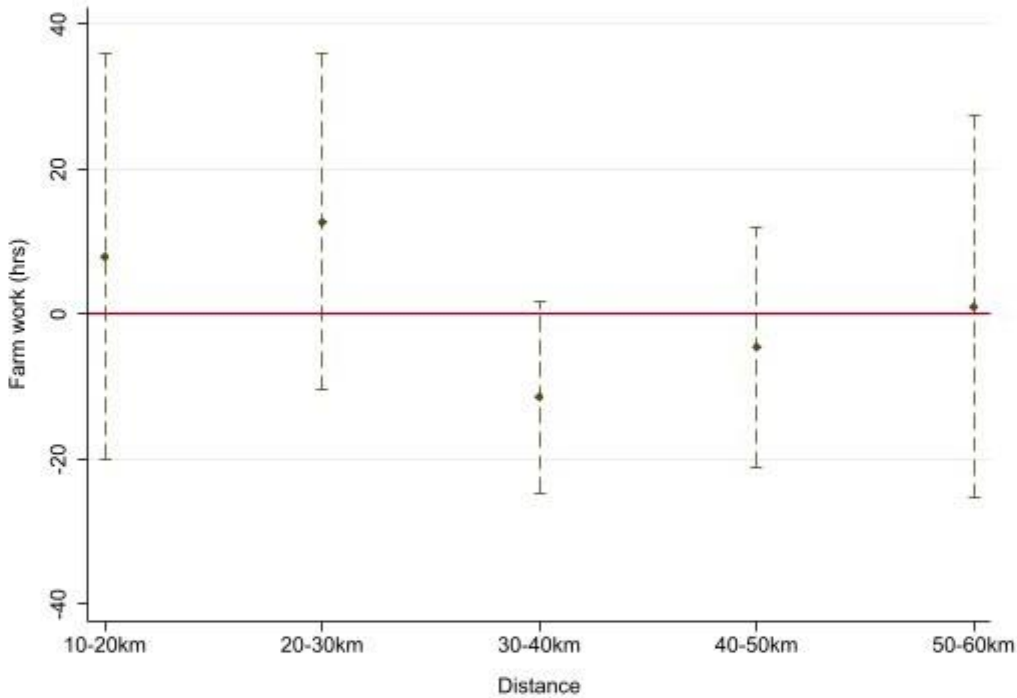

Figure 11. The impact of gold price on farm hours worked (14- to 17-year-olds)

The sample contains individuals fourteen to seventeen years old. The treatment group includes households with a mine between 10 to 20km, 20 to 20km, 30 to 40km, 40 to 50km, and 50 to 60km of their home. Farm hours worked measures the total hours worked in the past seven days of the interview date on household agricultural activities including livestock or fishing, whether for sale or for household food. Each estimate includes household and year-fixed effects. Controls include gender, household migration status, household head marital status, whether the household head works in agriculture, and whether the household lives in a rural area. Additional Season controls, which control for the annual mean precipitation and annual mean temperature in the region the household is located, and age dummies and an interaction of age and gender, are also included. —robust standard errors clustered at the village and year level.

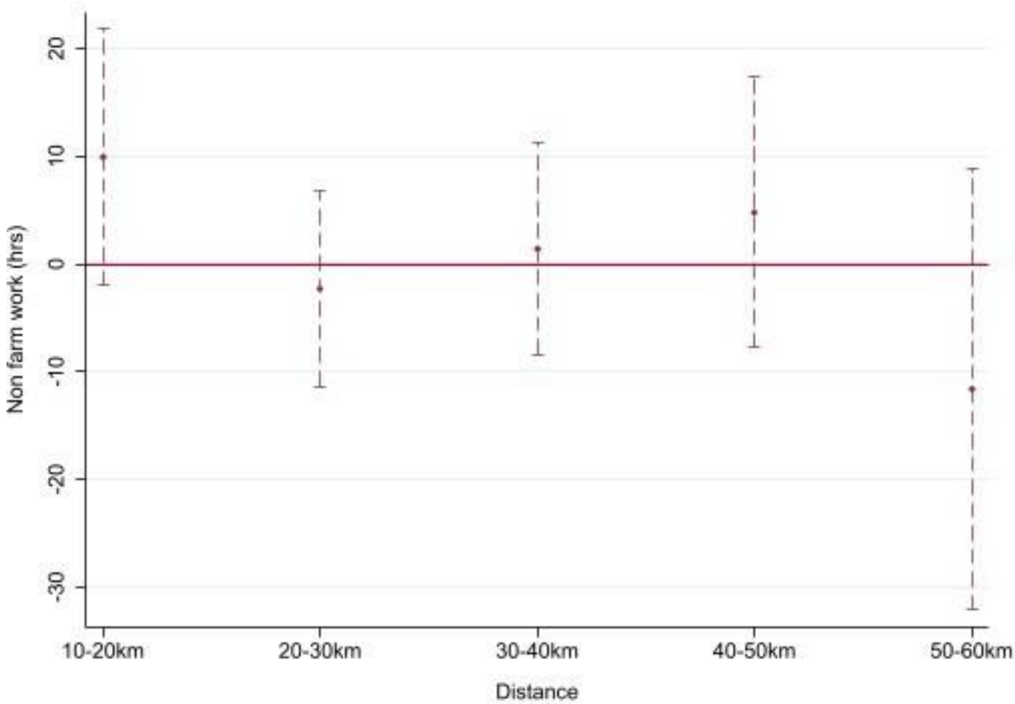

Figure 12. The impact of gold price on non-farm hours worked (14- to 17-year-olds)

The sample contains individuals fourteen to seventeen years old. The treatment group includes households with a mine between 10 to 20km, 20 to 20km, 30 to 40km, 40 to 50km, and 50 to 60km of their home. Non-farm work measures the total hours worked in the past seven days of the interview date as an unpaid family worker on a non-farm household business. Each estimate includes household and year-fixed effects. Controls include gender, household migration status, household head marital status, whether the household head works in agriculture, and whether the household lives in a rural area. Additional Season controls, which control for the annual mean precipitation and annual mean temperature in the region the household is located, and age dummies and an interaction of age and gender, are also included. —robust standard errors clustered at the village and year level.

References

Akresh, Richard, Emilie Bagby, Damien de Walque, and Harounan Kazianga. "Child Ability and Household Human Capital Investment Decisions in Burkina Faso." *Economic Development and Cultural Change* 61, no. 1 (2012): 157–86. https://doi.org/10.1086/666953.

Auty, Richard M. "The Political Economy of Resource-Driven Growth." *European Economic Review* 45, no. 4 (2001): 839–46. https://doi.org/10.1016/S0014-2921(01)00126-X.

Baland, J. M., & Robinson, J. A. (2000). Is child labor inefficient? Journal of Political Economy, 108(4), 663–679. Basu, K., & Pham, V. (1998). The economics of child labor. American Economic Review, 88(3).

Basu, K., & Pham, V. (1998). The economics of child labor. American Economic Review, 88(3).

Beegle, Kathleen, Rajeev Dehejia, and Roberta Gatti. "Child Labor and Agricultural Shocks." *Journal of Development Economics* 81, no. 1 (2006): 80–96.

Beegle, Kathleen, Rajeev H. Dehejia, Roberta Gatti, and Sofya Krutikova. 2008. "The Consequences of Child Labor: Evidence from Longitudinal Data in Rural Tanzania." Policy Research Working Paper no. 4677, World Bank, Washington, DC.

Burki, T. K. (2019). The true scale of artisanal mining. The Lancet Respiratory Medicine, 7(5), 384–385. https://doi.org/10.1016/S2213-2600 (19)30115-8

Chachage, C.S.L. 1995. The meek shall inherit the earth but not the mining rights: The mining industry and accumulation in Tanzania. In Liberalised development in Tanzania, ed. P. Gibbon, 37108. Uppsala: Nordiska Afrikainstitutet.

Cogneau, Denis, and Rémi Jedwab. "Commodity Price Shocks and Child Outcomes: The 1990 Cocoa Crisis in Côte d'Ivoire." *Economic Development and Cultural Change* 60, no. 3 (2012): 507–34. https://doi.org/10.1086/664017.

Deborah Fahy Bryceson, Jesper Bosse Jønsson, Crispin Kinabo & Mike Shand (2012) Unearthing treasure and trouble: mining as an impetus to urbanisation in Tanzania, Journal of Contemporary African Studies, 30:4, 631-649, DOI: 10.1080/02589001.2012.724866

EarthWord–Placer | U.S. Geological Survey (2017). ttps://www.usgs.gov/news/science-snippet/earthword-placer

Employment and Labour Relations Act, 2004, Chapter 366 https://www.tanzania.go.tz/egov_uploads/documents/Employment%20and%20LAbour%20Relation%20Act.pdf

Gylfason, Thorvaldur. "Natural Resources, Education, and Economic Development." *European Economic Review* 45, no. 4 (2001): 847–59. https://doi.org/10.1016/S0014-2921(01)00127-1.

IISD. (2017). Global trends in artisanal and small-scale mining (ASM): A review of key numbers and issues (p. 81). The International Institute for Sustainable Development. https://delvedatabase.org/resources/global-trends-in-artisanal-and-small-scale-mining-asm-a-review-of-key-numbers-and-issues

Human Rights Watch. "'I Had a Dream to Finish School': Barriers to Secondary Education in Tanzania."February 14, 2017. https://www.hrw.org/report/2017/02/14/i-had-dream-finish-school/barriers-secondary-education-tanzania.

IPIS. "IPIS - International Peace Information Service." Accessed May 29, 2022. https://ipisresearch.be/.

Kebede, Hundanol. (2021). The Pass-Through of International Commodity Price Shocks to Producers' Welfare: Evidence from Ethiopian Coffee Farmers. The World Bank Economic Review. 10.1093/wber/lhab020.

Kotsadam, Andreas, and Anja Tolonen. "African Mining, Gender, and Local Employment." *World Development* 83 (2016): 325–39. https://doi.org/10.1016/j.worlddev.2016.01.007.

Labys, Walter C., and Alfred Maizels. "Commodity Price Fluctuations and Macroeconomic Adjustments in the Developed Economies." *Journal of Policy Modeling* 15, no. 3 (1993): 335–52. https://doi.org/10.1016/0161-8938(93)90037-Q.

Lemelle, S.J. 1986. Capital, state and labor: A history of the gold mining industry in colonial Tanganyika 18901942. Ph.D. diss., The University of California at Los Angeles

Mabel A. Hoedoafia & Benjamin Spears Ngmekpele Cheabu & Vida Korang, 2014. "The Effects of Small Scale Gold Mining on Living Conditions: A Case Study of the West Gonja District of Ghana," International Journal of Social Science Research, Macrothink Institute, vol. 2(1), pages 151-164, March.

Mindat. Tanzania. https://www.mindat.org/loc-4384.html.

Muslihudin, Muslihudin, Aziz Bambang, Eko Hendarto, and Thomas Putranto. "The Impact of Traditional Gold Mining in Gumelar, Banyumas, Indonesia." *Ecology, Environment and Conservation* 24 (August 3, 2018): 607–13.

National Bureau of Statistics. Basic Information Document National Panel Survey (NPS 2012-2013).

OEC - The Observatory of Economic Complexity. “Tanzania (TZA) Exports, Imports, and Trade Partners | OEC.” Accessed May 29, 2022. https://oec.world/en/profile/country/tza.

Pelle Ahlerup, Thushyanthan Baskaran & Arne Bigsten (2020) Gold Mining, and Education: A Long-run Resource Curse in Africa? The Journal of Development Studies, 56:9, 1745-1762, DOI: 10.1080/00220388.2019.1696959

Pearson, M.N. 1998. Port cities and intruders: The Swahili coast, India, and Portugal in the early modern era. Baltimore: The Johns Hopkins University Press.

Ploeg, Frederick van der. “Natural Resources: Curse or Blessing?” *Journal of Economic Literature* 49, no. 2 (2011): 366–420. http://www.jstor.org/stable/23071620.

Reuters. “Tanzania’s Gold Exports Rise 23% in Year to July -Central Bank,” September 5, 2019, sec. Investing News. https://www.reuters.com/article/ozabs-uk-tanzania-gold-idAFKCN1VQ0S6-OZABS.

Reuters. “Gold Rush? Not for Us Say Tanzania’s Small-Scale Miners.” October 30, 2019, sec. Commodities. https://www.reuters.com/article/us-tanzania-mining-artisanal-feature-idUSKBN1X90G0.

Roberts, A.D. 1986. The gold boom of the 1930s in Eastern Africa. Journal of the Royal African Society 85, no. 341: 54562.

Ross, Michael L. “The Politics of the Resource Curse: A Review.” *SSRN Electronic Journal*, 2013. https://doi.org/10.2139/ssrn.2342668.

Sachs, J. D., & Warner, A. (2001). The curse of natural resources. European Economic Review, 45(4–6), 827–838. Sachs, J. D., & Warner, A. M. (1997). Natural resource abundance and economic growth (Technical report). Cambridge, MA: Harvard Institute for International Development.

Santos, Rafael J., 2018."Blessing and curse. The gold boom and local development in Colombia," World Development, Elsevier, vol. 106(C), pages 337 355.https://ideas.repec.org/a/eee/wdevel/v106y2018icp337-355.html

Schwartz, F. W., Lee, S., & Darrah, T. H. (2021). A review of the scope of artisanal and small-scale mining worldwide, poverty, and the associated health impacts. GeoHealth, 5, e2020GH000325. https://doi.org/ 10.1029/2020GH000325

Tanzania - Mining | International Trade Administration (2021). https://www.trade.gov/country-commercial-guides/tanzania-mining

World Bank (2019). 2019 state of the artisanal and small-scale mining sector (p. 85). Washington, DC: World Bank. https://delvedatabase. org/resources/state-of-the-artisanal-and-small-scale-mining-sector

World Gold Council. “Gold Price Historical Data | Gold Price History.” https://www.gold.org/goldhub/data/gold-prices.

Yamano, Takashi, Harold Alderman, and Luc Christiansen. 2005. “Child Growth, Shocks, and Food Aid in Rural Ethiopia.” *American Journal of Agricultural Economics* 87, no. 2:273–88.

Zabsonré, Agnès and Agbo, Maxime and Somé, Juste and Haffin, Irène, Gold Exploitation and Socioeconomic Outcomes: The Case of Burkina Faso (March 1, 2017). Partnership for Economic Policy Working Paper No. 2017-13, Available at SSRN: https://ssrn.com/abstract=3163638 or http://dx.doi.org/10.2139/ssrn.3163638