Local Industrial Shocks, Female Empowerment and Infant Health: Evidence from Africa's Gold Mining Industry

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Abstract

Can industrial development increase women's empowerment in developing countries? This is the first paper to causally explore the effects of a continent-wide exogenous expansion of industry on female empowerment and infant health. The paper uses the recent rapid increase in gold mining in Africa as a quasi-experiment. The identification strategy relies on temporal (before and after mine opening) and spatial (distance to mine) variation, as well as exogenous variation in the price of gold in a difference-in-difference analysis. Using a large sample of women and children living within 100km of a mine, the analysis shows that the establishment of a new mine increases income earning opportunities within the service sector by 41%, a woman is 23% less likely to state a barrier to healthcare access for herself, and the acceptance rate of domestic violence decreases by 24%. Despite risks of environmental pollution from gold mining, infant mortality more than halves with the mine opening. In particular, girl infants face better chances of survival. I exclude that the effects are driven by increased schooling attainment made possible by investment in schooling infrastructure, or that service jobs are limited to prostitution. I cannot rule out that urbanization is part of the mechanism. The findings are robust to different assumptions about trends, distance, migration, and withstand a novel spatial randomization test. These results support the idea that entrenched norms regarding gender can change rapidly in the presence of economic development.

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1 Introduction

Gender inequality and discrimination are, in part, caused by poverty and binding constraints where women's and girls' needs are not prioritized (Duflo, 2012; Miguel, 2005). When economic factors are the determinants of inequality, economic growth will work as a remedy. This could happen in two ways, first, by making everyone better off as poverty is reduced, second, by narrowing the gender inequality gap as the necessary trade-offs between men's and women's welfare become less acute. Alleviating the physical constraints automatically makes women better off, but it is unclear if it changes the norms that led their initial disadvantage. Poor countries are more likely to have norms that favor men (Jayachandran, 2014) but little is known about the causality running from economic development to more gender-equal norms.

The main contribution of this paper is to provide causal estimates of a continent-wide establishment of a modern industry on female empowerment. Using the rapid and exogenous expansion in gold mining in Africa as a quasi-experiment, I employ two different identification strategies: a difference-in-difference method and a method using the world price of gold as a proxy for mining activities. Female empowerment is broadly defined, but for the purpose of this study I measure it using the following outcomes: (a) access to employment, personal income, resources and healthcare, and (b) normative attitudes toward a woman's bodily integrity, and (c) pregnancy outcomes and infant survival.

The large-scale mining boom in Sub-Saharan Africa provides a unique opportunity to explore the effects of local industrialization on female empowerment. In particular, its main establishment decisions do not depend on local population characteristics but on geological characteristics uncorrelated with pre-existing local economies. Most of the knowledge we have on this topic comes from analyses of the manufacturing industry. However, such estimates are less reliable if the establishment decisions depends on local labor market characteristics. In labor-intensive manufacturing industries, one factor of production may be of extra relevance: women's labor supply.

The establishment of a new mine is not conditioned by local labor force characteristics. First and foremost, the necessary condition for mining is a mineral deposit, which is a random geological anomaly (Eggert, 2002). In addition, the capital to labor ratio is high, and the industry is dominated by a few large multinational firms (Gajigo et al., 2012) that are not *a priori* integrated in the local economy. This means that the mining sector provides a quasi-experimental setting that allows exploring the general equilibrium effects of local industrial shocks on female empowerment.

In addition to the literature on manufacturing, there is a well-identified literature on female empowerment from randomized control trials (RCT). Interventions range from cash transfers, to information provision, to vocational training and beyond. Well-implemented RCTs have the advantage of providing robust causal estimates, but they have the disadvantage of providing little evidence on how interventions could be scaled up. Scaling up can prove hard, because of general equilibrium effects that may not be well understood within the experimental design, or because the scaling up of programs can be prohibitively costly[1]. This study provides complementary evidence to the RCT literature.

[1] A recent Bayesian meta-analysis shows that RCTs with similar interventions show a correlation of 0.6-0.7 (Vivalt, 2014). The out-of-experiment validity of the findings is an additional subtle aspect, not yet analyzed.

Moreover, beyond providing the general setting for understanding the economic dynamics of female empowerment, it allows us to understand two issues of major policy relevance within the mining industry itself. First, the pace with which the mining boom is progressing across the continent, with few signs of slowing its expansion, confirms that the internal validity of the study is of major policy relevance. I use a large household survey data set from Demographic and Health Surveys, with more than 55,000 women and 48,000 children living within 100km from a mine. The high gold price[2] and the growing demand from emerging markets have led to a boom in gold extraction (see Figure 1), especially in developing countries. Africa now accounts for 20% of the world production of gold with South Africa as the continent leader, followed by Ghana, Mali, and Tanzania. However, there are at least 34 countries in Africa with significant gold deposits that do not yet have industrial-scale gold mining, but are producing small quantities with traditional methods. The economic importance of the gold sector is thus predicted to grow over time (Gajigo et al., 2012), motivating a better understanding of the social implications of the sector itself.

Second, it provides a setting to empirically understand the gender effects of extractive industries which have been subjected to much discussion, with theoretically ambiguous predictions. Natural resource extraction, in general, is accused of reducing female participation in labor markets due to increasing reservation wages (with raising male wages and through income transfers to households) and by suppressing the demand for women's labor by crowding-out female-dominated sectors, such as manufacturing (Ross, 2008). For similar reasons, the UN and the African Union argue in the African Mining Vision (UNECA, 2011) that the expansion of the mining sector is a threat to gender equality in Africa.

A priori, the expected effects from local industrial shocks are ambiguous. The association between women's labor force participation and economic modernization is U-shaped (Goldin 1995). In traditional agrarian societies, the labor force participation is high. As the agrarian sector shrinks parallel with the growth of modern industries, the participation rate decreases. The negative trend remains until new sectors emerge where women can find productive and non-stigmatized employment. It seems likely that the establishment of a mine in an agrarian society risks inducing such an effect. Gold mining can decrease local agricultural productivity (Aragon and Rud, 2013), and may fail to provide sufficient compensatory employment within the mining sector, especially for women. In fact, the physically arduous nature of mining has led to it be considered a "male" sector and in many countries there are stigmas regarding women working as miners.

However, there has been little empirical research to support these claims. The first rigorous empirical evidence exploring the cross-country local effects of mineral extraction, shows that the roll out of mineral mining across the African continent on the one hand decreased women's labor force participation by 230,000 jobs mostly in agriculture, but on the other hand created 90,000 jobs for women in the service sector and increased cash income earning opportunities (Kotsadam and Tolonen, 2013), although the broader welfare impacts are less well understood.

The main empirical strategy is a difference-in-difference approach, using the spatial and temporal

[2]Gold has an advantage over other minerals for two reasons. First, gold is a special commodity: as pure gold or high-carat jewelry it is a highly liquid financial asset. The stock of gold is continuously increasing (Taurasi 2014), and the production of gold and the gold price are, if anything, positively correlated as newly extracted gold is only a fraction of the gold stock and not enough to affect the price. This implies that the world price of gold is strictly exogenous to local production.

variation resulting from mine opening year and precise mine location. With this method, I control for initial level differences in development of the very local areas (within a threshold distance from the mine location), and the neighboring communities (within 100km from a mine location). With country-year and district fixed effects, the analysis depends on the timing of mine opening being exogenous to local changes in empowerment and infant mortality. As a complement to the baseline method, I allow for a relaxation of this assumption and use the change in gold price to estimate the causal effects by predicting mine opening, and by using the gold price as a proxy for the intensity of mining activities.

I explore heterogeneity in response depending on observable characteristics, migrant status, urbanization, mining intensity and with distance from mine. For the infant mortality estimates, I explore heterogeneity in exposure to pollution by interacting the treatment variable with rainfall in the child's birth year, since most of the pollution is dispersed in the water supply. I show that the results are robust to different specifications, such as the inclusion of mine fixed effects, country-year fixed effects, district time trends, different levels for clustering etc. In addition, I design a spatial randomization placebo test where I randomize mine location 600 times and re-estimate the treatment effects, to exclude the possibility that a mis-specification of the model is driving the results.

Despite the sector's traditional association with male labor, women do access new types of jobs in mining communities. Service and sales employment increases by 41%, and other determinants of welfare are also affected: there are significant gains in women's access to healthcare (a 23% decrease in stated barriers to acces), and in their attitudes toward domestic violence with the acceptance rate of violence decreasing by almost 24%[3]. I find no effects on decision making power between spouses, contrary to the hypothesis that mining risk increase men's bargaining power within the household. The estimated intention-to-treat effect size on service sector employment (9.5pp) are larger than benchmark findings within RCT literature with interventions aiming to increase women's work participation, indicating that the industry is effective in stimulating the uptake of non-farm employment. Infant mortality decreases by more than half with the onset of large-scale mining, and especially so for girls. The gender differential results are in line with previous studies that find that more income for women leads to larger improvements in girls' health than boys' (Duflo, 2003; Thomas, 1990; Qian, 2008), implying this is due more to behavior or norm changes than physical exposure to pollution. I rule out that the mine changed women's labor market opportunities and female empowerment through an educational channel, or through changes in marital behavior. Moreover, I rule out that the jobs created in the service sector are limited to jobs in prostitution. The results are indicative of gains in infant health coming through a household welfare channel. Overall, the effects of the mine on social development may be reinforced by spurring an urbanization movement.

The rest of the paper proceeds as follows: in Section 2, I describe the context of mining and household economics, in Section 3, the data and, in Section 4, the empirical strategy. In Section 5, I present main results, explore mechanisms and robustness. I conclude in Section 6.

[3]The questions are listed in the Appendix Table 22. The domestic violence attitude questions are of the type: "In your opinion, is a husband justified in hitting or beating his wife in the following situations: example", and for access to healthcare: "Many different factors can prevent women from getting medical advice or treatment for themselves. When you are sick and want to get medical advice or treatment, is each of the following a big problem or not? *example*"

2 Background

2.1 Extractive Industries

Mines are important global employers: 1% of the global workforce is thought be working in mining activities (ILO, 2010). New discoveries of natural gas, oil and minerals have led to booming foreign direct investment (FDI) in the extractives sector in Africa. It is now the largest sector in terms of FDI and it accounted for two-thirds of the increase in exports from Sub-Saharan Africa between 2003 and 2008 (Chuhan-Pole et al., 2013).

Our understanding of the welfare effects of natural resource extraction is limited, especially so at the sub-national level. Why natural resource endowments do not necessarily turn into high economic growth and prosperity is a much studied conundrum (often called 'the natural resource curse'; see van der Ploeg, 2011 for an overview). While the literature has shed some light on the macro-economic effects of extractive industries, is has provided little insights into the sub-national effects. A recently developing strand of literature is slowly filling the remaining gaps. Treatment variability at the sub-national level allows more convincing stories to be told regarding, e.g., conflict (Berman et al., 2014), forward and backward linkages and price effects (Aragon and Rud, 2013a), local Dutch disease and inequality (Loayza et al., 2013), employment opportunities (Kotsadam and Tolonen, 2013), externalities on agricultural productivity (Aragon and Rud, 2013b), and health effects (von der Goltz and Barnwal, 2014). Similarly, the links between mining booms and sexual risk taking behavior and the spread of HIV/AIDS (for copper boom in Zambia, see: Wilson, 2012; for migrant miners in Southern Africa, see: Corno and de Walque, 2012) have been studied. The strategy in this paper builds upon a method for estimating effects from mining using cross-country microdata developed by Kotsadam and Tolonen (2013).

The gender effects of mining are not well understood but sometimes hypothesized to be more strongly negative for women. A policy document from the African Mining Vision (funded by the UN and African Union) argues that natural resource extraction is a threat to women, since it can increase the wage gap between men and women. Ross (2008) argues that natural resource extraction harms women's labor market participation by increasing her reservation wage (through welfare transfers to her household or through higher male wages), and by decreasing the demand for female labor by crowding out female dominated sectors such as manufacturing. A previous empirical study (Kotsadam and Tolonen, 2013) found partial support for this hypothesis using micro-data from 29 Sub-Saharan countries. With the onset of large-scale mining, women shifted from agriculture to the service sector or left the labor market. A drop in male participation rate was also found, albeit smaller in magnitude. Additionally, it has been suggested that income earning opportunities created by the mining boom was part of the reason why sexual risk taking behavior decreased among young women in Zambian copper towns (Wilson, 2012).

Whether there is a link between natural resource extraction and violence is a contentious issue, also discussed within the 'natural resource curse' literature. The focus is generally placed on the extractive industries' role in financing war, or its potential economic gains motivating onset of conflict and war. Such effects have been explored cross-country (Collier and Hoeffler, 2005) as well as sub-nationally (Berman et al., 2014; and Maystadt et al., 2013). Within the community development literature, Aragon and Rud (2013) find that one large mine in Peru had a moderate positive effect on local crime rates. This paper is the first paper to move beyond the inter-state, intra-state, or local effects of extractive industries on social conflict. I consider attitudes toward violence at the lowest level of social organization: the household.

The link between violence toward women and mining has been little studied previously. Within anthropological research it has been noted that girls migrating to artisanal mining communities in Burkina Faso seeking economic opportunities risk encountering sexual harassment and violence (Werthmann, 2009). In addition, Southern African mining communities are associated with strong 'masculinity' norm (Campbell, 2007), which could lead to increasing acceptance of violence against women. However, we can also imagine that if large-scale mining creates economic opportunities for women, this can decrease the acceptance of violence against women. The link between income and domestic violence is discussed in more detail in section 2.2.

2.2 Female Empowerment

The associations between economic development and women's empowerment are many and complex. Economic development can bring women's empowerment by providing new opportunities; at the same time as women's empowerment (such as education rates and labor force participation) can stimulate economic growth (Duflo, 2012). However, the timing of this potentially positively reinforcing process is not evident. Modernization of the economy may initially decrease women's economic activities outside of the household if it does not provide employment opportunities considered suitable for women (Goldin, 1995).

Men and women have differential healthcare access, nutrition and schooling in developing countries (for overview, see Duflo 2012), and such differences can be accentuated in times of crisis. To the extreme, it has been found that unproductive women, in this case older women, are ostracized or killed by relatives in times of food shortage (Miguel, 2005). Economic development (also local economic development) can improve women's condition by making everybody better off and because it makes households more risk resilient.

It is generally thought that women's labor market participation is beneficial to the economy and for other socially desirable outcomes (such as lower population growth). Increasing women's labor market participation has thus been the goal of much policy, and a literature using randomized control trial (RCT) interventions to spur participation has developed. The RCT literature have found both weak (Field et al., 2010) and to more moderate results on employment (Attanasio et al., 2012; Bandiera et al., 2014; Jensen, 2012). Overall, there is a consensus that it is hard to increase women's labor force participation through policy interventions.

Income, and income earning opportunities, have been found to have secondary effects on marriage and fertility, such as increasing age at marriage and first cohabitation (Baird et al., 2011; Bandiera et al., 2014; Heath and Mobarak, 2014; Jensen, 2012), lower fertility (Baird et al., 2011; Bandiera et al., 2014; Jensen, 2012), and changing norms regarding ideal age at marriage and ideal fertility (Bandiera et al., 2014), schooling and employment (Heath and Mobarak, 2014). Free trade zones using female labor leads to a persistent higher equilibrium in girls' schooling (Sviatschi, 2014)[4]. The

[4]Decision making power is expressed in three different sets of circumstances - within the household, in the exercising

theoretical arguments behind these findings suggest that a woman's income (earned income, windfall income and/or potential income), both in absolute and relative terms, are important determinants of her bargaining power within the household.

Similarly it has been argued that income earning opportunities can provide protection against sexual and physical violence. Empirically, the link between income and domestic violence is, however, not so clear. On the one hand, as the gender gap in wages increases, women suffer more intimate partner violence (Aizer, 2010), and income can reduce risk of suffering from violence (Bandiera et al., 2014; Heath, 2014). On the other hand, effects are conditional on a woman's initial status in terms of property right (Panda and Agarwal, 2005); educational level (Heath, 2014), relative education versus the partner's (Hidrobo and Fernald, 2013), and age at marriage (Heath, 2014), so that if a woman's initial bargaining power is low, she is more likely to suffer domestic violence as her income increases.

In this paper, we focus on norms toward domestic violence. DHS employs a strict protocol when collecting the data and ensures that enumerators are trained for the purpose. Despite these precautions, misreporting and under-reporting are likely issues in domestic violence data. Focusing on attitudes is beneficial in this case since, despite being related to experiences of violence, it is less likely to suffer from misreporting, it is more often collected by DHS allowing for more cross-sectional and time variation, and, lastly, attitudes toward own body control are important aspects of empowerment. Despite not posing any formal restrictions on behavior, own perceptions of opportunities and rights are important determinants of outcomes. For example, aspirations have been shown to play a key role in development outcomes. Child sponsorship interventions, focused on raising disadvantaged children's self-esteem and self-confidence, result in higher schooling attainments and benefitting children are more likely to work as adults (Wydick et al., 2013).

Domestic violence is one important aspect of control over one's body, sexual integrity is another. An RCT combining information with vocational training found significant decreases in reported unwanted sexual activities to almost half its initial value (Bandiera, 2014). Notably, unwanted sexual activities is an extreme form of lack of control over one's body and there are many other, more common, ways in which women can lack control over their own body. The same intervention successfully targeted other outcomes as it decreased young women's economic dependence on men[5], early entry into matrimony and cohabitation, and resulted in a drop in teenage pregnancy (Bandiera, et al, 2014). This illustrates that for young women, economic constraints can provide threats to body and fertility control. In the more extreme case, it has been found that the supply of transactual sex is very elastic to income opportunities and economic shocks, on the intensive margin (Dupas and Robinson, 2012; Robinson and Yeh, 2011) and the extensive margin (Wilson, 2012). The latter study is exploring the copper boom in Zambia, and finds that the supply of transactional sex and prevalence of multiple partnerships were reduced in towns that benefitted from the higher copper price.

of property rights, and in the creation of policy. A policy maker are interested in increase women's bargaining power on moral grounds, and/or as it is instrumental in changing other development outcomes (Duflo, 2012).

[5]Romantic relationships between men and women do not always include any financial dependence from either party. However, romantic relationships with aspects of women's financial dependence on men range from the traditional relationships where a woman's own income is not enough for her support, relationships based on gift exchange, to transactual sexual relationships.

In this paper, I focus on three important sets of outcomes that can determine a woman's welfare that capture both positive and normative questions regarding a woman's autonomy over resources and her body, (1) her decision making power (if she has final say in household decisions), (2) if she can seek medical care for herself (if certain factors hinder a woman to seek healthcare: money, distance and/or permission), (3) acceptance of domestic violence (if a given condition is a valid reason for a husband to beat or hit his wife). I create three score indexes that I analyze, but all the original questions are presented in Appendix Table 22[6].

2.3 Determinants of Infant Health

Despite large drops in child mortality in Sub-Saharan Africa, it remains a pressing issue. On average one in nine children dies before the age of five (The World Bank, 2014). Economic as well as environmental factors determine the high mortality rate. And there is reason to believe that women's empowerment can help improve infant mortality rates.

In the canonical model of household bargaining, all income accruing to the household is pooled (Becker, 1964) and spent according to a joint utility function. Any changes in relative or absolute wage rate for men and women will, according to the pooled income hypothesis, have the same effects on infant mortality. Such predictions have failed to be empirically confirmed (see Browning and Chiappori, 1998; Hoddinott and Haddad, 1995; Thomas 1990, and Duflo and Udry, 2004). Windfall income to women generates larger drops in infant mortality rate and better anthropometrics, especially for girls (Thomas, 1990; Duflo, 2008), or for boys (Haddad & Hoddinott, 1994). Broadly speaking, such findings indicate that women have stronger preferences for child health than men do, and/or that child health is more likely a woman's responsibility, and that child gender preferences are important in determining outcomes. Exogenous shocks to women's incomes across Chinese districts led to an increase in girls survival rates, possibly by increasing women's perceived economic worth in a context of son preference (Qian, 2008). The effect of women's income is, however, not unambiguously positive for child health: exogenous shocks to women's wage rates led to a decrease in child survival rate in Colombia, arguably through increasing women's opportunity cost of child care (Miller and Urdinola, 2010).

The context in which we study child health is complex since the gold mining industry, like many industries, is associated with environmental degradation and pollution. A large body of literature traces health outcomes in early childhood, such as birth weight and infant mortality, to environmental factors affecting the fetus in utero. Links are found between in utero exposure to toxins (Currie and Schmieder, 2013; Currie et al., 2011), radiation (Almond et al., 2009; Black et al., 2013), ozone pollution (Moretti and Neidell, 2011) and worse birth outcomes. Beneficial effects on birth outcomes have been found after industrial clean-up processes (Currie et al., 2011)[7].

The gold mining is specifically associated with heavy metal pollution. The industry uses cyanide in the amalgamation process to separate the gold from the ore. Low level spillage from tailings ponds

[6] Additional indicators are available in the DHS that could help us understand female empowerment. However, they are not consistently collected across survey years and countries to allow us to analyze them here.

[7] Not only industry induced or man induced environmental effects have been found to affect child health outcomes; weather variability (Kudamatsu et al., 2014) and weather seasonality (Currie and Schwand, 2013) are important determinants of fetal health.

with cyanide-water mixture has been reported, in addition to accidents with high level leakage[8]. The gold ore in several African countries naturally contains arsenic and heavy metals such as lead, cadmium, chromium and nickel, that come to the surface during the extractive process. Lead exposure in utero is associated with increased risk of premature birth, low birth weight and retarded growth (Iyengar and Nair, 2000), and lead pollution from mining activities has been linked to stunting in children (von der Goltz and Barnwal, 2014)[9]. Studies of exposure to heavy metals in childhood are at risk of significantly underestimating the health costs, since effects are likely subclinical, i.e. non-detectable, in the short run. Cancers may, for example, only develop after years of chronic exposure. In this study I will focus on solely on mortality outcomes of infants. From this study, neither will we be able to say anything about the future health of the surviving children, nor can make any conjectures about the complete health status of these children in the short run.

To structure the potential mechanisms discussed in this section, I develop a short conceptual framework for infant mortality (see Appendix A). The hypotheses drawn from the framework argues that household income, women's income, bargaining power, and healthcare access are negatively associated with infant mortality. Women's opportunity cost of time and environmental degradation are, however, positively associated with infant mortality. The opening of a mine could affect all these variables, why we have no clear predictions regarding the effects of a large-scale mine on infant survival.

3 Data

The paper uses the best available pan-African data source with information on labor market outcomes, empowerment, fertility and child health: the Demographic Health Surveys (DHS). DHS has the additional advantage of having GPS coordinates available at the village or urban neighborhood (from here on called clusters). The geographic identifiers allow us to link the village in which the mother or the child was surveyed to the gold mines. The mine data comes from Raw Minerals Group and contains all large scale gold mines across the African continent, with GPS coordinates for each mine center-point and historic production volumes, from 1975 to 2013.

Combining the two data sources using the geographic information, I construct different measures of proximity. The final data set contains all DHS survey rounds that have geographic data, and for countries in which there is at least one large-scale gold mine[10] that was active at least one year

[8]A serious accident happened in May 2009 in Tanzania and it had substantial effects on health, agriculture and livestock around the mine (Bitala et al. 2009).

[9]Studies from mining areas in Ghana and Tanzania confirm existence of arsenic in soil and water below as well as above WHO threshold guideline levels. The WHO recommendation thresholds are thought to be conservative, and the epidemiological literature is inconclusive regarding the health effects of exposure to cyanide and arsenic and birth outcomes within this range (ATSDR 2007: Arsenic, Cyanide), but high exposure is associated with detrimental birth outcomes (Chakraborti et al., 2003; Hopenheyn, Ferreccio et al. (2003); Milton et al., 2005). Nevertheless, there has been controversy regarding these findings due to risk of omitted variable bias where exposure is linked with lifestyle habits (Kapaj et al., 2006). Epidemiological studies limited to the study of mother infant pairs show that arsenic exposure in utero correlates with low birth weight (1500 pregnant mothers in Bangladesh: Rahman et al. 2008), and high exposure correlates with stillbirth and neonatal death, but not with miscarriage or later infant death (the sample consisted of 202 married women surveyed during 2 years: von Ehrenstein, 2006). Appendix Table 23 explains in more detail the known effects of cyanide and arsenic.

[10]Some countries have small-scale, traditional gold extraction activities. This sector is not analyzed within this

during the study time period. This leaves us with a data set with four survey rounds for Burkina Faso, Ghana, Mali and Tanzania, three survey rounds for Côte d'Ivoire, Ethiopia and Senegal. In addition, Demographic Republic of Congo is kept in the study despite there currently only being one available survey round (new round released October 2014, soon added to the analysis). The survey years span from 1993 to 2012. Table 24 in the Appendix shows the sample size divided by country and survey year.

Figure 2 shows the geographic location of the gold mines used in the analysis. To the right in Figure 2 we zoom in on Tanzania, highlighting the mine location (the blue circles) and the DHS clusters (purple dots). The gold mines show a pattern of geographic clustering, such as around the Ashanti gold belt in Ghana and the Lake Victoria greenstone belt in Tanzania.

Descriptive statistics are presented in Table 1 for women, and Table 2 children and their mothers. The first column (whole sample) tells us the main characteristics of the sample. Women are on average 28.7 years old, and 27% live in urban areas. A little more than 40% of women have ever moved, and most work in agriculture (44%).

The index variables barrier to healthcare, accepts domestic violence and final say in household decisions presented in this table. These consist of averages of answer to a wider set of questions, all of which are presented in the Appendix Table 12. The original variables are dummy variables that take a value of one if the woman agrees with the statement, and zero otherwise. Between 23% to 48% of women think that violence can be justified: women agree to a statement that a husband has the right to hit his wife if she burns the food (23%), refuses sex (37%), argues with him (45%), neglects the children (48%) or goes out without his permission (47%). In addition, more than 50% state to have final say in food decisions, but only 17% have a say in how to spend husband's income. Roughly 30% state to have decision making power regarding healthcare and large purchases. Women in the sample also have low access to healthcare for self, where 88% to 92% of women think that permission, distance or money are issues for access to health. These variables are then used to construct the three indexes in Table 1 that take a value between 0 and 1, depending on the share of the statements that the woman agrees to.

The average number of children born to each woman is 3.26, and the women have not reached their ideal fertility, which is 5.4 children on average. The mean infant mortality in the first 12 months is almost 10 percent. The birth year of the children in the sample vary from 1987 to 2012, since the oldest child sampled in the first survey year, 1993, is five years old. Mother's age is just above 29 years on average, which means that the women in this sample are slightly older than those in the main analysis. The mothers to surveyed children also have lower education than their peers in the other sample, which may be a result of younger women being undersampled in the child sample and positive trends in education.

paper. Due to the informal and sometimes illegal nature of such activities, no proper account for their location and extent is available.

4 Empirical Strategy

With multiple survey rounds and historic records of openings of gold mines across Sub-Saharan Africa, the identification strategy relies on a difference-in-difference framework using several treatment definitions based on proximity to a mine. The true counterfactual in the baseline is 'no mine', and I try several methods to identify the relevant comparison group by varying the definition of the control group.

4.1 Baseline Specifications

The strategy of the paper follows from an approach used by Kotsadam and Tolonen (2013) to measure local employment effects from industrial mining across a continent. More generally, the strategy links to the field of economic geography concerned with exploring local industrialization effects, e.g., local multipliers (Moretti, 2010), agglomeration economies and total factor productivity (Greenstone et al., 2010), and toxic industries, housing prices and infant mortality (Currie et al., 2012). Currie et al. (2012) examine U.S. plants that produce toxic waste. Due to the risk of measurement error in reported quantities of toxic waste, the authors' preferred strategy is plant opening and closing year. For similar reasons, I rely on the opening of mines in the rather than annually reported production volumes that are not reliable estimates of ton of gold produced.

Mining is primarily determined by the availability of a mineral deposit. Despite true deposits being random, it is not possible to argue that known deposits are truly exogenous measures. We come to know about deposits, in many cases, after long processes of explorations. The level of explorations undertaken can be determined by (1) institutions, (2) royalties and tax-rules, (3) accessibility (Eggert, 2002) and (4) expected profitability. The first two determinants are likely to only vary within-country or at least, within subnational-regions. The latter two may however depend on within-region characteristics, such as, infrastructure and prices for factors of production. Deposits have been used in the natural resource literature (see e.g. Alcott and Keniston 2014) as an exogenous measure of mining activities. However, a deposit measure is time invariant, so by definition it only allows for a difference-in-means estimation. Instead of doing this, we take known deposits (ever extracted between 1975 and 2012) and add an annual indicator for production status of the mine:

$$Y_{icdt} = \beta_0 + \beta_1 deposit_c + \beta_2 deposit \cdot active_{ct} + \gamma_t + \alpha_d + \delta_{kt} + X_i + \varepsilon_{icdt} \quad (1)$$

where i indicates an individual observation, c cluster, d district, k country and t year. The variables of interest are *deposit*, an indicator variable that takes a value of one if there is a deposit within a baseline distance from the community, at most times defined to 15km, and a variable indicating the presence of an active mine (*deposit*active*) in the given year. Importantly, the specification includes year fixed effects γ_t which allows for the difference-in-difference interpretation. Moreover, the specification includes district fixed effects α_d, country-year fixed effects, δ_{kt}, and a vector of individual level controls X_i. In all regressions, I have limited the sample to within 100km from a deposit and I cluster at the DHS cluster level (unless otherwise stated).

The choice of distance is crucial for correctly estimating the effects. To be transparent about the choices made regarding distance, I will show the effects from different distance cut-offs as well as a spatial lag model. Mining areas can be several kilometers wide, as illustrated by the photo of Geita Gold Mine in Figure 3. To capture the communities around the mine, we need to consider an area which is larger than the mine itself. But we also need to understand how far people commute to work in or around the mines. In the late 1980s, the median worker in rural Tanzania and Ghana travelled roughly 5km to work (Shafer, 2000). A more recent study from Côte d'Ivoire estimates tracking mobile phone movements, that the average worker travels 5km but often up to 15km to work (Kung et al., 2013). In 2013, 80% of Government workers in Kumasi, Ghana, travelled less than 10km to work, mostly using public transport (Amoh-Gymiah and Aidoo, 2013). These estimates, plus the mine size of a few kilometers in diameter, suggest that roughly a 10 - 15km zone around the mine can be considered an integrated economic area. Distances along 10 - 15km will be the baseline treatment distances in the paper. Moreover, an additional reason to not consider smaller distances is that the geocoordinates in the DHS data are displaced with 1 to 5km to ensure that individuals cannot be identified, and up to 10km in 1% of the case.

The chosed distances are in line with distances used previous studies, where distances range from a maximum of 50 - 100km for Aragón and Rud (2012) mapping the effects of one large mine in Peru, 20km in a study on agricultural productivity in Ghana close to gold mines (Aragon and Rud, 2012b), 20km for labor market effects across Africa (Kotsadam and Tolonen (2013), down to 5km in a study regarding pollution effects from mining (von der Goltz and Barnwal, 2014). Beyond the local analysis, there are papers that explore district level effects, which shed light on the fiscal channels (Loyaza et al., 2013; Alcott and Keniston, 2013). A contribution of this paper is its empirical approach to estimating distance effects in spatial analyses where a radius of influence is not known *a priori,* by carefully mapping the spatial decay function with a spatial lag model.

4.2 Threats to Identification

The estimation strategy in this paper relies upon assumptions that the timing and the placement of the mines are not driven by local changes, such as trends in labor market participation or population characteristics. The mining industry may, to a lesser extent than other industries, depend on local characteristics. Mine locations are first and foremost determined by mineral deposits that are considered geological anomalies, and not by the availability of human capital and labor. Through the earth's crust there are pockets of mineral deposits, often clustered within a region (Eggert, 2002). The necessary condition determining an investment decision is the existence of a deposit: deposits are not mobile, whereas production technology and labor inputs are.

Nevertheless, we can think of various factors that could influence mine location or mine opening year. Access to, and costs of, inputs, agglomeration economies and historic legacy (Eggert, 2002) are considered important. Another important factor is institutions. A nation's rules regarding ownership, such as openness to foreign ownership of mineral wealth, rules for revenue sharing of tax and royalties, and environmental demands are likely important factors. Such regulatory framework is predominantly national, although several countries, such as Ghana, have regional income sharing rules (Garvin et al., 2009). We do not expect that within-region (i.e. subnational level 2, such as district level) differences in institutions will drive the investment decisions, assuming that at this subnational level institutions are homogenous.

The difference-in-difference identification strategy with district fixed effects and year fixed effects reduces the concern we may have of institutions driving the mine opening and location. Effects are identified within a certain subnational area which we can assume have the same institutions. In addition, the baseline estimation specification includes country-year fixed effects accounting for national changes in policies and institutions, and results using other specifications, such as district time trends, are presented in the robustness section.

Of more concern is infrastructure for water, electricity and transportation, which may vary within district. Transportation infrastructure and accessibility are argued to be important in both the exploration phase and the production phase (Eggert, 2002). If mining operations create new infrastructure, that means that our treatment is mine plus infrastructure. This is not a threat to identification, because we are interested in the total effect of the industrial shock.

If, however, mines open because infrastructure is developing in these areas, it affects interpretation of the results as they can no longer be understood as the general equilibrium effects of a large-scale mining shock. We may consider this infrastructure story less likely for gold than for various other minerals. Gold is a high value commodity, and airstrip access may be more important for transportation than railway or road network connectivity. This is not true for all commodities, as bulky commodities, such as iron ore, are more heavily reliant on good infrastructure. According to annual reports, gold mining companies operating in Africa develop necessary infrastructure themselves to some extent[11].

Other threats to identification are migration and urbanization. On the one hand, we are interested in the general equilibrium effects that a mining shock has on the local economy. This means that we are interested in knowing how the mine affects the economic opportunities of its new and old community members, where migration and urbanization are allowed to be mechanisms. On the other hand, we are interested in knowing the treatment effect on the original population, free from selection, in which case we have to remove migrants from the analysis. In this second case, we also allow for migration and urbanization to be part of the mechanism, i.e., maybe women's employment opportunities change through the indirect effect of a mine, urbanization.

A final concern we might have is the existence of artisanal and small-scale mining (abbreviated ASM), which is a large sector in terms on employment but small in terms of production, compared with the large-scale mining industry. No detailed, time varying record of legal and illegal ASM activities exists (to my knowledge), why I cannot control for the location of such activities. In some countries and districts, ASM will be part of the land use pre-existing the large-scale mine. If so, we will be estimating the general equilibrium effect of the potential partial replacement of one production method with another. It is unlikely that legal ASM activities will increase with the large-scale mine since the large-scale mine will typically have the mineral rights to all findings in the area. Moreover, it is hard to make any conjectures regarding the response of the illegal mining sector, although a decrease in illegal activities is likely as property rights of the minerals are more likely enforced with the arrival of the large mining company.

[11]African Barrick Gold owns a private airstrip at their Bulyanhulu mine in Tanzania, and we can see another airstrip in the picture of the Geita gold mine in Figure 3.

In one particular part of the analysis does the prevalence of ASM prior to the onset of large-scale mining pose a serious threat to the identification and the understanding of the results: infant mortality. Small-scale mining is associated with mercury pollution, which can be detrimental to child survival and development. If a large-scale mine crowds out smaller-scale activities, and we estimate a positive effect on child survival, this could be due to the disappearing of the polluting, initial industry rather than the advent of a more modern industry. Since few time-varying, complete records of detailed local nature of small scale mining exist, we cannot investigate this further. To overcome some of this concern, we compare the trends in infant mortality before the large scale mine in close communities, with the communities in the control group (See Figure 6, and see section 4.3 on Parallel trends for further discussion). We find that infant mortalily rates are indeed higher in mining communities before the mine opens, but that it is lower in the same communities afterwards, which is what we would expect if the large-scale mine has positive effects on survival rate (and not only through crowing-out effects).

To further convince the reader that the model is not mis-specified and the results spurious due to cross-sectional correlations, I conduct a spatial randomization placebo test.[12]

4.3 Parallel Trends

Difference-in-difference analysis hinges upon the assumption of parallel trends. In this analysis, that would be that the trends in the treatment (mining) communities and the control communities (further away from a mine) would be on the same trajectory, in absence of the mine opening. We will first look at balancing tables for the treatment and control groups, and then at parallel trends.

Two balancing tables (Table 1 for women and Table 2 for children) show that there are some differences in levels pre-treatment across the treatment (Column 3) and control group (Column 2). The summary statistics indicate that despite women having the same age or the same education, women in mining communities before a mine have higher fertility, are less urban, and work more in agriculture. For children in Table 2, we learn that mothers are on average 29 years old, have 1.9 years of education, and the mothers are less urban if they live in mining communities before a mine. Infant mortality is also substantially higher in the treatment group pre-treatment (Column 3). We find several significant differences between the two groups when we test the hypothesis of equality using t-tests- It seems like mining communities before the mines open are less well-off: less non-farm employment, higher acceptance of domestic violence, less access to health care and more infant mortality. However, the difference-in-difference framework allows for different levels, as long as the two groups are on similar pre-treatment trends.

To investigate if it is plausible to make this assumption, I look at the trends in observable characteristics and outcome variables for women within 15km from a mine, ten years before mine opening to ten years after the first opening year, and compare it to women who live between 30 and 50 km away from mines in the same time period. I have chosen to compare with women living 30-50km away to overcome any concern that the group is still treated by the mine, but still not too far away to look different (since these are comparisons of mean values).

[12] A further randomization test will be done, randomizing mine opening year, to convince the reader that the effects found can be interpreted as causal and not spurious effects casued by trends in empowerment and mortality rates.

Figure 4 shows that there are no pre-mine differences in trends in age and education, but women in mining communities may be slightly younger and more educated after the mine opening. Service and sales employment is lower in the mining communities before the mine (Figure 5a) but follows a similar trend as the treatment group. However, we notice an increase in service and sales employment roughly 1 to 2 years before the mine opens, which is in line with an investment story. Mines are capital intensive, and employment generation can be substantial during the investment phase. This is an indicator that we may consider the investment phase as part of the treatment years, although in the main analysis I assume first year of production as the start of the treatment period. The trends in agriculture are less clear, but it seems like agricultural employment dips around mine opening in mining communities and then reverts back to its pre-mine level in the long run. The control communities are on a steadily decreasing trend.

Infant mortality (Figure 6a) follows similar trends in mining communities and non-mining communities before the mine, although the level is higher in mining communities. The two levels start converging a few years before mine opening, caused by a sharp decline in mortality in the mining communities. The same graph but focusing on the change five years before and five years after mine opening, shows that the two trends diverge only one year before mine opening (Appendix Figure 14), in line with the investment story. We may be observing excess mortality in mining communities before the mine opens because of artisanal and small scale mining. However, we note that the infant mortality is lower in these communities after the mine, indicating that the effect is not only because a polluting industry (ASM) has been crowded out.

Total fertility among women aged 22 or below at mine opening (Figure 9a) is higher in mining communities than in control communities, but the trends are quite similar. It is natural that the total fertility is increasing for this group, since for each additional year (on the X-axis), the woman is older and thus has higher total fertility. Total fertility among all women is on downward sloping trend, and while the trends are similar in the two groups 10 to 3 years before mine, around this time the level difference is more or less evened out.

Overall, the figures of the evolution of observable characteristics, outcomes and potential confounding factors show similar pre-mine trends, which helps us rely on the difference-in-difference estimates.

5 Results

5.1 Main Results

Determining Treatment Distance

To allow for non-linear effects with distance and better understand the geographic distribution of effects, I do a spatial lag model. By including a lag structure for distance to deposits as well as active mines (active), we allow for two sets of non-linear spatial structures:

$$Y_{icdt} = \beta_0 \tag{2}$$

$$
\begin{aligned}
&+\sum_d \beta_d \, deposit_c \\
&+\sum_d \beta_d \, active_{ct} \cdot deposit_c \\
&+\gamma_t + \alpha_d + \delta_{kt} + \varepsilon_{icdt}
\end{aligned}
$$

for $d \in \{0-10,\, 10-20, \ldots, 80-90\}$

Figure 10b and 10c confirm that the effects on services and agriculture are found close to mines, sharply declining at 10 to 20km. Beyond 20-30km we see few effects on service and sales employment and the estimates are approaching zero. For agriculture, there is more variation in the estimates, but there is a tendency of lower participation rate in agriculture close to active mines.

Figure 10e and 10f and 10g show the result for our three main variables for empowerment: barriers to access healthcare, justification of domestic violence, and final say in household decisions. Figure 10e for 'Barriers to healthcare access' show that up to 20km from a mine, women state fewer barriers to health, especially compared with women at the same distance from a non-active mine (the dotted line), for whom access is more restricted than for peers further away. For justification of domestic violence, there is a clear shift from higher levels of acceptance (dotted line) to lower levels of acceptance (solid line) happening close to mines that become active. There is some difference at 60-70km away, at what distance we observe the same pattern, which may or may not be due to the mining activities. For final say in household decisions we do not see any clear pattern neither close to mines, and nor further away.

Lastly, Figure 10h and Figure 10i show the results for infant mortality. For boys, there is seemingly insignificantly lower mortality within 10km from a mine in active mining communities. For girls the difference between active and inactive communities is large in the closest distance bin. Before a mine, mortality rates are significantly higher here, and after a mine, they are significantly lower. The effect is, however, no longer observable at the 10-20km distance bin.

These findings motivate us to consider the very close distances. For occupational outcome, especially services, it is clear that the mine impact is found within 20km, but for domestic violence it is found within 10km. For children, the effect is exclusively found within 10km.

As a baseline measure we will continue with 15km distances from a mine, since this gives a bigger sample size and more precisely estimated effects. However, for children we ought to consider 10km distance bins, although we will also see the baseline results using 15km.

Economic Empowerment

Using the baseline specification (specified in Equation 1) and a treatment distance of 15km, the treatment effects on all outcomes are shown in Table 3. Panel A shows that women in mining communities are 9.5 percentage points more likely to work in services and sales and less likely to work in agriculture (-7.2pp, insignificant). To understand if there is a switch from agriculture to service sector employment, I estimate a multinomial logit. I find that there is a significant decrease in agriculture (-7pp) and a significant increase in service sector employment (11.5pp increase) (see Table 16, and a more detailed discussion in Section 5.3). Women are more likely to earn cash for work (baseline is insignificant, but the marginal effect from the multinomial logit is significant (8.9pp), see Table 16). The effect on overall labor market participation is smaller (4.7pp which is a 6% change in the overall participation rate, or 1.4pp from mlogit) and insignificant. We confirm that the onset of mining makes women shift from agriculture to service sector employment, and they are more likely to earn cash for their work[13].

Physical Empowerment

Table 3, Panel B shows the results for three index variables measuring a woman's physical empowerment. The outcome variable is an index that takes a value between zero and 1. If she answers that all reasons are valid, or situations correct, the index will take a value of one. The full list of questions is presented in the Appendix, Table 12 and with the questions from the questionnaire in Appendix Table 22. The first index "barriers to access healthcare" measures if a woman thinks that she is significantly hindered to seek healthcare for herself, where money, distance or permission are possible hindrances. Women close to active mines are significantly less hindered to seek healthcare, with a drop of 23%. In addition, in column 2, we learn that women in mining communities accept domestic violence 24% less. Column 3 shows that women in mining communities do not have significantly different final say in household decisions. The outcome variable is an index, and takes a value of 1 if the woman states that she alone, or jointly with her husband, has a final say in all of household decisions (healthcare/large purchases/family visits). There are more outcomes that are not included in the index, since they are only collected for a smaller sample. Using an index is the preferred strategy since it removes some of the concerns regarding multiple hypothesis testing, since we effectively limit the number of hypotheses tested with the index. For transparency, the results for all individual outcomes are presented in Appendix Table 17, and a discussion regarding multiple inference is found in Section 5.3.

Infant Mortality

Infant mortality remains high in many parts of Africa. The fertility records that we use have been collected in Africa over the last decades, and is recall data provided by women aged 15 to 49 regarding all births in the last five years. We believe that the data is of high quality, since births are important happenings that women are likely to remember, especially within a limited time frame. Despite this, there is often missing information on birth weight (an important pregnancy outcome, and indicator for infant health), which is attributed to high prevalence of unattended births where the weight was never recorded. For this reason, I choose to look at infant mortality when analysing infant health.

I develop a short conceptual framework for infant mortality (see Appendix A). To summarize, the framework argues that increases in household income would affect child health positively, and especially woman's income. Also access to health care is hypothesized positive for child health.

[13]These results are also confirmed by the Ghana Standard Living Measurement Surveys (GLSS) using the same strategy. Results available upon demand.

However, if a woman's bargaining power within the household decreases, it could have negative effects on child health if she is the main care giver, as well as if the opportunity cost of child care (i.e. through women's higher wages) increases, child health could deteriorate. Lastly, if environmental quality decreases because of pollution from a mine, that could have negative effects on health. We have already learnt that a mine can increase women's labor force participation outside of the household, which could have positive effects on survival rates (through the income effect), or negative effects (through the increase in opportunity cost). However, we have seen no significant changes in bargaining power. Overall, the effect of a mine on infant mortality is ambiguous.

When we anlyze infant mortality, the specification will be slightly different than in the women's regressions, because we now want to consider if there was a mine in the child's birth year, rather than in the survey year. The baseline specification includes birth year fixed effects, γ, birth month, μ, district fixed effects, α, country year fixed effects, δ, a vector for mother's characteristics, and child birth order.

Mine opening is associated with 0.009pp decrease in infant mortality, and disaggregated by gender we find that the treatment effect is positive for boys, but negative for girls (see Table 3, Panel C). The parallel trends and the spatial lag model did, however, tell us a story about decreasing infant mortality within the 0 - 10km distance from a mine. For this reason we continue the analysis by exploring, in more detail, infant mortality at the very closest distance. Table 4 shows the regression results for infant mortality in the first month (Column 1) and first 6 months of life (Column 2), and first year (Column 3). The effects for neonatal mortality and mortality in the first half year (3.1pp and 5.6pp) are smaller than the effect for infant mortality in the first year, which is 6.1pp. The 6.1pp decrease in infant mortality in the first 12 months is close to a two-third decrease in mortality rates. Decomposing by gender, we find that mine opening is associated with a 4.2pp insignificant decrease in mortality rates for boys (Column 4), and a 7.6pp decrease in mortality rates for girls. The drop in mortality rates for girls is equivalent to a 85% decrease in incidence. These drops happen in communities that prior to the mine had higher incidence of infant mortality, as indicated by the coefficients for deposit. To further understand the robustness of these results, and to understand why they happen within 10km, I will continue using the 10km distance in all subsequent regressions for infant mortality, unless otherwise stated.

5.2 Mechanisms

In this section, we will try to understand the mechanisms behind the results found on empowerment and infant mortality. We start by exploring heterogeneous effects for the migrant and non-migrant population, and explore effects on urbanization. We will explore if increases in service sector employment, cash earnings and household wealth explain some of the variation in physical empowerment and infant survival. We use an additional data source to measure wage effects for Ghana, and lastly we look at changes in marriage market outcomes and fertility.

Migration and Urbanization

We are interested in migration for two reasons, (1) because it affects the interpretation of our main results, (2) because migration may be a mechanism through which the effects of the mine are reinforced. The main analysis was done on the whole local population. This means that we can understand how labor markets, empowerment and infant mortality have changed within these communities. In the presence of selective migration to these communities, we cannot however, interpret the effects as treatment effect on the treated since the population composition has changed. Nevertheless, we may expect migration to be a mechanism: if mining communities grow because of inward migration, this can have additional effects on economic activity, and create indirect job opportunities. That said, mining induced migration flows can also increase the competition over jobs, resources and services (such as healthcare), so the welfare impacts of migration are *a priori* ambiguous.

The DHS provides information (for a subset of the sample; not all survey rounds collected the data) on whether the individual ever moved. In Table 5 Panel A, I show the results using the baseline specification, but excluding anyone who ever migrated from both the treatment and the control group. Assuming no selective outward migration from the mining communities, we can interpret these results as treatment effects on the initial population[14]. Women born in mining communities take advantage of new service and sales jobs created by the sector (Column 2). The likelihood that a woman works in services and sales is almost 10 percentage points higher than elsewhere, which corresponds to the baseline result presented in Table 3 Column 3. The observed change in behavior for these women is in line with the main results: they are less likely to be hindered to seek healthcare (Column 4, insignificant), less likely to justify domestic violence (Column 5, marginally significant), and infant mortality among their children decreases (Column 7, insignificant). The effect size for infant mortality is however smaller than the baseline estimate, and the standard error is large. Trying to further decompose the estimate by gender, the number of treated individuals becomes too small and the standard errors increase sharply. (Results available on demand) To further understand the treatment effect on migrant children, we can look at the trends in infant mortality (Figure 8). Among never-movers, the trends are in infant mortality are similar up until the few years before mine opening, when mortality rates start decreasing rapidly. Overall, we see the same patterns among migrants and never-movers, although the drop in mortality is more pronounced within the migrant community.

Women who have migrated to the current localities benefit more from the opportunities created; service and sales employment and the likelihood of cash earnings increase with 16pp (Panel B, Column 2). These women are less likely to work in agriculture, than are migrants elsewhere. This may be an indication that it is harder to access farm land in mining communities, because of higher competition over land resources, or that these women move to such areas to benefit from non-farm employment, why they naturally select in to services and sales. These women are also less likely to feel hindered to access healthcare, and infant mortality decreases with 6.6pp among their children.

It seems like women moving to mining communities take good advantage to economic opportuni-

[14] This may be a strong assumption to make. However, the data does not allow us to identify where people have moved from to understand the inward and outward migration of the mining communities.

ties generated by mines, but that women born to these communities, respond similarly. The results indicate that it is not likely that the main results are solely driven by selective inward migration of individuals interested in taking advantage of new opportunities and brining different norms, but that these individuals add to the local economy, and reinforce changes that are underway.

Large-scale mining can cause migration as well as urbanization. Overall, the extent of the migratory movements caused by mining is not well explored, although research has previously exploited work migration movements to understand health effects of mining (Corno and de Walque, 2012). Most of the research in Africa regarding work migration to mines is in the context of South Africa (e.g. Campbell, 1997 and Dunbar Moodie, 1994), a special case since the migrant mine labor system was started and ensured during the Apartheid rule (Cox et al., 2004). Nevertheless, migration and urbanization effects have been noted in the case of gold mining in Tanzania (Lange, 2006). African natural resource extraction has also been linked to urbanization in Africa, as the windfall income spurs the creation of 'consumption cities' rather than 'production cities' (Gollin et al., 2014; Jedwab, 2013). I map the share of the population that has ever migrated, and the share that live in an urban community, by distance from mine using a spatial lag model that allows for non-linear effects in distance. Figure 11 illustrates that urbanization rates are higher close to an active mine than to a deposit. The likelihood that a community is urban is roughly 15pp higher close to an active mine than the reference category (which is the omitted category: 90-100km away) and compared to a deposit, where the change in the likelihood of being urban is close to zero. The right side of Figure 11 shows that migration rates are 5pp lower close to active mines, than close to a deposit where it is 5pp higher than in the control group (omitted category: 90-100km away). This may seem surprising, given the urbanization effect that we have found. It could be explained by more urbanization migration among ever-migrants (which is a big share of the total population).

Service Sector Jobs, Wealth and Wages

The effect of the mine on female empowerment and infant mortality can, among other things, be caused by changes in economic empowerment (e.g. access to service sector job or cash earnings), or through gains in household income and wealth. I test these hypotheses in Table 6 where I have included controls for service and sales jobs, cash earnings and household wealth. The two first out of the three control variables, are as we have seen in the previous analysis, themselves outcomes of the mine. Columns 1-4 include controls for service and sales jobs. We learn that it is a strong predictor of cash earnings, and that women in the service sector are less likely to be hindered to seek medical care for herself, are less likely to accept domestic violence and enjoy more say within the household (note, these are not causal estimates). We note too, that the treatment variables active*deposit, remains statistically significant for healthcare access and domestic violence, indicating that it is unlikely that a mine affect these variables only through stimulating service sector employment.

In Panel B Column 2, we learn that women who earn cash income have better medical care access, are less accepting of domestic violence and enjoy more bargaining power in household decisions. The treatment variable, active*deposit, for barriers to healthcare is no longer significant, and a little smaller of magnitude, possibly indicating that own cash earnings are important in determining a woman's access to medical care, which is intuitive since money is one possible barrier to access.

Similarly for a service sector job, the treatment effect for domestic violence is still significant and negative. So while we see that there is a strong correlation between earning cash and be less accepting of violence, it does not seem like the treatment effect of the mine on domestic violence is working purely through the 'cash effect'.

In Panel C, Column 2 and 3, we learn that women with more household wealth have better access to healthcare and lower acceptance of violence. The effect on bargaining power (Column 4) is however very small and marginally significant. This could be explained by men's income being an important determinant for both household wealth and a woman's bargaining power. Also here, the treatment effects of the mine on healthcare access and domestic violence remain negative, although only the second is significant. However, we must note that no significant changes are found in household wealth, such as likelihood that the household is poor or rich, has electricity, owns a radio or has a female headed household (results upon demand).

The estimated effects for infant mortality (all children, boys and girls) in Columns 5-7, show that including a control for service sector employment or cash earnings do not change the results significantly, but controlling for household wealth reduces the coefficient for active*deposit significantly.

We learn that it is more common to earn income paid in money in mining communities when there is a mine, but far from all workers earn cash income. Additionally, the DHS data does not tell us anything regarding the wage rate. I complement the study with Living Standard Measurement Survey (LSMS) data for Ghana. The data is collected by the World Bank together with the Ghanaian Bureau of Statistics. I use the rounds for which we have geospatial information: 1998, 2005 and 2012.

The LSMS data contains information on whether the individual has worked the last 12 months (for cash, in-kind payment or barter), in the last 7 days, in what industry (including agriculture, mining and services (here defined as working in services, commerce or transportation and communication), construction and manufacturing), and wage from main job (defined as the job the person spent most time doing last week, with all non-paid employees having no wage) and the usual hours worked per week. Table 7 Column 7 shows that wage rate is unchanged for men, but increases for women as indicated by the interaction term active*deposit*woman, although women have lower wage rates to start with (as indicated by the coefficient for woman). We also confirm that men benefit from direct employment effects, i.e. in mining (Column 6), whereas women benefit from indirect job creation in the service sector (column 5). The results are suggestive of a decrease in work participation on the extensive margin, but an increase on the intensive margin as hours worked increase (insignificantly). Column 8 indicates that household income increases significantly.

Correlations show that women in service and sales jobs and women earning cash are more empowered (according to our three indexes), and so are women from wealthier households. We have found that women in mining communities are more likely to be working in this sector, earn cash, and enjoy higher wage rates. Controlling for these economic empowerment indicators, we find that the effect of the active mine decreases in general. This indicates that the effect of the mine on female empowerment is partly through an economic empowerment channel.

The effect of economic empowerment on infant health is less clear, and from the correlations, it seems like household wealth is the strongest predictor of infant survival. We remain unclear regarding the mechanisms behind the drop in infant mortality. We found that the mine affects (1) household income, woman's income, and healthcare access, which may be predictive of less infant mortality, but (2) by affecting women's wages, the opportunity cost of child care may have increased which may have had negative effects on infant survival. We estimate the composite effect of the mine on infant mortality, and we find stark evidence that the the mortality rate decreases, meaning that we know that the first set of effects dominate the second set, although we cannot say which ones of these matter, and how much.

Age at First Marriage, Education, Prostitution and Fertility

In this section I will further analyze variables that may have changed with the mine, and could drive the outcomes in the main analysis. The opening of a mine could change (1) marriage patterns (by for example increasing the availability of men through male migration), (2) schooling decisions, (3) sexual habits and engagement in sexual services, and (4) fertility patterns. Any such changes could drive the results in the main analysis, why we will continue by exploring mines' effects on these variables. A major caveat to this analysis is that all these outcomes could in fact change in parallel with the changes in labor markets and empowerment that we have already estimated. If we estimate changes in these variables, it will be hard to disentangle the causality between them, in fact, the processes could even be reinforcing.

Age at marriage is an important determinant of women's welfare and labor market participation, and especially womne's bargaining power within the household and exposure to domestic violence. There are reasons why we think a mine could change marriage patterns, for example, a mine could increase the number of available men looking for matrimony through spurring inward migration movements. If so, the mine could have a direct effect on marriage markets and women's matrimonial decisions. To investigate if changed matrimonial behavior, especially focusing on age at first marriage, can be part of the mechanism behind the gains in empowerment and infant survival that we find, we check if a mine affects age at first marriage and marriage rates. We do not find that women were significantly older at first marriage in mining communities, if there was an active mine in the community before she turned 14, 19 or ever in her life (see Table 8, Panel A). Women in active mining communities were 0.085 − 0.249 years older at first marriage (insignificant). Neither can we find any significant changes in marital status (ever married, currently married or cohabiting, or ever divorced) in mining communities (Appendix Table 18 Panel A). It does not seem likely that changing marital patterns are part of the mechanisms behind the estimated mine impacts on female empowerment.

Another potential mechanism is higher levels of education. A mine can have direct impacts on schooling, since it may affect both the demand and the supply of schooling. A mining company can decide to build a school within a corporate social responsibility program, which could increase local schooling attainment, and in the longer run spur non-farm employment and female empowerment. In addition, a mine could increase schooling supply through indirectly spurring an urbanization movement. Demand for schooling could change in parallel with the labor market changes, as returns to investment on schooling may change. However, we find little support for these hypotheses. Columns 1-3 in Panel B, Table 8 shows that women who were less than 14 years old at the time of mine opening do have slightly higher education (0.224 years), although insignificant, whereas for women under the age of 19 at mine opening (Column 2) have insignificantly lower education than peers further away. We can rule out that higher educational levels, made possible through mine-related investment in local schooling, are what is driving the comparatively large increase in service sector employment and the strong changes in norms regarding female empowerment. It is possible that we find only moderate, insignificant effects on schooling, because it takes time to change the schooling norms and that educational infrastructure is lacking in the short-run, which prohibits the expansion. The data does not permit analysis of long run changes in equilibrium in schooling attainment (which could of course be an outcome of the labor market changes observed).

The mining sector's traditional use of male labor has made it associated with social concerns regarding sexual services. Narratives from artisanal mining communities show that women seeking job opportunities are at risk of sexual violence (Werthmann, 2009) and that gold mining communities in Tanzania have high HIV incidence (Desmond et al., 2005). On the other hand, a study from Zambia shows that sexual risk taking behavior among young women decreased in mining communities with the copper boom (Wilson, 2012). The result from Zambia is in line with findings that women supply sex and, especially, risky sex to cope with negative economic shocks (Dupas and Robinson 2012; Robinson and Yeh, 2012). Looking at lifetime number of partners of all women, and separately for women who were below the age of 14 or 19 when the mine opened, we see no increase in the lifetime number of partners (Table 8, Panel C). This means that we can rule out the hypothesis that the service sector jobs that are created are in fact concentrated to work in prostitution. The effects are negative for the girls that were very young when the mines opened (Column 1) but positive for older women, however, no effects are precisely estimated.

It is possible that a mine establishment will change women's fertility patterns, so that the composition of children born changes. Any such changes to the pool of children born could affect infant mortality rates. Changes in fertility could also affect labor market outcomes, since pregnancies and young children can decrease labor force participation. A mine can thus change fertility patterns through changing the opportunity cost of having children (by increases income foregone), or through providing better access to family planning through increasing access to health care. Additionally, potential pollution from mining could lead to increased risk of spontaneous abortions. There is no clear indication of this from the medical literature, but both arsenic and cyanide are lethal at high doses and infants are due to size effects more sensitive than their carrying mothers. We observe a marginally significant decrease in total fertility according to Appendix Table 18 Panel B Column 1, and lower ideal fertility (Column 3). However, there are no significant changes in usage of contraception, and there is no indication that women in mining communities have suffered more miscarriages or that the sex ratio would be higher (as indicated by the probability that the child is male), so we do not think that changing fertility patterns due to better access to family planning or exposure to pollution are driving the changes in infant mortality. We cannot however exclude that the marginally significant change in total fertility behavior is affecting infant survival rates.

In this section we have learnt that while we can think of reasons why a mine would affect marriage behavior, education, engagement in prostitution as well as fertility behavior, we cannot find evidence pointing toward changes in these being the drivers behind our main results.

5.3 Sensitivity Analysis and Heterogeneous Effects

In this section we will explore heterogeneous effects due to intensity of mining, first by using a count variable of the number of active mines, second by using the world gold price to predict mine opening or higher production volumes. Then follows a general sensitivity analysis, where we explore different specifications such as control variables, fixed effects, time trends, clustering. We continue to see if the effects are robust to different assumptions about spillover effects, and we do a simple difference in means method. Using a spatial randomization placebo tests, we test if the results are spurious due to mis-specification of the model. We use multinomial logit, discuss multiple inference problem, and lastly we explore if changes in pollution exposure due to rainfall affecting infant mortality.

Intensity of Mining

The baseline results allow us to understand the effects of at least one mine opening. We are interested in knowing how the effects differ with the number of mines, which I will refer to as 'intensity' of mining.

To measure intensity, I calculate the number of mines that are close to the community:

$$Y_{icdt} = \beta_0 + \beta_1 deposit_c + \beta_2 deposit \cdot active_{ct} + \beta_3 intensity_{ct} + \gamma_t + \alpha_d + \delta_{kt} + \varepsilon_{icdt} \quad (3)$$

Table 9 shows the results for regressions with an intensity variable. We find that if there are more active mines in the area, it does not further decrease participation in agriculture, but insignificantly increases service sector employment (column 2). However, the more active mines the less likely is a woman to be hindered to seek healthcare for self and the less likely she is to accept domestic violence. The treatment variable for active*deposit is not positive for domestic violence, but the coefficient is smaller than the coefficient for intensity. If there is one active mine, the treatment effect is thus (0.077 - 0.172*1), equivalent to a 10pp decrease in the violence index. The effect decreases for each additional mine. Note that only a small number of individuals have more than one active mine in the vicinity, the maximum number of mines observed within the threshold is three. Infant mortality decreases with 9.4 to 9.8pp with one mine. However, the intensity variable indicates that the effect for each additional partly offsets the initial decrease.

The World Price of Gold

We expect a mine to produce more when the price is high, and of course, the value per ton extracted will be higher when the price is higher. This can trickle down to the economy, for example, through increasing employment and higher wage rates. This means that we can use the world price of gold to understand how effects differ when production is stronger, or more profitable. Using the gold price for intensity of mining also provides an alternative to using the production volumes, which we want to avoid given different, non-consistent standards being used across companies, and sometimes missing data (InterraRMG, 2013).

Gold is a special commodity and in comparison to other minerals and metals, gold functions rather as a financial asset than a raw material used in the production of other commodities. As a financial asset, it is predominantly in the shape of pure gold or high-carat jewelry[15] and the gold supply on the market is perfectly elastic. This means that new production of gold will not have a large influence of the traded price of gold: new production is small compared to the total inventory of gold (Taurasi, 2014). It is thus safe to assume that the investment and production decisions of a single mine, or even a mining company or a mining country, is driven by the gold price rather than driving it. Figure 1 shows that the number of active mines in our study, as well as their estimated total production, increased almost in parallel with the gold price the last 20 years.

We saw in Figure 1 that the world price of gold increased rapidly during the time period, and because the gold price is strictly exogenous to local population characteristics we can use it to overcome concerns that the activity of a mine is driven by local changes. I use the gold price in two different strategies. First, by interacting the deposit variable with the annual gold price, we are basically predicting the mine opening year. The gold price is recorded annually, so I exclude the year fixed effects because of perfect collinearity. The simplest (and strictest) regression thus looks like:

$$Y_{icdt} = \beta_0 + \beta_1 deposit_c + \beta_2 deposit \cdot goldprice_{ct} + \beta_3 goldprice_t + \alpha_d + \delta_{kt} + \varepsilon_{icdt} \tag{4}$$

Second, we can consider a triple-difference-specification, where the gold price is interacted with the baseline specification in Equation (2). Assuming that a high gold price results in higher production volumes or higher wages, we can explore such changes by interacting out main variables with the price. In this specification, we are no longer predicting mine opening year but exploring the intensive margin of gold extraction. In this specification we have five variables of interest:

$$\begin{aligned} Y_{icdt} = \; & \beta_0 \\ & +\beta_1 deposit_c \\ & +\beta_2 deposit \cdot active_{ct} \\ & +\beta_4 deposit \cdot goldprice_{ct} \\ & +\beta_5 deposit \cdot active \cdot goldprice_{ct} \\ & +\beta_6 goldprice_t \\ & +\alpha_d + \delta_{kt} + \varepsilon_{icdt} \end{aligned} \tag{5}$$

The results for these two strategies are presented in Table 10 Panel A and B. Panel A shows that the treatment effects are largely insignificant when we interact the deposit with the gold price, however most of the directions of the variables are similar to the baseline results. This is expected, since we are letting the gold price predict mine activity (which it seems to do, but not as efficiently as

[15]Investment in gold can be motivated by inflation fears (Adrangi et al., 2003; Blose, 2010), and as a safe haven in times of economic and financial turmoil (Baur and Lucey, 2010; Baur and McDermott, 2010)

the actual mine status). In Panel B, we use the strategy outlined in Equation 5. A higher gold price causes less labor market participation (marginally significant), less agriculture, more service and sales employment (Column 3), less acceptance of domestic violence (Column 6), and less infant mortality (Column 8). These results are in line with the baseline results, which increases our confidence with the main strategy.[16]

Controls, Fixed Effects, Time Trend and Clustering

I do several further robustness checks to ensure that the results are robust and not sensitive to the model specification. Appendix Tables 13, 14 and 15 show the main 8 outcome variables across 11 different specifications. The first three columns show parsimonious specifications without controls (1), with just age and education controls (2), or with the baseline specification but without urban control. For comparison, the baseline results are reproduced in Column 4. Adding an urban control does not change the results much, except for access to healthcare in Table 14 which is only significantly estimated with the control, and for domestic violence and infant mortality the coefficients are slightly stronger without individual controls. Overall, the effects do not seem very sensitive to the inclusion and exclusion of individual level controls.

Moreover, we want to vary the fixed effects and clustering of data. Columns 5 use country fixed effects but not district fixed effects, which are added in Columns 6. Columns 7 add closest mine fixed effects, Columns 8 use the baseline specification but with district time trend instead of country-year fixed effects. Column 9 clusters on district level, instead of the DHS cluster level. Overall, this exercise shows that the regressions results are stable, both in magnitudes and significance levels. [17]

Spillover Effects

In the baseline estimation strategy, we did not include a dummy for active-but far away, since this one effectively is captured by the year fixed effects if the mine has no spillover effects beyond the mine location. Since some communities are close to mines and some are not close to mines, a dummy for active but far away (i.e. no deposit) is not very informative since it is uncertain what mine is the one to consider. We can however create a dummy capturing if there is any active mines within 100km from the community. The active*deposit variable now captures the additional effect of being very close to an active mine, beyond the effects of being within the vicinity (less than 100km) of a mine. Note, that we do not demand this dummy to always be zero. The specification looks like:

$$Y_{icdt} = \beta_0 + \beta_1 deposit_c + \beta_2 deposit \cdot active_{ct} + \beta_3 active_{ct} + \gamma_t + \alpha_d + \delta_{kt} + \varepsilon_{icdt} \qquad (6)$$

[16] These estimates are also run with the log of the gold price. Results available on demand.

[17] To explore if the effects are driven by certain countries, Table 20 shows the main analysis run on a country-specific sample. Where the full model has not been possible to estimate, the space is left blank. This may be because some questions are not collected in all countries, or because the sample size for a given question is too small to estimate the full model. The effects on service sector employment (Column 3) is positive is all countries except Senegal where it is negative and significant, and Tanzania where the effect is close to zero. All coefficients on accepts domestic violence are negative, but we loose power with the sample split. Infant mortality decreased in all countries where we could estimate the model with 6.3pp to 10.6pp.

Appendix Tables 13, 14 and 15, Columns 10, show the results using this difference-in-difference specification. Including the extra dummy does not change the original estimates (in Columns 4) more than marginally. However we note that the dummy is significant for some of the occupational and empowerment variables, however not for infant mortality. This indicates that there are economic spillovers that affect labor markets further away than our baseline distance, but that changes to infant mortality are only found close to active mines.

If we expect that there are spillovers, beyond the treatment distance, that affects our control group we will underestimate the treatment effects. In Appendix Table 19 Panel A the results are re-estimated with the control group limited to individuals living more than 30km away from the mine location. The estimated effects are generally slightly stronger, as expected, although the estimate for infant mortality for boys is now larger and marginally significant (Column 5). This specification could be part of the baseline specification, but since it increases researcher's degrees of freedom, it is kept as a robustness strategy. Additionally in Appendix Table 19 Panel B, I have dropped individuals surveyed or born 2 years before a mine opening. The reason for doing this is to not contaminate the control group with individuals affected by the mine investment phase, which is on average one to two years long. If we exclude such individuals, the effects remain similar to baseline, although sometimes a little stronger. Moreover, I ran the regressions including individuals sampled two years before and including a dummy so to allow for heterogeneous effects. The directionality of the dummy was the same as the main treatment effects in all cases (and opposite the effects of deposit) (results available upon demand). This indicates that the mine has effects on the local economy two years prior to mine opening, and that if we are interested in the total mine effect, we should include these years in the main estimated effects. Nevertheless, if we are interested in the production phase of the mine, the specification should be as the baseline specification.

Simple Difference

The main strategy is a difference-in-difference strategy. We want to double check our results with a simple difference estimation. Columns 11 in Tables 13, 14 and 15 show the simple difference between inactive mine area and active mine area. The estimates for the simple difference are similar to the difference in coefficients between our baseline estimates, active*deposit and deposit. In fact, when we consider the change in outcomes between the pre-mine and post-mine communities, rather than comparing to the untreated, the effects are generally larger. The treatment effect in the simple difference is 13.1pp increase in service sector employment, similar to the treatment effect estimated with the baseline method, 0.095+0.037 = 0.132, i.e. 13.2pp). This is expected, since we learn that the mining communities are, before the mine starts, less developed than further away. This level difference is not a threat to the main estimation strategy, since the difference-in-difference method allows for such differences as long as the areas are on similar trends, but it could change the interpretation since we are in fact interested in the change from pre-mine community to mine-community, which is then given by the difference of the coefficients ((active*deposit)-deposit).

Spatial Randomization Placebo Test

A randomization inference test can convince us that the main results are not spurious because of a mis-specified model. To ensure that the interpretation of the results is causal, I demonstrate using a spatial randomization placebo test that the exact location of the mine in needed to obtain the results. If the mine location if offset between 0 and 50km in any direction while the mine keeps its de facto opening year, the results attenuate toward zero. Figure 13 shows the distribution of treatment effects (active*deposit) when the mine location was randomized 600 times, and the red lines show the initial treatment effects (7.5 percentage points increase in the probability of a woman working in the service sector, and 0.4 decrease in stated number of acceptable reasons for a husband to hit his wife). The false data generated had the mine location offset by up to 50km, entailing that it in some cases will overlap with the true treatment area (defined to 15km), so we do not expect the distribution of point-estimates to be centered right at zero, but that it is closer to the baseline point-estimates. The exact p-values are presented in the figure (P = 0.04 and P = 0.12), showing that it is unlikely that the model specified in Equation 1 is driving the results.

Multinomial Logit

The occupational outcomes are using the DHS standard distinctions, but I have focused on three large groups: not working, working in agriculture and working in services and sales. The respondent will only belong to one category, which is the category identified as the main occupation in the last 12 months. As a robustness check, I run a multinomial logit since the individual sorts in to one of several occupational categories. To ensure that the choices sum to 1, I include 'Other', consisting of those smaller categories not included in the main analysis (skilled and unskilled manual labor, professional and clerical categories, making up in total roughly 10% of the labor force).

Table 16 presents the marginal effects. The effects have the same directionality as the baseline results, magnitudes are slightly bigger and all coefficients but 'not working' are significant at $\alpha = 0.01$. The coefficients for deposit show that the deposit is associated with higher levels of work participation, mostly in agriculture. Panel B shows that the likelihood of a woman earning cash or a combination of cash and in kind increases with a mine, whereas the likelihood of not being paid for work decreases.

Multiple Inference Hypothesis Testing

We have analyzed women's empowerment using three clusters of indicators: (1) attitudes toward domestic violence, (2) barriers to healthcare and (3) bargaining power within the household. As discussed earlier, I constructed the three indexes to avoid issues with multiple inference testing. All original variables with more than 27k respondents, which excludes 'final say over daily purchases' and 'final say over husband's salary' from the bargaining power index. These two indicators have 19,072 and 9,516 observations respectively. Limited overlap between the variables when these two indicators are included in the index prohibits any analysis of the data. The summary statistics are presented in Table 12, and the exact questions in Table 22.

For transparency, the results for all indicators are shown in Table 17, Panel A, B and C. The point-estimates in Panel A, exploring effects on bargaining power (final say), are insignificant and fairly small (from negative 2.2pp to positive 2.7pp). In Panel B, we find that women are less likely to accept domestic violence for all stated reasons except burning food, which is insignificant. Women are less likely to consider either distance, money or permission a barrier to seek healthcare for herself, although these are weakly significant or non-significant (Panel C).

We should be cautious in interpreting these results, as the risk of observing a significant result due to chance increases with the number of hypotheses tested. If $\alpha = 0.05$ and there are 5 outcomes (like Panel B), the risk of getting a significant result by chance is calculated by:

$$P(at\ least\ one\ significant) = \quad 1 - (1 - 0.05)^5 \approx 0.23$$

One solution to this issue if of course to use an index which was the preferred method (see Casey et al., 2012 for a longer discussion). An alternative solution is to use the Bonferroni corrected p-values on the original estimates. The Bonferroni correction redefines the significance cut-off level to $\alpha/n = 0.05/5 = 0.0025$, a more conservative level than before. The new significance levels are presented in Table 17, Panel A, B and C. Only two coefficients remain significant: if a husband can beat his wife if she refuses sex (Panel B, Column 2), and if she neglects the children (Column 4).[18] Given that the point-estimates for the independent regressions are mostly significant (with the exception of final say), and in the same direction as for the index regressions, we can feel quite confident that the results are not driven only by chance.

Rainfall

Gold mining can cause Acid Mine Drainage which is the process where heavy metals brought to the surface in the extraction process are set free as water washes off from tailings piles (Almås et al., 2009; Bitala et al., 2009). The geographic spread of pollutants from mines can increase with rainfall (Almås and Makono, 2012), and concentration of the same pollutants can increase in the dry seasons (Williams, 2001).

In Appendix Table 21, a rainfall indicator is interacted with the active mine dummy. The rainfall variable is constructed as country averages for the three pregnancy trimesters (trimester 1: month 1-3 from conception, trimester 2: month 4-6, trimester 3: month 7-9 of a pregnancy). Since time of conception is not known, the trimesters are constructed by counting back from the date of birth.

The rainfall data comes from University of Delaware, which provides reanalyzed grid cell data with monthly averages. The data has been processed to provide country-level population weighted time series of monthly averages.

I set out to test if the child health effects differ with levels of rainfall during pregnancy. Table 21 shows that the mine area dummy is positively associated with infant mortality, but that this initial characteristic is offset if the mine is actively producing in the birth year. The interaction effects between rainfall in levels and the presence of an active mine are insignificant in all birth trimesters.

[18] Another way of dealing with the same issue is to use principal component analysis. For each of the three sets of clusters I create a principal component score, and use the score as the dependent outcome. The results are presented in Table 14 Panel A, B and C. The results have the same direction as the baseline but with bigger coefficients.

Further analysis, using more detailed data, ought to be done before we conclude that there are no heterogeneous effects on infant mortality with exposure to pollution from mining.

6 Conclusions

The large-scale gold mining industry is rapidly expanding in Africa. This is happening while policy makers have little understanding how large-scale mining operations affect local communities. In this analysis, I have tried to fill the gaps of knowledge regarding women's welfare in the wake of the mining boom. The analysis contributes to the understanding of a more general question: if local industrial shocks can empower women.

I show using micro data from eight African countries, that the gold mining industry brings indirect employment for women by stimulating the demand for services. In mining communities, women are more likely to work in services and sales, in contrast to control communities, where women are more likely to engage in agriculture. Additional welfare increases are noted: women in mining communities are 23% less likely to state a barrier to healthcare and are 24% less likely to accept domestic violence. Infant mortality more than halves and the drop is larger for girls than for boys. We observe stronger effects when the price of gold is high, which can be explained by a high price leading to higher production volumes and/or higher wages to miners, and more trickle down of economic effects into mining communities. If the community is close to more mines, the effects are stronger. These main results are robust to different assumptions about trends, different distance measures, exclusion of migrants, and withstand a spatial randomization placebo test. I rule out that the expansion in service sector employment and female empowerment was through increased engagement in sexual services, increased schooling attainment or changes in marriage formation. I find some indication that gains in household welfare could be an important factor in determining child survival, and that urbanization is a likely channel through which the effects of the mine are reinforced.

RCTs that aim at increasing labor participation rates of (young) women find magnitudes of 6.1pp increase in employment (Attanasio et al., 2012, at the cost of 812 USD/person), 6.8pp (72% increase) among teenage women (Bandiera et al., 2014, at the cost of 85 USD per participating young woman, or 17.9 USD per young woman in the intention-to-treat group), or 2.4pp increase women working away from home (11%, at the cost of 12 dollars per woman, Jensen, 2012)[19]. These studies do, however, not discuss the implicit shift from other type of activities that enabled the increase time spent on income-generating activities. Women who were previously not working, might have engaged in household chores and seasonal, subsistence farming, that would not be classified as "work away from home" or "income generating activities". If so, our estimates of a 9pp to 11.5pp increase in service and sales employment are large compared to the literature, and similar to effects from a rural electrification program in South Africa, where participation increased with 9pp (Dinkelman, 2011). The implication is that large-scale mines are effective in stimulating female labor force participation

[19]The rate of return on all these interventions were positive.

in non-farm employment.

Using the Ghana Living Standards Measurement Survey, I look at the worth of a service sector job for a woman. Women in Ghana working in services and sales have a mean daily wage rate roughly 80% higher than women working in agriculture (with at least any cash earnings, note that this excludes women in agriculture who only earn in kind or nothing at all). Correcting for service sector women's longer work day (7.5h compared with 4.7h in agriculture), there is still a substantial wage gap between agricultural and service sector workers: women in services earn on average 12.3% more. The wage gap is indicative of productivity differences across sectors. Empirical analysis has confirmed this pattern in Africa, with too many workers stuck in low-productivity agriculture (Gollin et al., 2013). By stimulating modern sector employment, large scale mining can thus help decrease the sectoral productivity gap by pulling women from low-productivity agriculture to higher paying service sector jobs.

The estimated gains from mining stretch beyond the labor markets. One pressing issue globally is intimate partner violence. In 2010, it was estimated that 30% of women worldwide had experiences of intimate partner violence (Devries et al. 2013), and prevalence is among the highest in Sub-Saharan Africa. Its global costs are estimated to 5.18% of World GDP (Fearon and Hoeffler, 2014), and sexual violence against women costs an additional 0.078% of World GDP annually. This is through direct health costs, losses to current and future income and psychological costs for women and children, and so on. In this paper, I estimate that women's acceptance rate of violence decreases, from a almost shockingly high mean (almost 1 in 2 women think violence is justified), with 24%. Attitudes toward domestic violence may only be weakly correlated with actual violence. However, changes in attitudes are necessary for long run transitions to lower equilibrium levels of experienced violence. That women do not accepting violence is a first step toward a violence free society. If a 24% reduction in acceptance of domestic violence leads to anything from a 1% to a 24% decrease in the prevalence of violence, the economic gains may be huge. To quantify the monetary gains from such a potential decrease in violence is beyond the scope of this study.

Despite concerns that revenues from mining are unevenly distributed, between the mining companies and the local communities, as well as between men and women, the analysis confirms that mining can change women's and infants' welfare. The analysis is not a complete welfare analysis of women's conditions in mining communities, but the largest, most ambitious, quantitative attempt until present day. I welcome further analysis in the future using a richer set of outcomes. The main counterfactual in this study is 'no mine', and I estimate the average impact of a large gold mine. Policy makers may want to think of another counterfactual, where policies are in place to stimulate local communities' economies, and to ensure that women benefit from the mining activities. The next step should be to evaluate policies to understand how such positive effects can be reinforced and what best-practice really is.

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Tables and Figures

Figure 1: Time: The evolution of the production of gold production in the study countries in million tonnes of gold ore and the demographic and health survey sample years by study country

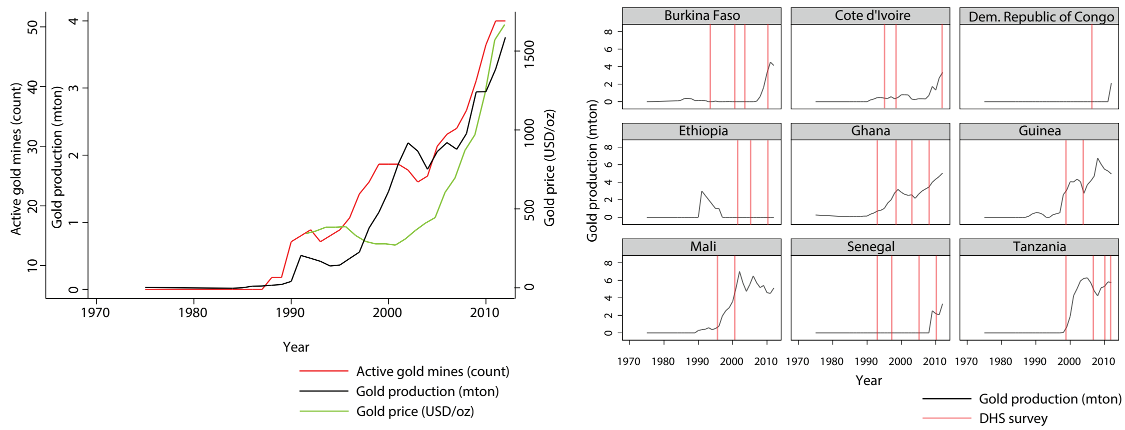


Figure 2: Geography: Map of gold mines in the study countries and illustration of geographic dispersion of DHS clusters in North-Western Tanzania

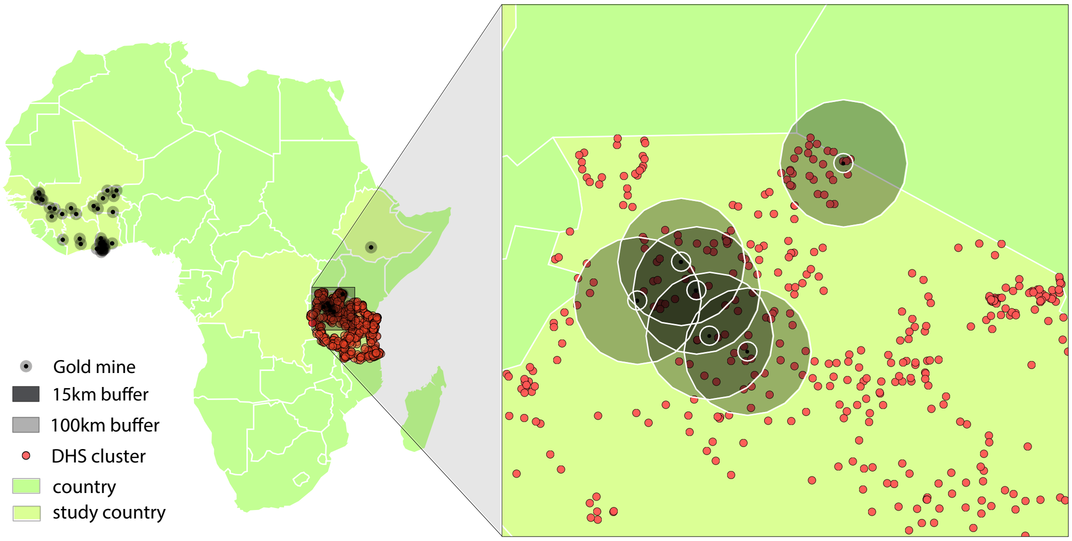


Figure 3: The geography of a mine: the Geita Gold Mine and the Lake Victoria basin

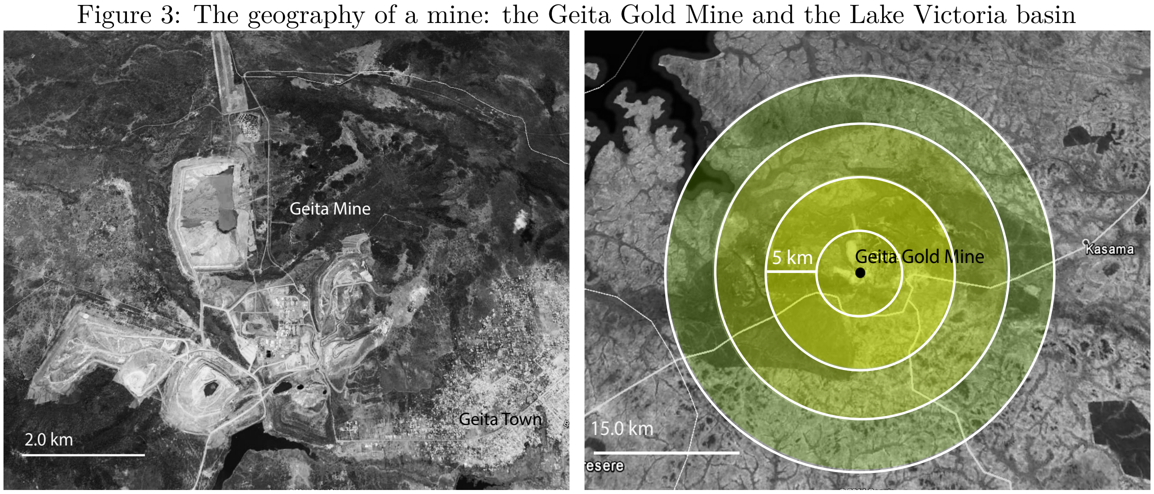
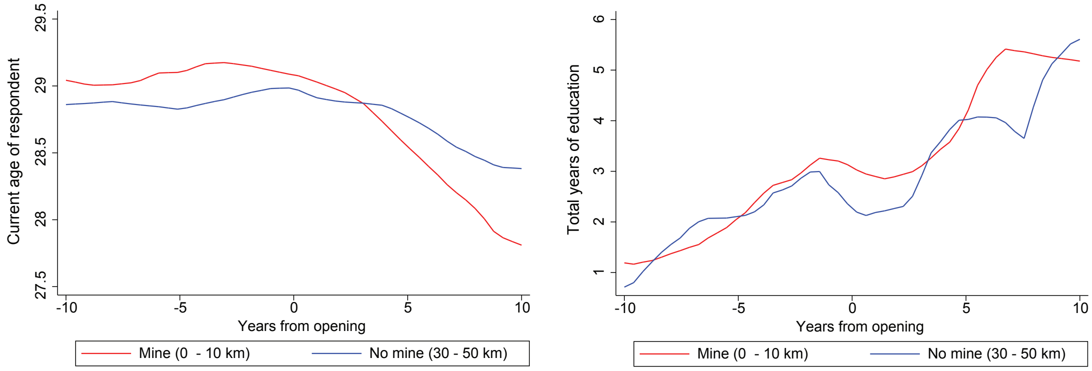


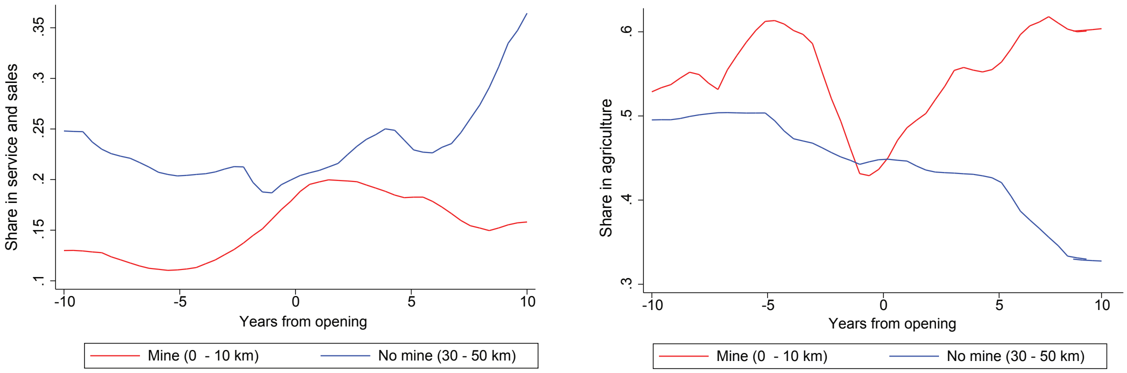
Figure 4: Trends in Observable Characteristics



a. Current Age of Respondent

b. Total Years of Education

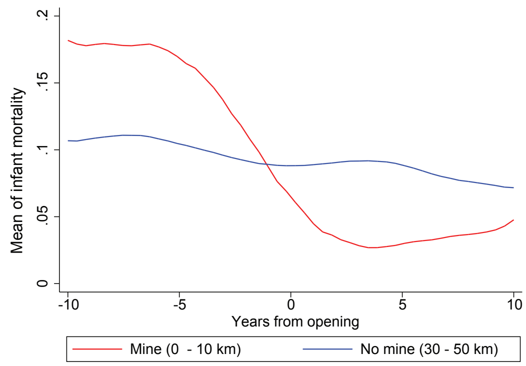
Figure 5: Trends in Occupational Outcomes



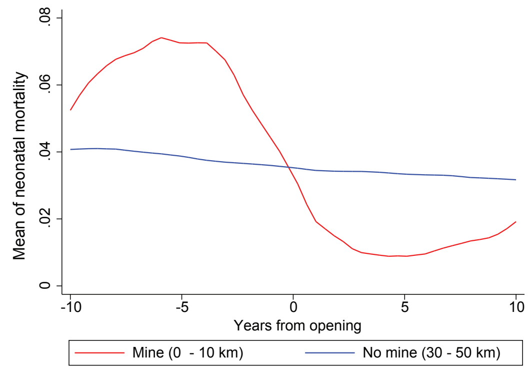
a. Service and Sales Employment

b. Agricultural Employment

Figure 6: Trends in Infant Mortality

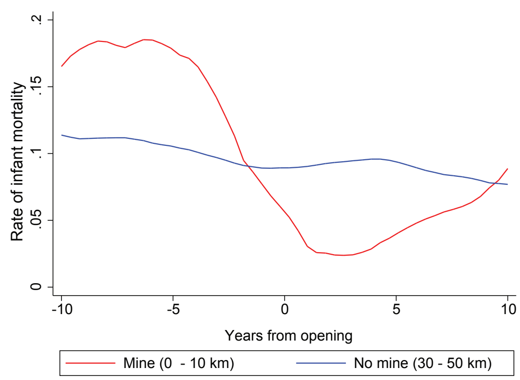


a. Infant Mortality (first 12 months)

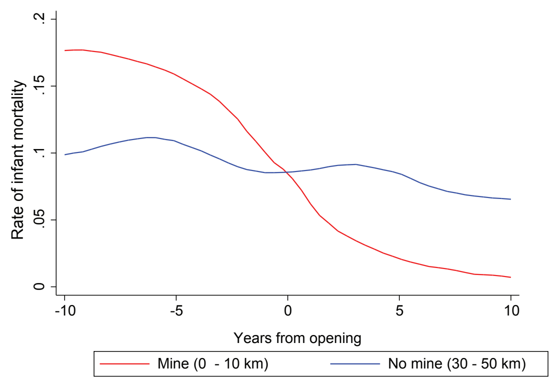


b. Neonatal Mortality (first 1 month)

Figure 7: Trends in Infant Mortality for Boys and Girls

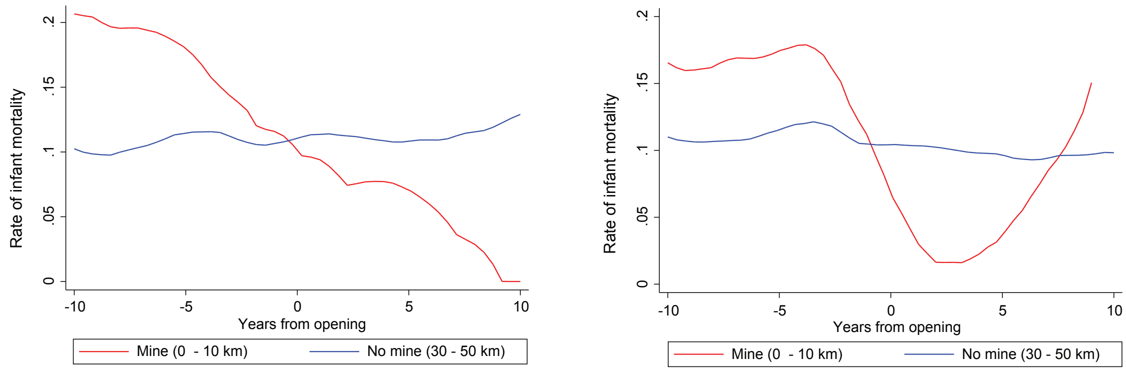


a. Infant Mortality (first 12 months) for boys



b. Infant Mortality (first 12 months) for girls

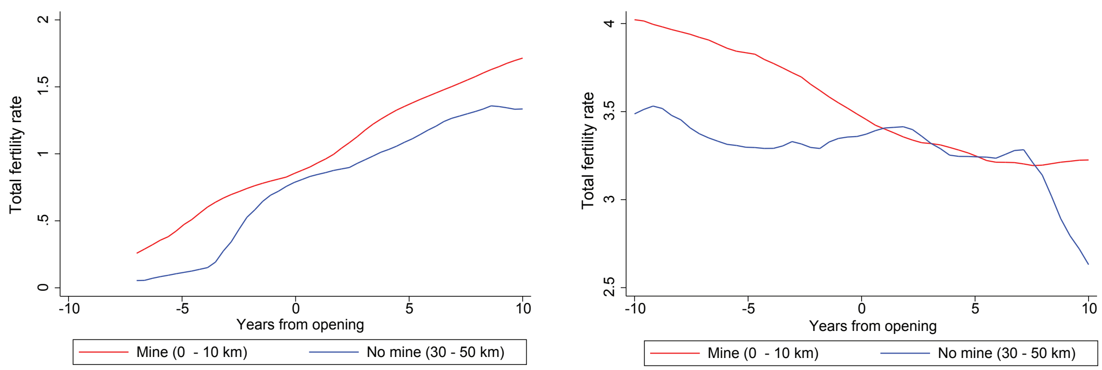
Figure 8: Trends in Infant Mortality for Children born to Never-Movers and Migrants



a. Infant Mortality (first 12 months) never-movers

b. Infant Mortality (first 12 months) migrants

Figure 9: Trends in Fertility



a. Total Fertility Rate among Women below 22 Years at Mine Opening

b. Total Fertility Rate among All Women

Figure 10: Spatial Lag Model: Main outcomes

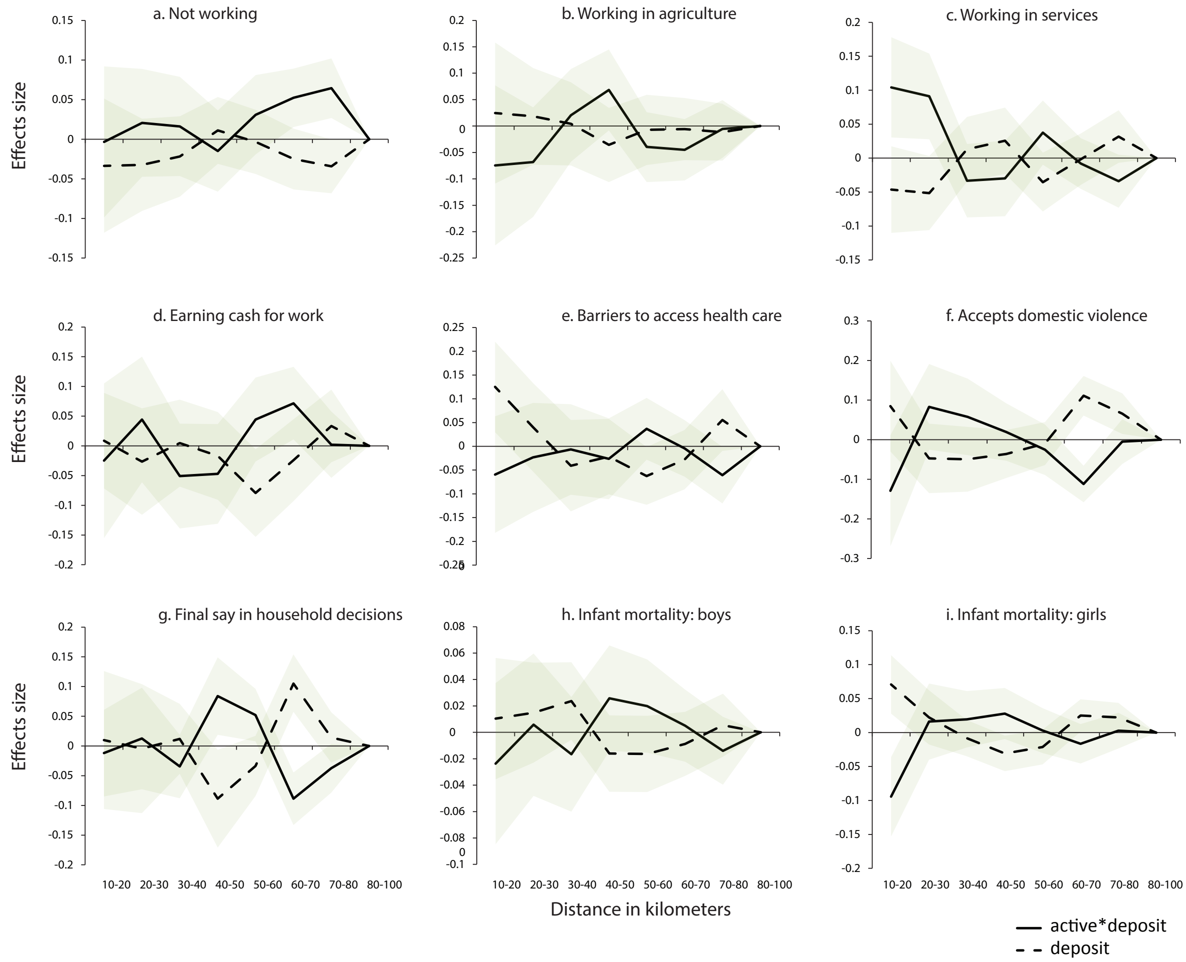
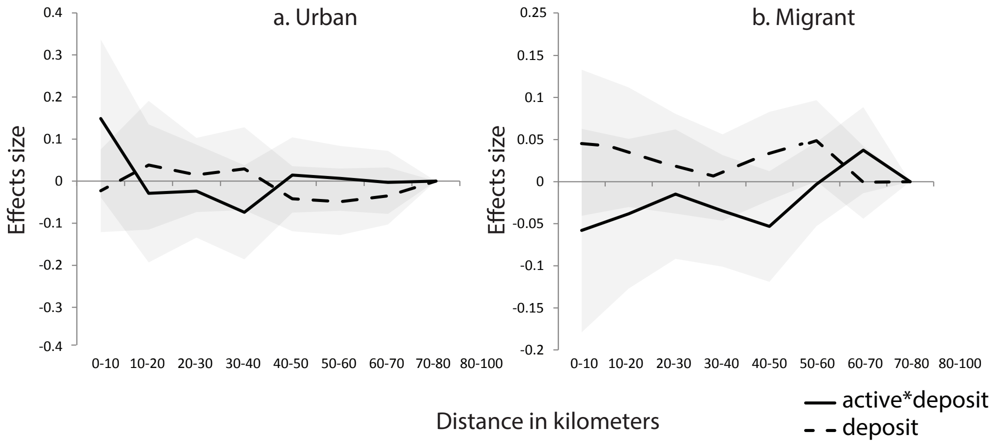


Figure 11: Spatial lag model: Urbanization and Migration



Regression results from two spatial lag models using 10km bins for the outcomes urban (Figure a) and migrant (Figure b), with 95% confidence intervals.

Figure 12: Marginal Effects from Multinomial Logit

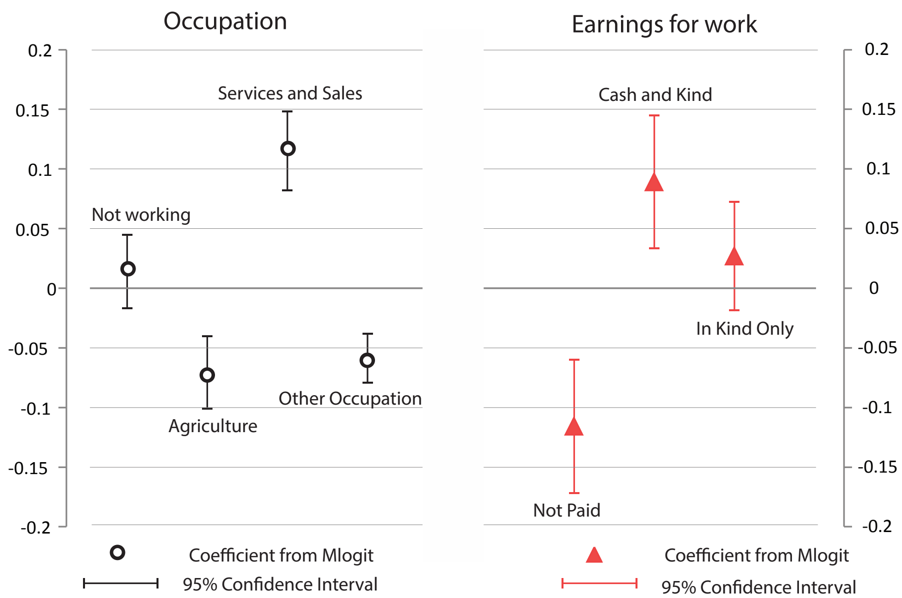


Figure 12 shows marginal effects calculated from two multinomial logit regressions. The first regression is sector of occupation, and the second regression earnings for work. Both regressions are using the baseline specification with 15km distance dummy. The specification includes controls for urban, education, age, district fixed effects and year fixed effects. The Appendix Table 16 presents the main coefficients.

Figure 13: Spatial Randomization Placebo Test

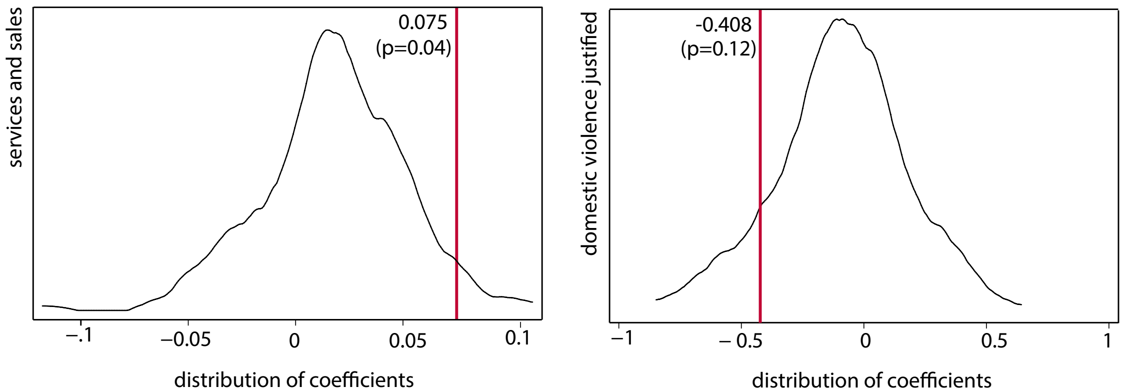


Figure 13 shows the desnity distribution of point-estimates from 600 re-estimations of the baseline specification with the mine location randomly moved up to 50km from original mine location. The likelihood of a woman working in the service sector (baseline specification), and the likelihood of a woman accepting domestic violence (count), with the baseline coefficients marked by the red vertical line.

Table 1: Summary Statistics for the Women Sample

	(1)	(2)	(3)	(4)	(5)	(6)
	Mean value					
Sample	whole sample	control group	pre-treatment	post-treatment	Min	Max
Woman characteristics						
age	28.7	28.7	28.9	28.4	15	49
education	2.95	2.90	2.96	4.55	0	22
fertility	3.26	3.26	3.65*	3.05	0	21
never mover	0.407	0.409	0.364*	0.365	0	1
urban	0.27	0.27	0.157*	0.214	0	1
Occupational outcomes						
not working	0.201	0.202	0.157*	0.171	0	1
agriculture	0.438	0.436	0.516*	0.449	0	1
service and sales	0.233	0.235	0.158*	0.228	0	1
earns cash	0.563	0.561	0.587	0.621	0	1
Empowerment indexes						
barriers to access care	0.393	0.394	0.388	0.327	0	1
accepts domestic violence	0.404	0.406	0.501*	0.298	0	1
bargaining power	0.318	0.314	0.357*	0.414	0	1
Treatment variables						
active * deposit (15km)	0.026				0	1
deposit (15km)	0.047				0	1
active (100km)	0.559				0	1
gold price (USD/oz)	599.2				270.98	1570.62
N	57,676	54,990	1,052	1,634		

Note: control group is within 10-100km from a deposit;
pre-treatment group has deposit = 1, but active*deposit = 0;
post-treatment group has deposit = 1, and active*deposit = 1
* $p<0.05$ for t-test between control group and pre-treatment group

Table 2: Summary Statistics for the Child Sample

	(1)	(2)	(3)	(4)	(5)	(6)
	Mean value				Min	Max
Sample	whole sample	control group	pre-treatment	post-treatment		
Mother characteristics						
age	29.17	29.17	28.65	28.56	15	49
education	1.88	1.857	1.876	4.48	0	21
urban	0.187	0.188	0.044*	0.221	0	1
Child characteristics						
male	0.506	0.506	0.512	0.552	0	1
birth number	3.97	3.973	4.312*	3.719	0	17
birth year of child	2000	2001	1996*	2003	1987	2012
Infant mortality						
1 month	0.038	0.038	0.066*	0.029	0	1
6 months	0.057	0.064	0.108*	0.038	0	1
12 months	0.097	0.01	0.151*	0.059	0	1
12 months boys	0.103	0.104	0.15*	0.073	0	1
12 months girls	0.093	0.095	0.154*	0.042	0	1
Treatment variables						
active * deposit (10km)	0.010				0	1
deposit (10km)	0.023				0	1
active (100km)	0.459				0	1
gold price (USD/oz)	536.2				271	1571
gold price* mine	0.118				0	15.71
gold price* active * deposit	0.069				0	15.71
rainfall (trimester)	0.01				0	2.11
N	48,151	47,021	574	556		

Note: control group is within 10-100km from a deposit;
pre-treatment group has deposit = 1, but active*deposit = 0;
post-treatment group has deposit = 1, and active*deposit = 1
* $p<0.05$ for t-test between control group and pre-treatment group

Table 3: Occupation, Empowerment and Infant Mortality

	(1)	(2)	(3)	(4)
	Occupational outcomes			
	not working	agriculture	service and sales	cash
Panel A.				
active*deposit	0.047	-0.072	0.095***	0.021
	(0.031)	(0.049)	(0.026)	(0.045)
deposit	-0.071**	0.021	-0.037	-0.018
	(0.032)	(0.047)	(0.022)	(0.036)
N	55,944	55,944	55,944	35,020
R^2	0.197	0.403	0.164	0.356
controls (age, education, urban)	Y	Y	Y	Y
FE year, country-year, district	Y	Y	Y	Y
mean outcome variable	0.201	0.438	0.233	0.563
	Empowerment indexes			
	barriers to access healthcare	accepts domestic violence	household bargaining power	
Panel B.				
active*deposit	-0.092**	-0.097**	0.009	
	(0.046)	(0.042)	(0.049)	
deposit	0.033	0.055	-0.023	
	(0.035)	(0.039)	(0.038)	
N	31,485	30,693	27,482	
R^2	0.240	0.344	0.286	
controls (age, education, urban)	Y	Y	Y	
FE year, country-year, district	Y	Y	Y	
mean outcome variable	0.393	0.406	0.318	
	Infant mortality (died within 12 months)			
months	12	12	12	
sample	all children	boys	girls	
Panel C.				
active*deposit	-0.009	0.016	-0.034	
	(0.018)	(0.025)	(0.023)	
deposit	0.025*	0.008	0.041**	
	(0.014)	(0.018)	(0.018)	
N	38,269	18,982	18,383	
R^2	0.031	0.042	0.044	
mother, child controls	Y	Y	Y	
FE birth month, year	Y	Y	Y	
FE country-year, district	Y	Y	Y	
mean outcome variable	0.097	0.103	0.093	

Note: *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level. Panel A and B include controls for age, education, urban, and fixed effects for survey year, district and country-year. Panel A shows results for binary occupational outcomes, (1) if the woman is working (in the last 12 months), (2) if she works in agriculture, (3) services or sales, (4) if she earns cash income for her work (not in kind or nothing). Panel B shows results for empowerment index variables ranging from 0 to 1. Column (1) “is money/distance/permission a hinder to seek healthcare for self?, Column (2): “is a husband justified to beat his wife if she burns the food/refuses sex/goes out without his permission/neglects the children. Column (3) “Do you have, alone or together with your partner, say in healthcare/large purchases/family visits decisions”. Active*deposit takes a value of 1 if there is an actively producing mine within 15km from the household locality in the survey year. Panel C: All regressions control for mother’s age, age square, mother’s education, urban location, child’s birth order and fixed effects for birth year, birth month, district, and country-year. Active*deposit takes a value of 1 if there is an actively producing mine within 15km from the household locality in the birth year.

Table 4: OLS results for Neonatal Mortality and Infant Mortality at 10km

	(1)	(2)	(3)	(4)	(4)
			infant mortality		
months	1	6	12	12	12
sample	all	all	all	male	female
distance	10km	10km	10km	10km	10km
active*deposit	-0.031***	-0.056***	-0.061***	-0.042	-0.076***
	(0.011)	(0.015)	(0.020)	(0.028)	(0.026)
deposit	0.024**	0.037***	0.039**	0.024	0.056***
	(0.009)	(0.012)	(0.015)	(0.021)	(0.021)
N	48,107	43,003	37,365	18,982	18,383
R^2	0.018	0.027	0.035	0.047	0.049
birth order	Y	Y	Y	Y	Y
mother age	Y	Y	Y	Y	Y
age square	Y	Y	Y	Y	Y
Mean value	0.038	0.057	0.097	0.103	0.093

Note: *** p<0.01, ** p<0.05, * p<0.1 Clustered standard errors clustered at DHS cluster level. All regressions control for mother's age, age square, mother's education, urban, child's birth number, and fixed effects for birth year, birth month, district, country-year. Outcomes are infant mortality in first month of life (column 1), first 6 months (column 2), and first 12 months (Column 3), all with 10km treatment distance.

Table 5: Never Movers and Migrants

	(1) agri- culture	(2) service sales	(3) earns cash	(4) barriers to healthcare	(5) accepts violence	(6) bargaining power	(7) infant mortality
Panel A. Never Movers							
active*deposit	-0.031	0.099**	0.052	-0.076	-0.124*	-0.006	-0.020
	(0.061)	(0.047)	(0.069)	(0.067)	(0.067)	(0.056)	(0.051)
deposit	0.003	-0.010	-0.020	-0.049	0.034	0.036	0.024
	(0.051)	(0.029)	(0.056)	(0.053)	(0.046)	(0.043)	(0.036)
N	16,288	16,288	10,685	8,801	8,523	8,064	9,366
R^2	0.392	0.167	0.346	0.234	0.359	0.361	0.057
Panel B. Migrants							
active*deposit	-0.100*	0.160***	0.161***	-0.133**	-0.101	0.003	-0.066**
	(0.055)	(0.044)	(0.047)	(0.066)	(0.064)	(0.053)	(0.031)
deposit	0.027	-0.044	-0.074*	0.063	0.038	0.004	0.053***
	(0.046)	(0.027)	(0.040)	(0.039)	(0.039)	(0.038)	(0.020)
N	24,178	24,178	15,685	11,732	11,340	10,851	15,505
R^2	0.441	0.171	0.414	0.216	0.397	0.372	0.053
controls	Y	Y	Y	Y	Y	Y	Y
survey year FE	Y	Y	Y	Y	Y	Y	
birth-year FE							Y
country-year	Y	Y	Y	Y	Y	Y	Y
district FE	Y	Y	Y	Y	Y	Y	Y

*** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level. All regressions Column 1-6 include controls for age, education, urban, and fixed effects for survey year, district and country-year. Column 6 controls for mother's age, age squared, mother's education, birth order, urban location, as well as fixed effects for birth year, birth month, country, district, and country-year. Panel A includes subset of sample that have never moved, Panel B only individuals who have ever moved. Please see Table 3 for more information.

Table 6: Service and Sales, Cash and Wealth as Mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	cash	barriers to	accepts	bargaining		mortality	
	earnings	healthcare	violence	power	kids	boys	girls
A. Services and sales							
active*deposit	-0.042	-0.089*	-0.101**	0.004	-0.066***	-0.044	-0.085***
	(0.041)	(0.046)	(0.042)	(0.049)	(0.020)	(0.028)	(0.027)
deposit	0.004	0.035	0.060	-0.025	0.042***	0.027	0.059***
	(0.034)	(0.035)	(0.038)	(0.038)	(0.016)	(0.021)	(0.022)
service and sales	0.366***	-0.029***	-0.014**	0.082***	0.009	-0.005	0.022
	(0.010)	(0.006)	(0.007)	(0.007)	(0.013)	(0.018)	(0.017)
N	34,587	31,076	30,294	27,264	36,320	18,475	17,845
B. Cash							
active*deposit		-0.062	-0.075**	0.006	-0.090***	-0.069*	-0.110***
		(0.047)	(0.037)	(0.055)	(0.028)	(0.039)	(0.036)
deposit		0.020	0.051	-0.025	0.066***	0.059*	0.074***
		(0.038)	(0.031)	(0.042)	(0.022)	(0.032)	(0.024)
earns cash		-0.035***	-0.017**	0.110***	0.002	0.008	-0.005
		(0.007)	(0.008)	(0.009)	(0.005)	(0.007)	(0.007)
N		25,591	24,867	23,001	25,074	12,742	12,332
C. Household wealth							
active*deposit		-0.043	-0.085**	-0.015	-0.050**	-0.057	-0.039
		(0.048)	(0.040)	(0.067)	(0.024)	(0.040)	(0.038)
deposit		0.017	0.068*	-0.000	0.031	0.032	0.030
		(0.042)	(0.041)	(0.057)	(0.020)	(0.035)	(0.036)
wealth		-0.026***	-0.011***	0.005*	-0.003*	-0.004	-0.003
		(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
N		28,987	27,955	25,005	23,982	11,942	11,523
controls	Y	Y	Y	Y	Y	Y	Y
survey year FE	Y	Y	Y	Y			
birth year FE					Y	Y	Y
country-year	Y	Y	Y	Y	Y	Y	Y
district FE	Y	Y	Y	Y	Y	Y	Y

Note: *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level. All regressions Column 1-4 include controls for age, education, urban, and fixed effects for survey year, district and country-year. Columns 5-7 controls for mother's age, age-square, mother's education, birth order, urban location, as well as fixed effects for birth year, birth month, district, and country-year. Please see Table 3 for more information regarding the baseline specification.

Table 7: Occupation on intensive and extensive margin and wage rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	worked (12m)	worked (7d)	hours (7d)	agri-	service	miner	ln wage	ln hh
	12 m	7d	7d	culture	sales		rate	income
active*deposit	-0.096**	-0.078*	5.160	0.064	-0.053	0.036	-0.099	0.589**
	(0.048)	(0.044)	(3.509)	(0.087)	(0.042)	(0.075)	(0.216)	(0.246)
deposit	-0.001	-0.009	-5.956**	-0.092	-0.010	0.139**	0.090	-0.071
	(0.040)	(0.034)	(2.889)	(0.071)	(0.030)	(0.063)	(0.139)	(0.165)
active*deposit	0.052	0.061	-3.458	-0.054	0.115**	-0.035	0.836**	
*woman	(0.037)	(0.042)	(3.377)	(0.058)	(0.056)	(0.064)	(0.373)	
deposit	-0.009	-0.030	-1.567	0.069*	-0.037	-0.108**	-0.637**	
*woman	(0.032)	(0.036)	(2.632)	(0.039)	(0.041)	(0.050)	(0.267)	
woman	-0.027***	-0.052***	-4.033***	-0.092***	0.140***	-0.012***	-0.315***	
	(0.007)	(0.008)	(0.665)	(0.010)	(0.010)	(0.002)	(0.048)	
N	8,188	8,592	5,423	5,776	5,776	5,776	1,476	6,226
R^2	0.355	0.332	0.123	0.303	0.141	0.081	0.315	0.153
mean dep var	0.585	0.587	41.3	0.514	0.030	0.012	40,363	5,057k
controls	Y	Y	Y	Y	Y	Y	Y	Y
year FE	Y	Y	Y	Y	Y	Y	Y	Y
district FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at the village level. All regressions include controls for age, education, urban, and fixed effects for survey year and district. The outcome variable in Column 8 is annual household income from salaries and wages, and I additionally control for household size. The data is the Living Standards Measurement Survey for Ghana.

Table 8: Mechanisms: Age at marriage, education and sexual partners

	(1)	(2)	(3)
Sample			
Age at mine opening	below 14	below 19	all women
Panel A. Age at first marriage			
active*deposit	0.148	0.085	0.249
	(0.534)	(0.359)	(0.185)
Observations	5,942	10,660	46,009
R-squared	0.297	0.288	0.202
Panel B. Total years of schooling			
active*deposit	0.224	-0.168	0.129
	(0.716)	(0.406)	(0.178)
Observations	11,675	18,376	57,581
R-squared	0.484	0.478	0.474
Panel C. Total lifetime sexual partners			
active*deposit	-0.415	0.344	0.103
	(0.354)	(0.323)	(0.305)
Observations	4,722	7,844	19,120
R-squared	0.112	0.092	0.119
controls	Y	Y	Y
survey year FE	Y	Y	Y
country-year	Y	Y	Y
district FE	Y	Y	Y

Note: *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level. All regressions include controls for age, urban, and fixed effects for survey year, district and country-year. Panel A and Panel C control for years of education.

Table 9: Intensity of mining

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	agri-	service	barriers to	accepts	bargaining		mortality	
	culture	sales	healthcare	violence	power	kids	boys	girls
active*deposit	-0.071	0.046	-0.015	0.077	-0.028	-0.097***	-0.098***	-0.094***
	(0.086)	(0.059)	(0.068)	(0.107)	(0.070)	(0.025)	(0.034)	(0.035)
deposit	0.021	-0.036	0.033	0.056	-0.023	0.042***	0.028	0.057***
	(0.047)	(0.022)	(0.035)	(0.038)	(0.038)	(0.016)	(0.021)	(0.021)
intensity	-0.001	0.047	-0.076*	-0.172*	0.037	0.032**	0.051**	0.013
	(0.068)	(0.050)	(0.044)	(0.097)	(0.045)	(0.014)	(0.021)	(0.021)
N	55,944	55,944	31,485	30,693	27,482	37,365	18,982	18,383
controls	Y	Y	Y	Y	Y	Y	Y	Y
survey year FE	Y	Y	Y	Y	Y			
birth year FE						Y	Y	Y
country-year	Y	Y	Y	Y	Y	Y	Y	Y
district FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level. All regressions Column 1-5 include controls for age, education, urban, and fixed effects for survey year, district and country-year. Column 6-8 controls for mother's age, age squared, mother's education, deposit, urban location, as well as fixed effects for birth year, birth month, district, country-year. Intensity is a count variable indicating how many mines are found close by. Please see Table 3 for more information regarding the baseline specification.

Table 10: Using World Price of Gold to Estimate Effects on Occupation, Empowerment and Infant Mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		occupation		earns	barriers to	accepts	bargaining	infant
	no work	agric.	services	cash	healthcare	violence	power	mortality
Panel A. Goldprice I								
goldprice*	-0.003	-0.001	0.003	-0.001	-0.003	-0.008**	0.002	0.001
deposit	(0.002)	(0.004)	(0.002)	(0.004)	(0.003)	(0.004)	(0.003)	(0.002)
Panel B. Goldprice II								
goldprice*	0.015*	-0.025**	0.016***	-0.001	-0.005	-0.044***	0.013	-0.016***
active*deposit	(0.008)	(0.012)	(0.006)	(0.012)	(0.008)	(0.010)	(0.012)	(0.004)
goldprice*	-0.017**	0.022*	-0.011**	-0.001	0.002	0.036***	-0.011	0.013***
deposit	(0.008)	(0.011)	(0.006)	(0.012)	(0.008)	(0.010)	(0.011)	(0.004)
means								
dep var	0.201	0.438	0.233	0.563	0.394	0.404	0.318	0.097
price*deposit	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.118
price*active	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.069
controls	Y	Y	Y	Y	Y	Y	Y	Y
birth month FE								Y
country-year	Y	Y	Y	Y	Y	Y	Y	Y
district FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level. All women's regressions (Column 1-7) include controls for age, education, urban, and fixed effects for district and country, country-year. Column 8 controls for mother's age, age-squared, birth order, mother's education, urban, and fixed effects for birth month, district, country-year. Annual gold price comes from Raw Minerals Group and is available from 1992 to 2011. Panel A predicts gold mine with the annual gold price, Panel B interacts the gold price with the active mine dummy as well as mine location. Please see Table 3 for more information regarding the baseline specification.

A Appendix: Conceptual Framework

In this conceptual framework, I spell out the main determinants of child health and hypothesize how they might change with industrial mining. The model builds loosely on Rosenzweig and Schultz (1982). A primary care giver gets utility from the following function

$$U = U(X, Y, H) \tag{7}$$

where X is a vector of health neutral goods, Y is a vector of health related goods/behaviors and H is the health status of child.

The child health production function is

$$H = F(Y, Z, E, \mu) \tag{8}$$

where Z is health market inputs, such as healthcare, E is environmental quality and μ is the child's initial health endowment. The primary care giver maximizes (1), given (2), subject to a budget constraint

$$I = XP_x + YP_y + ZP_z \tag{9}$$

If only the main care giver invests in child health, we can think of I as the income that the care giver alone decides over. Let us assume two things: first, the primary care giver is the mother of the child. This correlates with the gendered structures of child rearing in Africa, but is, of course, not a universal truth. Second, I assume that income is not pooled, but that a share s is transferred from the husband to the woman for her to allocate freely on the areas of which she has the responsibility. We can think of this as a child care monetary transfer from husband to wife. The woman's disposable income is thus

$$I_{disp,w} = s(I_w + I_m) \tag{10}$$

where $0 < s < 1$. Where I_w= woman's income = $w_w L_w$, the wage rate for women on the labor market times the hours worked. The husband's income is defined as I_h= husband's income = $w_h L_h$, where the wage rate is the wage rate for men on the labor market. s = share of total household income woman decides over, and we assume s to be a function of income and relative income:

$$s = F(I_w, I_h, (I_w/I_h)) \tag{11}$$

That is s is determined by the absolute income of each partner, and the relative share. I assume that s increases with the husband's income from the absolute effects, but may decrease due to the relative change in income. We can assume that s is more elastic with respect to a woman's income, since the absolute and relative effects will move in the same direction. Starting from a low baseline bargaining power, this is not unrealistic. Suggestive evidence shows that labor hours increase with woman's income, since additional income increases the bargaining power she enjoys over earned income (Heath, 2014).

Table 11: Child Health

Positive	Negative
hh income effect ($I_w + I_h$)	opportunity cost time (P_y)
woman's income (I_w)	environment (E)
bargaining power (s)	
healthcare (P_z)	

The opening of a mine is an exogenous shock to the community. For now, let us assume that households cannot choose to move out of the mining community upon discovering the mine's entry. The mine changes local wages, by changing the female wage rate I_w and I_h but also the relative income (I_w/I_h). In addition, the price of healthcare access decreases because there is more CSR or public spending in the area. However, the impact of health is ambiguous since the opening of the mine may also change the environmental quality, E.

However, with the change in wages the opportunity cost of child rearing changes too. Let's define Y (health related goods/behavior) as time spent on child rearing. P_y increases as w_w increases, and the change in Y will depend on the relative income and substitution effect. Women's opportunity cost of child care has been suggested important in determining child health (Miller and Urdinola, 2010).

B Appendix: Tables and Figures

Figure 14: Infant Mortality in the First 12 Months

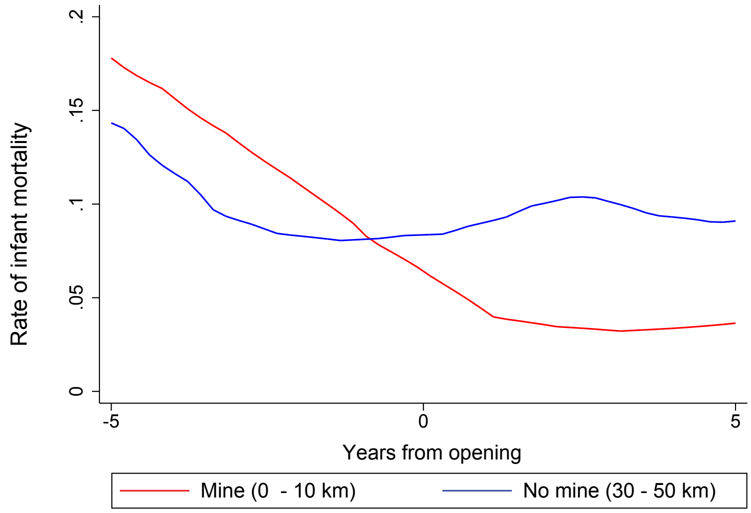


Table 12: Summary statistics: all physical empowerment outcomes

Variable		Mean	Std. Dev.
barriers to healthcare			
distance	... is a barrier to seek healthcare	0.910	0.285
money	... is a barrier to seek healthcare	0.922	0.268
permission	... is a barrier to seek healthcare	0.877	0.340
domestic violence	*husband has right to beat wife if she....*		
burns the food	... burns food	0.232	0.422
refuses sex	... refuses sex	0.369	0.482
argues	... argues with him	0.454	0.498
neglects children	... neglect the children	0.481	0.500
goes out	... goes out without permission	0.471	0.499
# reasons	average number of stated reasons	2.002	1.928
final say			
healthcare	has final say on healthcare	0.292	0.454
large purchase	has final say on large purchase	0.274	0.446
daily purchase	has final say on daily purchase	0.388	0.487
husband salary	has final say on spending husb. salary	0.171	0.377
family visits	has final say on family visits	0.406	0.491
food	has final say on food	0.543	0.498
N		57.685	

Table 16: Marginal Effects from Multinomial Logit

	(1)	(2)	(3)	(4)
	Not working	Agriculture	Service and Sales	Other
A. Occupation				
active * deposit (ME)	0.014	-0.070***	0.115***	-0.058***
	(0.016)	(0.016)	(0.017)	(0.011)
deposit (ME)	-0.046***	0.051***	-0.068***	0.013***
	(0.013)	(0.012)	(0.014)	(0.008)
B: Earnings				
	Not paid	Earns cash and kind	Only in kind	
active * deposit (ME)	-0.116***	0.089**	0.027	
	(0.029)	(0.029)	(0.023)	
deposit (ME)	0.100***	-0.06**	-0.041**	
	(0.023)	(0.024)	(0.019)	
controls	Y	Y	Y	Y
country FE	Y	Y	Y	Y
year FE	Y	Y	Y	Y
country*year FE	Y	Y	Y	Y

Average marginal effects (dy/dx) calculated after multinomial logit. Panel A has 56011 observations, Panel B 25835 observations. The multinomial logit controls for age, education and urban and fixed effects for country, year and country by year. Please see Figure 12.

Table 13: Alternative specifications: Occupation

	(1) nothing	(2) controls	(3) controls	(4) baseline	(5) FE	(6) FE	(7) FE	(8) trend	(9) clusster	(10) diff	(11) diff
A: Not working											
active * deposit	0.014	-0.006	0.046	0.047	0.016	0.047	0.045	0.064**	0.047	0.041	-0.008
	(0.032)	(0.030)	(0.031)	(0.031)	(0.030)	(0.031)	(0.031)	(0.032)	(0.032)	(0.031)	(0.032)
deposit	-0.046*	-0.045*	-0.068**	-0.071**	-0.044*	-0.071**	-0.066**	-0.082**	-0.071**	-0.067**	
	(0.026)	(0.023)	(0.032)	(0.032)	(0.025)	(0.032)	(0.032)	(0.032)	(0.031)	(0.032)	
active										0.042***	
										(0.012)	
B: Agriculture											
active * deposit	-0.068	-0.018	-0.067	-0.072	-0.072	-0.072	-0.071	-0.048	-0.072	-0.067	-0.092
	(0.067)	(0.064)	(0.057)	(0.049)	(0.047)	(0.049)	(0.050)	(0.052)	(0.057)	(0.049)	(0.060)
deposit	0.080	0.081*	0.007	0.021	0.043	0.021	0.007	0.007	0.021	0.018	
	(0.050)	(0.048)	(0.052)	(0.047)	(0.039)	(0.047)	(0.049)	(0.050)	(0.052)	(0.047)	
active										-0.034**	
										(0.017)	
C: Service and Sales											
active * deposit	0.071**	0.057*	0.092***	0.095***	0.115***	0.095***	0.087***	0.071***	0.095***	0.099***	0.131***
	(0.032)	(0.031)	(0.030)	(0.026)	(0.026)	(0.026)	(0.027)	(0.028)	(0.029)	(0.027)	(0.036)
deposit	-0.077***	-0.078***	-0.026	-0.037	-0.069***	-0.037	-0.033	-0.024	-0.037	-0.039*	
	(0.021)	(0.019)	(0.026)	(0.022)	(0.020)	(0.022)	(0.023)	(0.023)	(0.023)	(0.023)	
active										-0.025*	
										(0.013)	
D: Cash earnings											
active * deposit	0.034	-0.012	0.005	0.021	0.043	0.021	0.010	0.045	0.021	0.012	0.062
	(0.068)	(0.060)	(0.046)	(0.045)	(0.042)	(0.045)	(0.047)	(0.048)	(0.051)	(0.045)	(0.049)
deposit	0.026	0.016	-0.009	-0.018	-0.032	-0.018	-0.008	-0.025	-0.018	-0.013	
	(0.049)	(0.042)	(0.038)	(0.036)	(0.030)	(0.036)	(0.037)	(0.036)	(0.043)	(0.036)	
active										0.045**	
										(0.018)	
age, education		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
urban				yes	yes	yes	yes	yes	yes	yes	yes
year fe			yes	yes	yes	yes	yes	yes	yes	yes	yes
country fe					yes						
district fe			yes	yes		yes	yes	yes	yes	yes	yes
country * year fe			yes	yes			yes		yes	yes	yes
mine fe							yes				
district time trend								yes			
district clustering									yes		
diff-diff										yes	
simple diff											yes

*** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level, except for Column 9.

Table 14: Alternative specifications: Female empowerment

	(1) nothing	(2) controls	(3) controls	(4) baseline	(5) FE	(6) FE	(7) FE	(8) trend	(9) cluster	(10) diff-diff	(11) diff	(12) PCA
A: Justifies domestic violence												
active * deposit	-0.253***	-0.221***	-0.089**	-0.097**	-0.118**	-0.097**	-0.087**	-0.098*	-0.097*	-0.073*	-0.142***	-0.362**
	(0.086)	(0.068)	(0.043)	(0.042)	(0.047)	(0.042)	(0.044)	(0.051)	(0.052)	(0.043)	(0.049)	(0.158)
deposit	0.118	0.139**	0.050	0.055	0.039	0.055	0.058	0.045	0.055	0.039		0.204
	(0.074)	(0.056)	(0.040)	(0.039)	(0.038)	(0.039)	(0.041)	(0.044)	(0.038)	(0.038)		(0.143)
active										-0.086***		
										(0.020)		
B: Barriers to health care access												
active * deposit	-0.061	-0.041	-0.078	-0.092**	-0.052	-0.092**	-0.101**	-0.110**	-0.092*	-0.074*	-0.065	-0.340*
	(0.050)	(0.044)	(0.048)	(0.046)	(0.044)	(0.046)	(0.050)	(0.055)	(0.054)	(0.044)	(0.076)	(0.176)
deposit	-0.007	0.005	0.026	0.033	0.021	0.033	0.028	0.037	0.033	0.021		0.129
	(0.035)	(0.028)	(0.038)	(0.035)	(0.030)	(0.035)	(0.039)	(0.039)	(0.030)	(0.034)		(0.133)
active										-0.066**		
										(0.029)		
C: Bargaining power)												
active * deposit	0.057	0.035	0.005	0.009	-0.028	0.009	-0.000	-0.001	0.009	-0.002	-0.199*	0.031
	(0.073)	(0.061)	(0.049)	(0.049)	(0.050)	(0.049)	(0.053)	(0.044)	(0.069)	(0.049)	(0.106)	(0.182)
deposit	0.043	0.028	-0.021	-0.023	0.038	-0.023	-0.015	-0.030	-0.023	-0.016		-0.082
	(0.061)	(0.050)	(0.038)	(0.038)	(0.041)	(0.038)	(0.041)	(0.034)	(0.045)	(0.037)		(0.141)
active										0.035**		
										(0.015)		
age, education		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
urban				yes	yes	yes	yes	yes	yes	yes	yes	yes
year fe			yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
country fe					yes							
district fe			yes	yes		yes	yes	yes	yes	yes	yes	yes
country * year fe			yes	yes			yes		yes	yes	yes	yes
mine fe							yes					
district time trend								yes				
district clustering									yes			
diff-diff										yes		
simple diff											yes	

*** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level, except for Column 9.

Table 15: Alternative specifications: Infant mortality in the first 12 months

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	controls	control	control	baseline	FE	FE	FE	trend	cluster	diff	diff
A: All children											
active * deposit	-0.102***	-0.086***	-0.065***	-0.063***	-0.051***	-0.063***	-0.068***	-0.051**	-0.063***	-0.063***	-0.063
	(0.023)	(0.022)	(0.020)	(0.020)	(0.019)	(0.020)	(0.019)	(0.021)	(0.023)	(0.020)	(0.038)
deposit	0.051**	0.051***	0.042***	0.041***	0.037**	0.041***	0.041***	0.036**	0.041**	0.041***	
	(0.020)	(0.019)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.018)	(0.019)	(0.016)	
active										0.001	
										(0.005)	
N	37,402	37,387	37,365	37,365	37,387	37,365	37,365	37,365	37,365	37,365	876
R^2	0.001	0.005	0.033	0.033	0.019	0.033	0.034	0.044	0.033	0.033	0.155
B: Boys											
active * deposit	-0.085***	-0.071**	-0.046	-0.043	-0.035	-0.043	-0.049*	-0.032	-0.043	-0.044	-0.013
	(0.029)	(0.029)	(0.034)	(0.035)	(0.025)	(0.028)	(0.027)	(0.029)	(0.035)	(0.028)	(0.049)
deposit	0.044*	0.044**	0.028	0.027	0.028	0.027	0.028	0.021	0.027	0.027	
	(0.023)	(0.022)	(0.026)	(0.025)	(0.019)	(0.021)	(0.021)	(0.022)	(0.025)	(0.021)	
active										0.005	
										(0.007)	
N	19,007	18,995	18,982	18,982	18,995	18,982	18,982	18,982	18,982	18,982	472
R^2	0.000	0.005	0.042	0.042	0.019	0.042	0.044	0.054	0.042	0.042	0.211
C: Girls											
active * deposit	-0.124***	-0.105***	-0.081***	-0.080***	-0.072***	-0.080***	-0.082***	-0.071***	-0.080***	-0.080***	-0.132*
	(0.027)	(0.027)	(0.027)	(0.027)	(0.025)	(0.027)	(0.027)	(0.026)	(0.026)	(0.027)	(0.068)
deposit	0.059***	0.059***	0.057***	0.056***	0.046**	0.056***	0.054***	0.051**	0.056**	0.056***	
	(0.023)	(0.022)	(0.022)	(0.021)	(0.020)	(0.021)	(0.021)	(0.024)	(0.025)	(0.021)	
active										-0.001	
										(0.007)	
N	18,395	18,392	18,383	18,383	18,392	18,383	18,383	18,383	18,383	18,383	404
R^2	0.001	0.005	0.044	0.044	0.021	0.044	0.046	0.058	0.044	0.044	0.238
age, education		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
urban				yes	yes	yes	yes	yes	yes	yes	yes
birth year fe			yes	yes	yes	yes	yes	yes	yes	yes	yes
birth month fe			yes	yes	yes	yes	yes	yes	yes	yes	yes
country fe					yes						
district fe			yes	yes		yes	yes	yes	yes	yes	yes
country*year fe			yes	yes			yes		yes	yes	yes
mine fe							yes				
district trend								yes			
distr. cluster									yes		
diff-diff										yes	
simple diff											yes

*** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level, except for Column 9.

Table 17: Female Empowerment Estimated with Initial Variables and Bonferroni p-values

	(1)	(2)	(3)	(4)	(5)
Panel A	she has a final say on (how to spend on)...				
	healthcare	large purchase	daily purchase	family visit	husband wage
active*deposit	-0.003	0.008	0.027	0.017	-0.022
	(0.057)	(0.050)	(0.053)	(0.060)	(0.066)
p-value	0.960	0.870	0.610	0.773	0.740
(Bonferroni sign.)					
N	27,582	27,565	19,072	27,505	9,516
Panel B	a husband has the right to beat the woman if she...				
	burns food	refuses sex	argues	neglects kids	goes out
active*deposit	0.008	-0.123***	-0.099**	-0.110***	-0.083**
	(0.042)	(0.036)	(0.050)	(0.042)	(0.040)
p-value	0.841	0.001***	0.047	0.009**	0.038
(Bonferroni sign.)					
N	31,423	31,038	31,396	31,426	31,455
Panel C	is ... a barrier to seeking healthcare?				
	distance	money	permission		
active*deposit	-0.146*	-0.086*	-0.043		
	(0.079)	(0.050)	(0.047)		
p-value	0.065	0.084	0.353		
(Bonferroni sign.)					
N	31,485	31,488	31,486		
Bonferroni sign. (0.99)	for Panel A, B	0.002, ***	for Panel C	0.0033, ***	
Bonferroni sign. (0.95)	for Panel A, B	0.01, **	for Panel C	0.0016, **	
Bonferroni sign. (0.90)	for Panel A, B	0.02, *	for Panel C	0.033, *	

Note: *** p<0.01, ** p<0.05, * p<0.1, or corrected Bonferroni significance levels as stated above. Clustered standard errors at DHS cluster level. All regressions include controls for age, education, urban, and fixed effects for survey year, district, year and country-year fixed effects. Panel A shows results binary outcomes for 7 variables on final say in household decisions. Three of these, with sufficient sample size and overlapping surveying, were used in the household decision but here the whole set are presented. Panel B shows the results from using the outcome variables on domestic violence. The questions are the type: "is a husband justify to beat his wife if she burns the food/refuses sex/goes out without his permission/neglects the children. Panel C shows if the woman thinks that distance, money or getting permission are barriers to access healthcare for herself. The questions are "is money/distance/permission a hinder to seek healthcare for yourself?"

Table 19: Changing the control group: drop individuals 15-30 or 10-30km away

	(1) service and sales	(2) barriers to healthcare	(3) accepts violence	(4) infant mortality	(5) mortality boys	(6) mortality girls
Panel A. Drop individuals 10/15 - 30km away						
active*deposit	0.088***	-0.108**	-0.101**	-0.089***	-0.076**	-0.100***
	(0.028)	(0.046)	(0.046)	(0.024)	(0.033)	(0.030)
deposit	-0.039	-0.001	0.042	0.054***	0.042	0.068**
	(0.027)	(0.038)	(0.050)	(0.020)	(0.026)	(0.026)
N	50,523	28,844	28,107	32,898	16,737	16,161
R^2	0.165	0.237	0.349	0.033	0.042	0.044
Panel B: Drop 2 years before opening						
active*deposit	0.103***	-0.093*	-0.084**	-0.066***	-0.050*	-0.082***
	(0.027)	(0.049)	(0.036)	(0.020)	(0.028)	(0.028)
deposit	-0.050**	0.035	0.052	0.044***	0.034	0.057**
	(0.023)	(0.038)	(0.033)	(0.016)	(0.023)	(0.022)
N	54,707	31,393	30,604	33,127	16,814	16,313
R^2	0.165	0.240	0.345	0.035	0.044	0.049
controls	Y	Y	Y	Y	Y	Y
survey year FE	Y	Y	Y			
birth year FE				Y	Y	Y
country-year	Y	Y	Y	Y	Y	Y
district FE	Y	Y	Y	Y	Y	Y

Note: *** p<0.01, ** p<0.05, * p<0.1 Clustered standard errors clustered at DHS cluster level. All regressions Column 1-3 control for woman's age, education, urban, and fixed effects for survey year, district, country-year. All regressions Column 4-6 control for mother's age, age square, mother's education, birth order, urban, and fixed effects for birth year, birth month, district, country-year.

Table 18: Observable characteristics of women and selective fertility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	age	ever married	curr cohab.	divorced				
Panel A. All women								
active * deposit	0.507	0.006	0.016	-0.003				
	(0.382)	(0.017)	(0.019)	(0.008)				
active * deposit at age 14								
deposit	-0.226	0.001	-0.004	-0.001				
	(0.345)	(0.015)	(0.017)	(0.007)				
N	57,590	57,589	57,589	57,589				
R^2	0.038	0.351	0.274	0.041				
Panel B. Selective fertility		children			uses...		sex ratio	
	total	alive	ideal #	want no more	contraception	contraception	miscarriage	male child
active*deposit	-0.180*	-0.099	-0.048	0.014	-0.020	-0.030	0.013	0.010
	(0.092)	(0.091)	(0.075)	(0.024)	(0.020)	(0.022)	(0.018)	(0.024)
deposit	0.026	0.031	0.017	-0.016	0.011	0.019	-0.021	0.000
	(0.084)	(0.082)	(0.057)	(0.020)	(0.017)	(0.018)	(0.020)	(0.020)
want no more kids						0.056***		
						(0.004)		
N	57,590	56,717	47,453	46,449	52,388	46,449	40,421	48,107
R^2	0.673	0.616	0.302	0.035	0.083	0.099	0.088	0.008
total # kids	N	N	N	Y	N	N	N	N
active at	survey	survey	survey	survey	survey	survey	survey	birth

Note: *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level. All regressions include controls for age, education, urban, and fixed effects for survey year, district and country-year fixed effects. Panel A includes all the sample, and "active at age 14" takes a value of one if the woman was living close to an active mine before she turned 15, i.e. while she was in school age. Age is age in years, total fertility is the number of children ever born, ever married if the woman was ever married regardless of current marital status, curr cohabiting if the woman currently lives with a partner, married or non-married, no education is a dummy if the woman has zero years of education, and + 3 yrs is a dummy indicating if she has 3 years or more of education.

Table 20: Main results by country

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	agri-culture	agri-culture	service sales	earns cash	barriers to healthcare	accepts violence	bargaining power	infant mortality
Burkina Faso								
active*deposit	0.003	-0.012	0.066	-0.064	0.039	-0.093*	0.028	-0.063***
	(0.054)	(0.094)	(0.058)	(0.078)	(0.092)	(0.053)	(0.118)	(0.017)
Observations	20,784	20,784	20,784	14,911	15,553	14,937	13,799	16,173
R-squared	0.240	0.389	0.199	0.346	0.218	0.275	0.171	0.088
Cote d'Ivoire								
active*deposit	-0.177*	0.011	0.166*	0.094				
	(0.094)	(0.173)	(0.091)	(0.159)				
Observations	3,770	3,770	3,770	751				
R-squared	0.163	0.411	0.151	0.363				
Ghana								
active*deposit	0.019	-0.131***	0.108***	0.041	-0.012	-0.028	-0.096	
	(0.028)	(0.047)	(0.032)	(0.034)	(0.059)	(0.041)	(0.067)	
Observations	14,058	14,058	14,058	10,728	7,368	7,186	5,849	
R-squared	0.223	0.345	0.120	0.114	0.196	0.194	0.288	
Guinea								
active*deposit								-0.060*
								(0.031)
Observations								6,219
R-squared								0.135
Mali								
active*deposit	0.194*	0.047	0.223**	0.269***	-0.337***	-0.113	0.084*	
	(0.108)	(0.102)	(0.105)	(0.099)	(0.060)	(0.085)	(0.050)	
Observations	6,833	6,833	6,833	5,469	5,098	4,947	5,069	
R-squared	0.114	0.394	0.104	0.132	0.086	0.095	0.152	
Senegal								
active*deposit	0.082	-0.022	-0.286***					-0.078**
	(0.098)	(0.095)	(0.048)					(0.035)
Observations	1,040	1,040	1,040					5,105
R-squared	0.170	0.249	0.135					0.070
Tanzania								
active*deposit	-0.116**	0.058	-0.016	0.132*				-0.106***
	(0.049)	(0.108)	(0.021)	(0.070)				(0.036)
Observations	6,872	6,872	6,872	1,582				763
R-squared	0.180	0.362	0.116	0.372				0.115
controls	Y	Y	Y	Y	Y	Y	Y	Y
survey year FE	Y	Y	Y	Y	Y	Y	Y	
birth year FE								Y
birth month FE								Y
district FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors at DHS cluster level. All regressions include controls for age, education, urban, and fixed effects for survey year and district fixed effects.

Table 21: Interacting rainfall (in levels) in pregnancy trimesters with active mine

	(1)	(2)	(3)
	infant mortality	infant mortality	infant mortality
	12m	12m	12m
sample	children	boys	girls
active mine	-0.051	-0.024	-0.082
	(0.096)	(0.094)	(0.181)
rain (trim1) *active	0.009	-0.000	0.024
	(0.049)	(0.048)	(0.085)
rain (trim2) *active	-0.031	-0.017	-0.054
	(0.023)	(0.032)	(0.039)
rain (trim3) *active	0.006	-0.003	0.028
	(0.047)	(0.043)	(0.097)
deposit	0.042**	0.025	0.060***
	(0.017)	(0.023)	(0.023)
N	31,105	15,755	15,350
R^2	0.032	0.045	0.041
mean of infant mortality	0.097	0.103	0.093
mean of rain (trim)*active	0.001	0.001	0.001
birth year FE	Y	Y	Y
birth month FE	Y	Y	Y
country-year FE	Y	Y	Y
district FE	Y	Y	Y
birth trimester rainfall	Y	Y	Y

Note: *** p<0.01, ** p<0.05, * p<0.1 Clustered standard errors clustered at DHS cluster level. All regressions control for mother's age, mother's education, urban location, as well as fixed effects for birth year, birth month, district, country-year. All regressions control for birth trimester levels of rainfall, coefficients not reported here.

Table 22: DHS survey questionnaire

Survey question	answer
Barriers to access healthcare	
Many different factors can prevent women from getting medical advice or treatment for themselves. When you are sick and want to get medical advice or treatment, is each of the following a big problem or not?	
1. Getting permission to go?	big problem/not a big problem
2. Getting money needed for treatment?	big problem/not a big problem
3. The distance to the health facility?	big problem/not a big problem
4. Having to take transport?	big problem/not a big problem
5. Not wanting to go alone?	big problem/not a big problem
6. Concern that there may not be a female health provider?	big problem/not a big problem
Attitudes toward domestic violence	
(Sometimes a husband is annoyed or angered by things that his wife does). In your opinion, is a husband justified in hitting or beating his wife in the following situations:	
1. If she burns the food?	yes/no/dk
2. If she refuses to have sex with him?	yes/no/dk
3. If she argues with him?	yes/no/dk
4. If she neglects the children	yes/no/dk
5. If she goes out without telling him?	yes/no/dk
Earnings and decision making	
6. Who usually decides how the money you earn will be used: mainly you, mainly your husband/partner, or you and your husband/partner jointly?	respondent/partner/jointly/other
7. Who usually decides how your husband's/partner's earnings will be used: you, your husband/partner, or you and your husband/partner jointly?	respondent/partner/jointly/ husband has no earnings/other
8. Who usually makes decisions about healthcare for yourself: you, your husband/partner, you and your husband/partner jointly, or someone else?	respondent/partner/jointly/ somebody else/other
9. Who usually makes decisions about making major household purchases? you, your husband/partner, you and your husband/partner jointly, or someone else?	respondent/partner/jointly/ somebody else/other
10. Who usually makes decisions about making purchases for daily household needs? you, your husband/partner, you and your husband/partner jointly, or someone else?	respondent/partner/jointly/ somebody else/other
11. Who usually makes decisions about visits to your family or relatives? you, your husband/partner, you and your husband/partner jointly, or someone else?	respondent/partner/jointly/ somebody else/other

Table 23: Health effects of toxic waste from gold mining

	(1)	(2)
Heavy metal	Arsenic	Cyanide
Characteristics		
compounds	organic and inorganic	e.g. hydrogen CN, sodium CN
natural in	soil, mineral	food, plants
spreads with	air, water, soil	air, water, soil
through	dust, runoff, leakage	natural and industry processes
decompose	cannot be destroyed	hydrogen CN half-life is 1-3 years
Health issues		
inhaling	lung issues	chest pain, coma, death
ingestion	nausea, death	chest pain, coma, death
skin exposure	warts, darkening, swelling	skin sores
carcinogenic	yes	no
in childhood	lower IQ	rapid breathing, coma, death
in utero	fetal loss, premature delivery	inconclusive
Sources:	ATSDR 2007: Arsenic; Kapaj et al. 2006	ATSDR 2006: Cyanide

Table 24: Sample size and survey rounds by country

Country	Year	Observations
Burkina Faso	1993	5,599
	1999	5,779
	2003	10,468
	2010	14,898
Congo DR	2007	8,843
Cote d'Ivoire	1994	3,714
	1998	1,836
	2012	7,602
Ethiopia	2000	10,513
	2005	9,767
	2010	11,385
Ghana	1993	2,168
	1998	3,233
	2003	3,805
	2008	2,968
Guinea	1999	5,650
	2005	6,165
Mali	1996	5,841
	2001	12,839
Senegal	1993	5,419
	1997	6,997
	2005	10,569
	2010	12,008
Tanzania	1999	2,975
	2007	7,104
	2010	7,672
	2012	8,273
N		208,223