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 establishment of an industry on female empowerment and infant health. The paper uses the recent rapid expansion in gold mining in Africa as a quasi-experiment. The identification strategy relies on temporal (before and after mine opening) and spatial variation (distance to mine), 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 from a mine, the analysis shows that the establishment of a new mine increases income earning opportunities within the service sector by 41%, women are 23% less likely to state a barrier to health care access for herself and women's acceptance of domestic violence decreases by almost 20%. 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. The results are robust to different assumptions about trends, distance, migration, and withstand a novel spatial randomization test.

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. 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 make women better off, but does it change the norms that conditions their initial disadvantage? Poor countries are more likely to have norms that favor men (Jayachandran, 2014)

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but little is known about the causality running from economic development to more gender-equal norms. This paper uses the establishment of a modern industry to explore the effects of development on female empowerment.

The main contribution of this paper is to provide causal estimates of a continent-wide establishment of an industry on female empowerment. The paper uses the explosive expansion in large-scale gold mining in Africa as a quasi-experiment and two different identification strategies: a difference-in-difference method and a method using the price of gold as a proxy for mining activities. For the purpose of this study, female empowerment is defined to women's access to employment, income, resources and health care access and normative attitudes toward a woman's bodily integrity, pregnancy outcomes and infant health.

The large-scale mining boom in Sub-Saharan Africa provides a good opportunity to explore the effects of local industrialization on female empowerment. First, its main establishment decisions do not depend on local population characteristics but on geological characteristics. Second, the boom is happening at such speed across a continent, and is predicted to continue, that the internal validity of the estimates is of major policy relevance. Third, the setting provides an opportunity to study the gender effects of extractive industries, an industrial sector often thought to hinder female empowerment, although such effects have not been robustly estimated. I will describe these motivations in more detail below.

First, the paper contributes to the literature on industrial development and women's welfare. 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 depend local labor market characterstics. In labor intensive manufacturing industries, one factor of production may be of extra relevance: women's labor supply.

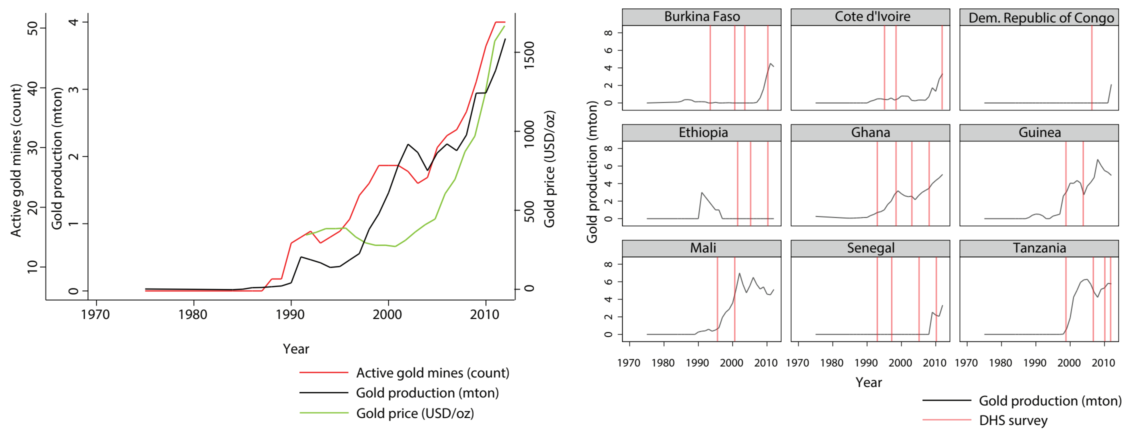
For one industrial sector, the mining sector, this is not of great concern. The establishment of a new mine is not conditioned by local labor force characteristics. First and foremost, the necessary condition for mining is a mineral deposit, which is a random geological anomaly (Eggert, 2002). In addition, 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 to explore the general equilibrium effects of local industrial shocks on female empowerment.

Second, the study is motivated by the internal validity of the results. 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, information to vocational training and beyond. Well implemented RCTs have the advantage of providing robust 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.

The scale and scope of the study is a contribution to our understanding on female empowerment. 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. Gold mining[1] has rapidly become an

[1]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),

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



economically important industry in many developing countries, especially in Africa. The high gold price and the growing demand from emerging markets has led to a boom in gold extraction. 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). Figure 1 shows that most mines have started producing during the time period of interest. The increase in active gold mines corresponds to the increase in global price of gold during the period.

A third contribution of the paper is that it sheds light on a particular industry, often thought to be detrimental to women's welfare: the extractives sector. Natural resource extraction, in general, is accused of crowding out women from labor markets by increasing their reservation wage (by higher male wages and more income transfers to households) and suppressing the demand for women's labor by crowding out female-dominated sectors, such as manufacturing (Ross, 2008). For similar reasons, a recent policy document, the African Mining Vision (UNECA, 2011) argues that the expansion of the mining sector is a threat to gender equality in Africa.

A priori, it is ambiguous what effects we are to expect from a local industrial shock. As first noted by Goldin (1995), the association between women's labor force participation and economic modernization is U-shaped. 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. A priori, 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 it may fail to provide sufficient compensatory employment within

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.

the mining sector, especially for women. In fact, the heavy nature of mining, has led to it being a "male" sector and in many countries there are stigmas regarding women working as miners.

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). This paper explores the welfare impacts of the structural shift first estimated by Kotsadam and Tolonen.

In this paper, I explore the causal effect of industrial gold mining on women's empowerment and infants' health in all African countries for which there is at least one large-scale gold mine and spatially coordinated Demographic and Health Survey (DHS) data.

I will use two empirical strategies to identify the effect of local industrialization on women's empowerment. The main method is a difference-in-difference approach, using the spatial and temporal variation that comes from mine opening year and mine location. In this method, I control for the 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 health.

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, exploring the intensive margin effects and by using the gold price in an instrumental variables approach.

I explore heterogeneity in response depending on observable characteristics, migrant status, urbanity, 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.

Despite the sector's traditional association with male labor, women access new types of jobs in mining communities. Service and sales employment increases with 41% for women, and a mine affects other determinants of women's welfare: there are significant gains in women's access to health care (23% decrease in stated barriers to seek health care) and her attitudes toward domestic violence, with the acceptance rate violence decreasing with almost 20%[2]. The estimated intention-to-treat effect size on service sector employment (9.5pp) are larger than benchmark findings within RCT literature (where in income generating activities outside of the home increase by 6.1pp (Attanasio et al., 2012), 6.8pp (Bandiera et al., 2014), and 2.4pp (Jensen, 2012), but in line with the effects

[2]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 health care: "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*"

from large rural electrification projects (Dinkelman, 2011). The paper finds no significant effects on decision making power within the household. 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' infant mortality rates than for boys (Duflo, 2003; Thomas, 1990; Qian, 2008).

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

2 Background

2.1 Extractive industries

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 the sub-national effects. 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. The shift of focus towards sub-national and local effects is driven by the recognition that decentralized effects matter, and by the availability of more suitable, more detailed, sub-national and often geographic data.

Treatment variability at the sub-national level allows more convincing stories to be told regarding, e.g., backward linkages and price effects (Aragon and Rud, 2013a), local Dutch disease effects and inequality (Loayza et al., 2013), employment opportunities for women (Kotsadam and Tolonen, 2013), externalities on agricultural productivity (Aragon and Rud, 2013b), and health effects (von der Goltz and Barnwal, 2014).

Similar analyses have explored 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). The strategy of this paper builds upon the paper by Kotsadam and Tolonen (2013) which developed a method for comparing outcomes from mining using cross-country microdata.

The gender effects of mining are not well understood, but generally 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 may 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 (income effect), 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 and more than half a million observations. Industrial mining onset creates a gender-specific local structural shift whereby overall labor market participation for women decreases. The extensive margin decrease in work participation is caused by a large drop in subsistence farming albeit partly offset by an increase in service sector activity. The drop in male participation rate is much smaller in magnitude and as a share of the mean, and men are more likely to be found across several sectors, including manual labor. Interestingly, increasing copper price decreases sexual risk taking behavior among young women in Zambian copper mining towns, possibly by generating other income earning opportunities (Wilson, 2012).

The link between natural resource extraction and violence is a contentious issue, also discussed within the 'natural resource curse' literature. The focuses 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 in the macro-literature (Collier and Hoeffler, 2005) as well as sub-nationally (Berman et al., 2014; and Maystadt et al., 2013), where commodity price shocks can drive civil conflict (Dube and Vargas, 2013). Within the community development literature, Aragon and Rud (2013) find that one large mine in Peru had moderate positive effects 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.

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.

2.2 Female Empowerment

The links 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 increases in women's education 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).

Evidence suggests that men and women have differential health care 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, such as 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 can help households to cope with risk.

Randomized control trial interventions focusing on generating income earning opportunities have found both weak (Field et al., 2010) and strong results on employment (Attanasio et al., 2012; Bandiera et al., 2014; Jensen, 2012). 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).[3] The 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). 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 underreporting 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[4],

[3]Decision making power is expressed in three different sets of circumstances - within the household, in the excercising 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).

[4]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

early entry into matrimony and cohabitation, and resulted in a drop in teenage pregnancy (Bandiera, et al, 2014). Young women have previously been shown to respond to sexual and reproductive health information. An RCT from Kenya shows that young women often engage in relationships with older men with more income ("sugardaddies"), but that merely information about relative HIV risks of young and old partners, make young women shift toward partners more their own age (Dupas, 2011). This illustrates that for young women, economic constraints can provide threats to body and fertility control, especially combined with lack of adequate information.

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.

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. First, her decision making power (if she has final say in household decisions), second, if she can seek medical care for herself. The latter question asks if certain factors hinder a woman to seek health care: money, distance and/or permission. A third indicator concerns domestic violence. A woman is asked if a given condition is a valid reason for a husband to beat or hit his wife (note, this question is not relating to the woman herself). All the original questions are presented in Appendix Table 22.[5]

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 in pooled income hypothesis, have the same effects on infant mortality. Such predictions have failed to be empirically confirmed (see Browning & Chiappori (1998); Hoddinott and Haddad (1995); Thomas (1990) for seminal work, 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 (maybe because it is seen as women's responsibility), and that child gender preferences are important in determining outcomes. In addition, exogenous shocks to women's incomes across Chinese districts led to an girls survival rates, possibly by increasing women's perceived economic worth in a context of son preference (Qian, 2008).

transactual sexual relationships.

[5]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.

Nevertheless, increasing wage rates for women can have a competing negative effect on child health. In Colombia, higher wages for women led to a decrease in child survival rate, 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. 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).[6]

Gold mining is associated with heavy metal pollution. The large scale gold mining industry uses cyanide in the amalgamation process to separate the gold from the ore. Left from the process is a water-based cyanide mixture, which is often stored in tailings dams. Low level spillage from these ponds can go unnoticed and beyond the low, chronic seepage into waterways, accidents with high level leakage have occured[7]. In addition to cyanide, the gold ore in several African countries naturally contains arsenic and heavy metals such as lead, cadmium, chromium and nickel. Lead exposure in utero is associated with increased risk of premature birth, low birth weight, and if exposure happens in early childhood, it can cause lower IQ and retarded growth (Iyengar and Nair, 2000). Lead pollution from mining activities has been linked to stunting in children (von der Goltz and Barnwal, 2014). However, studies conducted around Ghanaian and Tanzanian mines do not generally confirm high levels of lead.

Studies from mining areas in Ghana and Tanzania, however, do confirm the existence 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). High or chronic arsenic exposure has been linked to fetal death and premature delivery (Chakraborti et al., 2003), and low birth weight (Hopenheyn, Ferreccio et al. (2003)), miscarriages and stillborns (Milton et al., 2005) and the effects have been found to differ with the stages of pregnancy (Hopenheyn et al., 2003).[8]

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

[7] A notable serious accident happened in May 2009 in one of the Tanzanian gold mines and it had substantial effects on health, agriculture and livestock around the mine (Bitala et al. 2009). These events are not confined to a developing country setting; in 2000 there was a detrimental accident in Romanian Baia Mare Aurul gold mine. The accident spurred the signing of a 'Cyanide Code', to regulate the use of cyanide in the gold production (www.cyanidecode.org). The code was set up with the help of United Nations Environmental Program (UNEP).

[8] Nevertheless, there has been controversy regarding these findings due to risk of omitted variable bias where exposure is thought to be 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

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, we will not be able to say anything about the future health of survival children.

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 that was active at least one year 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 Cote 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).

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

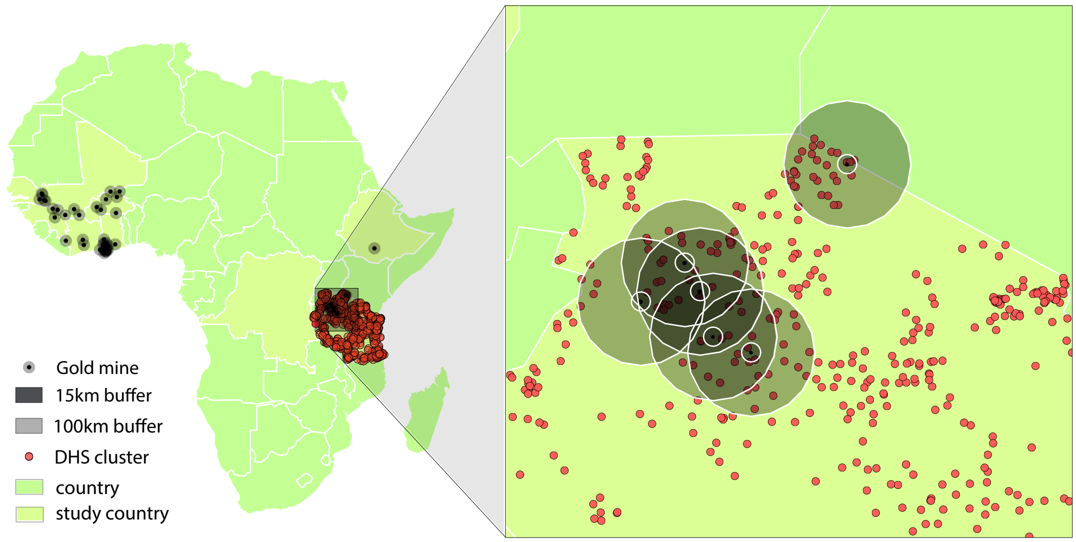
The survey years span from 1993 to 2012. Table 24 in the Appendix shows the sample size divided by country and survey year. Descriptive statistics are presented in Table 1 for women, and Table 2 children and their mothers. Women are on average 28.7 years old, and 30% live in urban areas. The index variables[9] barrier to health care, accepts domestic violence and self-perceived bargaining power are 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 11. The original variables are dummy variables that take a value of one if the woman agrees with the statement.

Roughly 90% of women state that distance, money or receiving the permission from somebody in the household are barriers to seek health care and between 23% and 48% of women state that a

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.

[9]The index variables are naïve indexes where a woman receives an average score depending on how many statements she agreed to. Following Hidrobo and Fernald 2013, I am considering using an index score constructed from z-scores. The z-scores would be created from the mean and standard deviation in the control group, and the index is the average of the z-scores of its components.

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



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 income. Roughly 30% state to have decision making power regarding health care and large purchases.

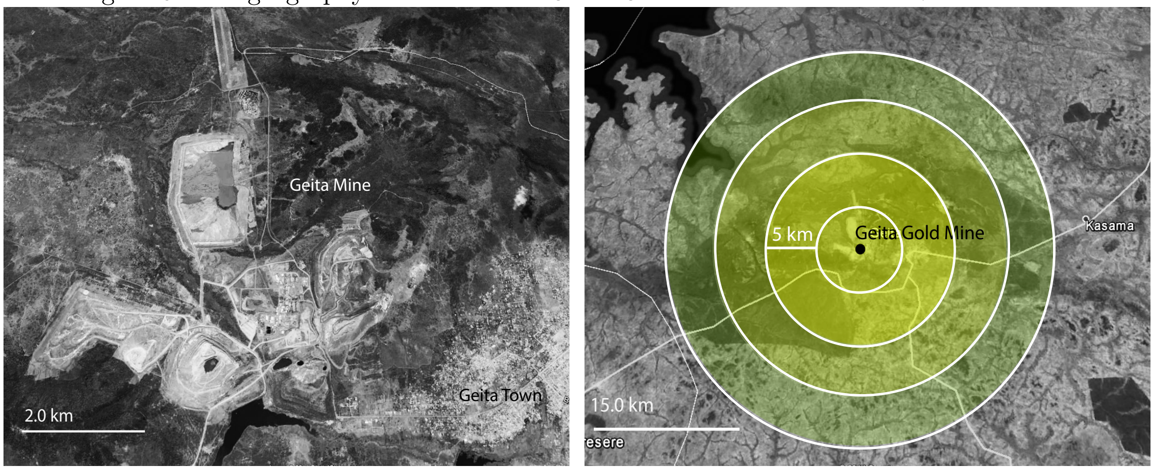
The average number of children born to each woman is 3.24, and the women have not reached their ideal fertility, which is 5.4 children on average. 14% of women are using contraception at the time of the survey, and in 60% of the cases the decision of contraception is taken jointly. 16.3% of women report having experienced, at least one, miscarriage.

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 rising educational levels.

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

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



control group.

The strategy of the paper follows from an approach used by Kotsadam and Tolonen (2014) to measure local employment spillovers from industrial mining across a continent. More generally, the strategy links to the field of economic geography concerned with exploring local industrialization and agglomeration 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, in a first instance, I rely on the opening of mines in the rather than annually reported production volumes.

The estimation strategy in this paper, relies upon assumptions that the timing and the placement of the mines are not correlating with other local changes, such as labor market and 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 to be geological anomalies, and not by the availability of human capital and labor. Through the earth's crust there are pockets of deposits of minerals, often clustered within a region (Eggert, 2002). The necessary condition determining an investment decision is thus the existence of a deposit: deposits are not mobile, whereas production technology and labor input are.

Nevertheless, we can think of various factors that could influence mine opening year or mine location. 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. Such regulatory framework is predominantly national, although several countries, such as Ghana, have regional income sharing rules. We do not expect that within-region (i.e. subnational) differences in institutions will drive the investment decisions, assuming that at this subnational level institutions are homogenous.

The difference-in-difference identification strategies with district fixed effects and year fixed effects

Table 1: Summary statistics for the women's framework

Variable		Mean	Std. Dev.
Observable characteristics			
age	age in the survey year	28.68	9.53
education	education in years	2.97	4.09
urban	living in an urban community	0.27	0.444
Occupation			
not working	she has not been working in last 12 months	0.21	0.407
agriculture	she works in agriculture	0.433	0.496
service and sales	she works in service or sales	0.229	0.420
earns cash	she earns cash for work	0.564	0.496
Empowerment			
barriers health care	barriers to access health care for self	0.399	0.342
accepts domestic violence	a husband has the right to beat his wife	0.501	0.482
bargaining power	has final say in household decisions	0.324	0.382
Treatment variables			
active * deposit	active mine within 15km	0.026	0.166
deposit	mine area within 15km	0.047	0.211
active	active mine within 100km	0.559	0.496
gold price	world gold price in survey year USD/oz	599.2	369.1
gold price**	(world gold price in survey year USD/oz)100	5.99	3.691
gold price * deposit	interaction gold price and deposit	0.249	1.372
gold price * active * deposit	interaction gold price and active mine	0.179	1.28
Observations		57.685	

Note: ** this variable is used in the regression framework

reduces the concerned we may have of institutions. Effects are identified within a certain subnational area which we can assume have the same institutions, or within a calendar year. 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 trend, 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 important in the exploration phase (Eggert, 2003), and can be important also in the production phase. If mining operations create new infrastructure, that means that our treatment is mine + 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 anyway developing in these areas, if affects how we may interpret the effects.

According to annual reports from gold mining companies operating in Africa, companies to some extent develop necessary infrastructure themselves. African Barrick Gold owns a private airstrip at their Bulyanhulu mine in Tanzania, or the airstrip that can be seen in the close up photo of

Table 2: Summary statistics for the infant mortality framework

Variables		Mean	Std. Dev.	Min	Max
Mother's characteristics					
age	mother's age	29.17	7.11	15	49
education	education in years	1.88	3.37	0	21
urban	living in an urban area	0.187	0.390	0	1
Infant mortality					
death 1	infant mortality (1 month)	0.038	0.192	0	1
death 6	infant mortality (6 months)	0.057	0.231	0	1
death 12	infant mortality (12 months)	0.097	0.296	0	1
death 12 boys	infant mortality for boys	0.103	0.304	0	1
death 12 girls	infant mortality for girls	0.093	0.291	0	1
birth year	of the child	2000	-	1987	2012
Treatment variables					
active * deposit	w/in 10km from active mine	0.010	0.101	0	1
deposit	w/in 10km from a mine area	0.023	0.151	0	1
active	active mine within 100km	0.459	0.498	0	1
gold price	gold price in USD / oz	536.2	312.5	271	1571
gold price**	gold price in 100 USD / oz	5.361	3.125	2.71	15.71
gold price* mine	gold price * mineral deposit	0.118	0.897	0	15.71
gold price* active * deposit	gold price * active mine	0.069	0.780	0	15.71
rainfall	level of rainfall per trimester	0.01	0.107	0	2.11
Observations		51,855			

Note: ** this variable is used in the regression framework

Geita gold mine in Figure 3, and the companies sometimes open electricity plants to ensure steady provision of electricity to their operations. In the case of gold mining, road and railway network is of less importance. Gold is a high value commodity, and air strip access is more important for the final good 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.

Another threat to identification is migration and urbanization effects. 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, inclusive of its migrant population and urbanization effects, affects the economic opportunities of its community members. When we explore effects on the whole population, we understand how the economy has changed. On the other hand, we are interested in knowing the treatment effect on the original population, free from selection, in what case we have to remove migrants from the analysis. Also in this second case do we 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.

The baseline strategy compares outcomes close and far away from mines, before and during the active production phase. There are three different treatment groups in the baseline specification, (1) treated (treatment*post, called active*deposit in the output tables), which is defined as close to an actively producing mine, (2) treated but before opening (treatment*pre, called deposit), defined as close to a gold deposit that will be extracted in the future, (3) non-treated, defined as living far away from a deposit or a mine (the reference category). For the third group, non-treated, the time aspect of pre and post is not clearly identified. Since by definition, the group is defined as far away from a mine, it is not evident which mine's the production status should be considered. There is substantial variation in the mine opening year, allowing us to identify the treatment effects, making the exact timing of 'pre' and 'post' vary within countries, subnational regions and districts. However, I include year fixed effects.

While I in the baseline specification, make no distinction if the non-treated are living far away from an active mine or far away from a non-active mine, but in the robustness section I overcome this by imposing a sample limitation and to consider all mines within a clearly defined geographic area. The results do not substantially change with the alternative strategy, although the no-treatment*post is in some instances significant, showing that there are spillover effects sometimes reaching beyond our baseline treatment distance.

4.1 Baseline Specifications

Mining is determined firstly by the availability of ore, a 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, depending on infrastructure and prices for factors of production. Assuming that all the determinants are time stable, the causal effect of having a deposit can be estimated in a difference-in-difference method with year and subnational-region fixed effects. Deposits are often used in the natural resource literature (see e.g. Alcott and Keniston 2014) as a more exogenous measure. However, a deposit measure is time invariant, so by definition it only allows us to do a difference-in-means estimation. As a robustness strategy, we interact the arguable exogenous measure of deposit with the gold price

We take known deposits that have ever been extracted between 1975 and 2012. We wind back the time to the first study year, and treat all deposits the same. This gives us a difference in means specification. We look at an outcome Y,

$$Y_{icdt} = \beta_0 + \beta_1 deposit_c + \gamma_t + \alpha_d + \delta_{kt} + \varepsilon_{icdt} \tag{1}$$

Where i is for the woman, c the cluster, d for district, k, country and t year. The variable of interest is 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. The specification includes year fixed effects γ, district fixed effects α, country-year fixed effects,δ. 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 main specification uses mine opening as a natural experiment, allowing for a variation on the difference-in-difference specification:

$$Y_{icdt} = \beta_0 + \beta_1 deposit_c + \beta_2 deposit \cdot active_{ct} + \gamma_t + \alpha_d + \delta_{kt} + \varepsilon_{icdt} \quad (2)$$

where mine opening is captured by the interaction effect between deposit and active, capturing if at least one of the mines within 15km is open.

Note that a lone standing dummy active is not included here, which would be the case in a traditional difference-in-difference framework. 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 we have limited the sample to 100km, we can however, create such a dummy defines as 'if there is any active mines within 100km from the community'. The dummy will capture the greater mining region effects of mining, in addition to the localized effects captured by deposit*active. The specification will look like:

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

Chosen baseline distances are 10km and 15km. The choice of distances are crucial for rightly 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. The spatial distribution of the effects of mining is not clear. Mining areas can several kilometers wide as illustrated by the photo of Geita Gold Mine in Figure 3. To capture the communities around the mine, we thus need to consider an area which is larger. The pollution effects are likely less dispersed than the economic effects, why it makes sense to look at a smaller distance.

Within the mining literature, distances range from 50 - 100km for Aragón and Rud (2012) mapping the effects of one large mine in Peru, 20 km 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), although they find that the effects decrease almost linearly with distance and that at 50km few effects are seen, and the shortest distance: 5 km in a study regarding pollution effects from mining (von der Goltz and Barnwal, 2014). This paper adds to the literature by showing the main findings' robustness to alternative distance specifications, such as alternating the distance cutoff and introducing a spatial lag model allowing for non-linearity in treatment effects.

5 Results

5.1 Main results

A priori, we are agnostic regarding the true treatment distance. We find some support in the economic literature and the mining literature on what is a mine's caption area, with distances ranging from 6km (pollution spread) to 50km (Kotsadam and Tolonen, 2013).

To allow for non-linear effects with distance, 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:

$$
\begin{aligned}
Y_{icdt} \quad = \quad & \beta_0 \\
& + \sum_d \beta_d \, deposit_c \\
& + \sum_d \beta_d \, active_{ct} \cdot deposit_c \\
& + \gamma_t + \alpha_d + \delta_{kt} + \varepsilon_{icdt}
\end{aligned} \tag{4}
$$

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

Figure 4b and 4c confirms that the occupational 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 4e and 4f and 4g show the result for our three main variables for empowerment: barriers to access health care and justification of domestic violence, and final say in household decisions. Figure 4e for 'Barriers to health care access' show that up to 20km from a mine, there is a tendency of women stating 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 also further away, at 60-70km away, at what distance we observe the same pattern. For final say in household decisions we do not see any clear differences close to mines, and variability in the measure further away.

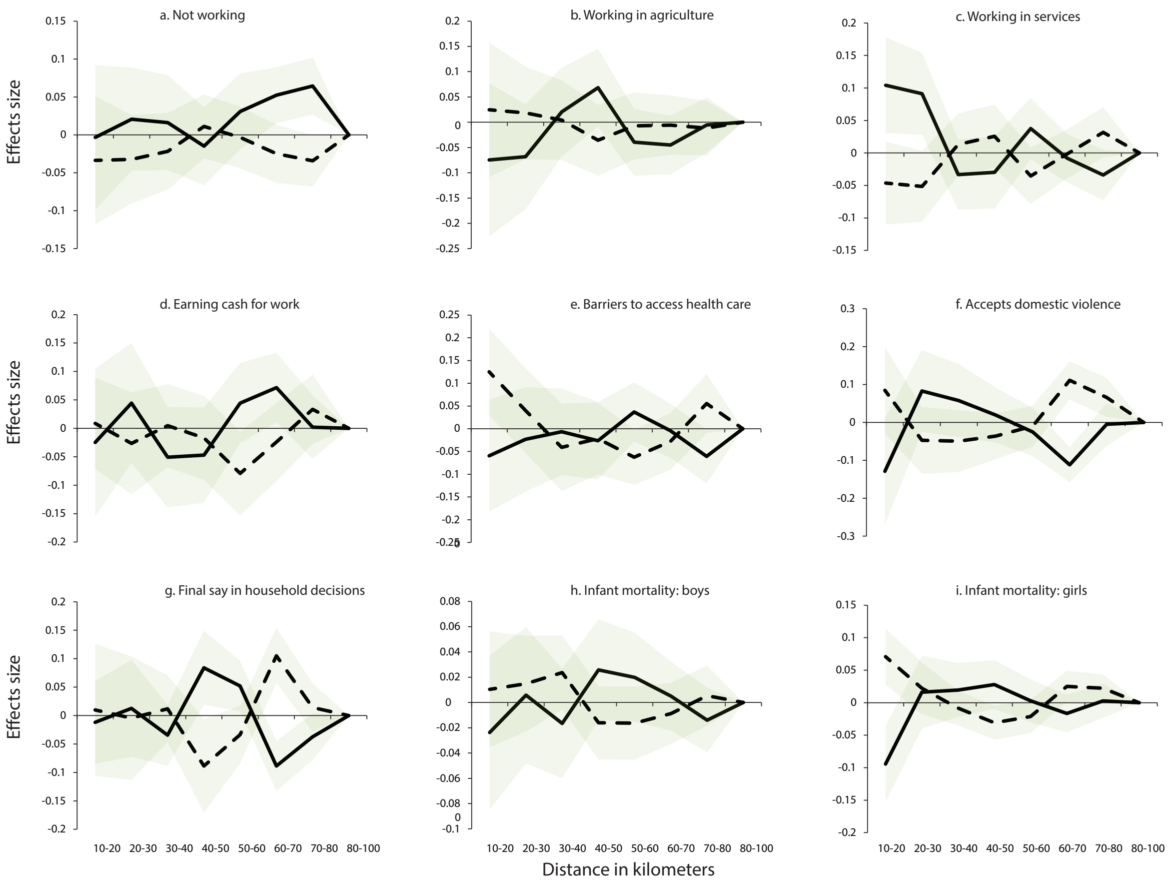
Lastly, Figure 4h and i show the results for infant mortality. For boys, there is seemingly insignificantly lower mortality within 10km from a mine in active mining communities. For girls the difference between active and inactive communities is large in the closest distance bin. Before a mine, mortality 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.

This exercise motivates 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.

Using the baseline specification, the treatment effects on all outcomes are estimated 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 do a multinomial logit. I find

Figure 4: Spatial Lag Model: Economic and Physical Empowerment and Infant Health



that there is a significant decrease in agriculture (-7pp) and a significant increase in service sector employment (11.5pp increase) (see Table 17). 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 17). 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. The onset of mining make women shift from agriculture to service sector employment, and they are more likely to earn cash for their work[10].

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)[11]. These studies do, however, not discuss the implicit shift from other type of activities that enabled the increase time

[10]These results are also confirmed by the Ghana Standard Living Measurement Surveys (GLSS) using the same strategy.

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

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 estimate of a 9pp to 11.5pp increase in service and sales employment may be a large labor market effect compared to the literature. The effect size is similar to those from a rural electrification program in South Africa, where participation increased 9 percentage points.

Table 3, Panel B shows the results for three index variables measuring a woman's say in household decisions. The first index "barriers to access health care" measures if a woman states that she is significantly hindered to seek health care for herself, where money, distance or permission are possible hinders. Women close to active mines are significantly less likely to feel hindered to seek health care, with a drop of 23%. In addition, in column 2, we learn that women in mining communities are almost 20% less likely to accept domestic violence. Also here, the outcome variable is an index that takes a value between zero and 1, if the woman is more or less inclined to accept domestic violence. If she answers that all reasons are valid, the index will take a value of one. The full list of questions is presented in the Appendix, Table 11 and with the questions from the questionnaire in Table 22. Column 3 shows that women in mining communities are not significantly more likely to state to have 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 (health care/large purchases/family visits). There are more outcomes that are not included in the index, since they are only collected for a smaller sample. For transparency, the results for all individual outcomes are presented in the appendix.

Infant and child mortality remains high in many parts of Africa. Primary caretakers' access to resources is an important factor in the health production function of children. The fertility records that we use have been collected in Africa over the last decades. Due to often rural and unattended births, there is often missing information on birth weight. For the main specification, I choose to look at infant mortality.

The specification is slightly different for the infant mortality specifications than in the women's regressions. The baseline specification now includes birth year fixed effects, γ, birth month, μ, district fixed effects, α, country year fixed effects, δ, and a vector for mother's characteristics. The active mine treatment variable considers the mine's status in the birth year of the child, in contrast to previously, when the survey year was considered. The baseline specification uses a distance span of 10km. It is reasonable to expect different geographic spreads of economic effects and pollution effects. Since the environmental burden of large-scale mining is asymmetrically carried by very close communities (e.g. arsenic pollution spread up to 6 to 15km (Golow et al., 1996)), I have chosen to use a shorter distance variable.

Mine opening is associated with 6.5 percentage point decrease in the likelihood that a child died within the first 12 months (see Table 3, Panel C), which is equivalent to a two-thirds decrease in the incidence of infant mortality. For boys, the change is 4.8pp, equivalent to a 47% decrease in the incidence. The largest drop is among girls; a 8 pp decrease in the mortality rate, equivalent to 85% decrease. These drops happen in communities that prior to the mine had higher incidence of infant mortality, as indicated by the coefficients for deposit.

Table 3: Main results: Occupation, Empowerment and Infant Mortality

	(1)	(2)	(3)	(4)
Panel A: Occupational outcomes				
	not working	agriculture	service and sales	cash
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
mean outcome variable	0.21	0.433	0.229	0.564
Panel B: Empowerment indexes				
	barriers to access health care	accepts domestic violence	household bargaining power	
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	
mean outcome variable	0.399	0.501	0.324	
Panel C: Infant mortality (died within 12 months)				
	died within 12m all children	died within 12m boys	died within 12m girls	
active*deposit 10km	-0.061***	-0.042	-0.076***	
	(0.020)	(0.028)	(0.026)	
deposit 10km	0.039**	0.024	0.056***	
	(0.015)	(0.021)	(0.021)	
N	37,365	18,982	18,383	
R^2	0.035	0.047	0.049	
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, survey month, country, district and country-year fixed effects. Panel A shows results for binary occupational outcomes, column 1 if the woman is working or not (in the last 12 months), column 2 if she is engaging in agriculture, column 3 if she works in services or sales, column 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 barriers to health care access: "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 measures final say in decisions: "Do you have, alone or together with your partner, say in health care/large purchases/family visits decisions". All indicators are not collected in all surveys and years, the sample sizes differ the indicators. 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 shows results for infant mortality. All regressions control for mother's age, age square, mother's education, urban location, child's birth order as well as fixed effects for birth year, birth month, country, district, and country-year. Active*deposit takes a value of 1 if there is an actively producing mine within 10km from the household locality in the birth year.

Table 4 shows the regression results for infant mortality in the first month (Column 1) and first 6 months of life (Column 2). As should be, the drops are smaller than the baseline estimates (3.1pp and 5.1pp). Column 4-6 show the results using the 15 km distance spane. At this distance, the treatment effect for boys is positive, for girls still negative but insignificant. This implies that the correct treatment distance for infant mortality is smaller than for the female empowerment variables. I will continue using the 10km distance in all subsequent regressions.

Table 4: Main results: Neonatal Mortality and Infant Mortality at 10km and 15km

	(1)	(2)	(3)	(4)	(5)	(6)
	infant mortality					
months	1	6	12	12	12	12
sample	all	all	all	all	male	female
distance	10km	10km	10km	15km	15km	15km
active*deposit	-0.031***	-0.056***	-0.061***	-0.009	0.016	-0.034
	(0.011)	(0.015)	(0.020)	(0.018)	(0.025)	(0.023)
deposit	0.024**	0.037***	0.039**	0.025*	0.008	0.041**
	(0.009)	(0.012)	(0.015)	(0.014)	(0.018)	(0.018)
N	48,107	43,003	37,365	38,269	18,982	18,383
R^2	0.018	0.027	0.035	0.031	0.042	0.044
birth order	Y	Y	Y	Y	Y	Y
mother age	Y	Y	Y	Y	Y	Y
age square	Y	Y	Y	Y	Y	Y
Mean value	0.038	0.057	0.097	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. Panel A shows the results for infant mortality in first month of life (column 1), 6 months (column 2), and in column three 12 months but with 15km distance for deposit.

5.2 Mechanisms

In this section, we will try to understand the mechanism behind the results found on empowerment and infant mortality. We start with exploring heterogeneous effects for the migrant and non-migrant population. We will explore of increases in service sector employment, cash earnings and household wealth explains some of the variation. Lastly, we use additional data sources to measure wage effects.

Migration and Urbanization

Thus far, the analysis has been conducted on the local population. While we are interested in the mining community per se, we may worry about migration in the interpretation of our results. In the DHS, we have 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

Table 5: Never Movers and Migrants

	(1) agri-culture	(2) service sales	(3) barriers to health care	(4) accepts violence	(5) bargaining power	(6) infant mortality
Panel A. Never Movers						
active*deposit	-0.031	0.099**	-0.076	-0.124*	-0.006	-0.027
	(0.061)	(0.047)	(0.067)	(0.067)	(0.056)	(0.053)
deposit	0.003	-0.010	-0.049	0.034	0.036	0.026
	(0.051)	(0.029)	(0.053)	(0.046)	(0.043)	(0.036)
Panel B. Migrants						
active*deposit	-0.100*	0.160***	-0.133**	-0.101	0.003	-0.068**
	(0.055)	(0.044)	(0.066)	(0.064)	(0.053)	(0.031)
deposit	0.027	-0.044	0.063	0.038	0.004	0.052***
	(0.046)	(0.027)	(0.039)	(0.039)	(0.038)	(0.020)

*** 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, survey month, country, district and country-year. Column 6 controls for mother's age, mother's education, 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.

specification, but excluding anyone who ever migrated. Assuming no selective outward migration from the mining communities, we can interpret these results as treatment effects on initial population.

Women who have not moved to the current location are less likely to work after a mine opening (insignificant), but more likely to work in services and sales (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.

These women who were born in the mining community are also less likely to be hindered to seek health care after the mine started producing, although not significantly so. Women who have migrated (Panel B) are 13pp less likely to feel hindered to seek health care. In addition, they are 12.4pp less likely to justify domestic violence (Column 4), which is slightly stronger than the baseline result in Table 3 Panel B Column 2. Infant mortality is negative for children born to never-movers, but insignificant and smaller than the baseline result. (The sample size does not allow us to split the sample be the child's gender and estimate the full model, why such results are not presented here).

Panel B shows the result for women who have migrated, and we learn that are similar to the original population, although the effects are slightly larger for agriculture, service sector, access to health care and infant mortality. The effect size on domestic violence is however lower than the effect for never-movers.

Large-scale mining can cause migration as well as urbanization. The extent of the migratory movements caused by mining is not well explored, although research has previously exploited work migration 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 Southern Africa (e.g. Campbell, 1997 and Dunbar Moodie, 1994), although urbanization effects has been noted in the case of gold mining in Tanzania (Lange, 2006). I try to map the share of the population that has migrated in their life, and that live in an urban community, by distance from mine using a spatial lag model that allows for non-linear effects in distance. Appendix Figure 7 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 7 shows that migration rates are 5pp higher close to active mines, than close to a deposit where it is 5pp lower than in the control group.

We are interested to see if effects are different in urban and rural areas, with the caveat that urbanization can be an effect of the mining. Appendix Table 15 shows heterogenous effect by urbanity and the variable of interest is urban*active*deposit. Urban is positively associated with lower labor market participation, services, cash, women's bargaining power, and negatively associated with agriculture, barriers to health care access and acceptance of domestic violence. The interaction effect is, however, insignificant.

To understand further how the migrant and non-migrant population can change the dynamics in mining communities, we explore changes in observable charactersitics. Table 19 in the Appendix Panel B explore changes in the migrant population and Panel C for the non-migrant population. Migrant women in mining communities are 4 percentage points more likely to be currently in a cohabiting or married relationship. Otherwise there are few significant differences in observables across the different populations. In addition, women in mining communities have fewer children on average, with the biggest drop in total fertility seen among women who have never moved. Column 7-9 show results for schooling. In column 8 and 9, treatment "active at age 14" takes a value of 1 if there was at least one active mine within 15km from the girls, before she turned 14 years old. Young girls growing up in mining communities have slightly higher education, but the results are not significant.

Service Sector Jobs, Wealth and Wages

In Table 6 we 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. A mine increases the likelihood of a service sector job and of earning cash. Columns 1-4 include controls for service and sales jobs. We learn that it's 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, she is less likely to accept domestic violence and she enjoys more say within the household (note, these are not causal estimates). We note too, that the treatment variables active*deposit, remains statistically significant for health care access and domestic violence.

In Panel B Column 2, we also learn that women who earn cash income have better medical care access and are less accepting of domestic violence and that they enjoy more bargaining power in household decisions. The treatment variable, active*deposit, for barriers to health care 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.

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 is working purely through the 'cash effect'.

In Panel C, Column 2 and 3, we learn that household wealth makes women increases access and decreases acceptance of violence. The effect on bargaining power (Column 4) is however very small and marginally significant. This correlation is according to theory, if it is because men's income is important in determining both household wealth and a woman's bargaining power. Also here, the treatment effects on health care access and domestic violence are negative, although only the second is significant. However, 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).

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. The DHS data, however, does not tell us anything regarding the wage rate. I thus complement the study with Living Standard Measurement Survey (LSMS) data for Ghana. The data is collected by the World Bank together with the Ghananian 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. Appendix Table 16 shows that wage rate is unchanged for men, but increases for women as indicated by the interaction term active*deposit*woman. The results are suggestive of a decrease in work participation the extensive margin, but increase on the intensive margin as hours worked increase (insignificantly). Column 8 indicates that household income increases significantly.

Table 6: Mechanism: Service and Sales, Cash and Wealth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	cash	barriers to	accepts	bargaining		mortality	
	earnings	health care	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

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, survey month, country, district and country-year. Columns 5-7 controls for mother's age, mother's education, urban location, as well as fixed effects for birth year, birth month, country, district, and country-year. Please see Table 3 for more information regarding the baseline specification.

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.

Changes in Fertility

It is possible that a mine establishment will change women's fertility patterns. This could be for various reasons; (1) they are aware of potential health concerns and decide to 'opt-out' for now, (2) they can chose to 'opt-in' because their household are richer, (3) the opportunity cost may increase since there are (possibly) more better paid jobs, (4) marriage markets may change, given the possible change in demographic structure and overall change in the economy, or simply because they are better prepared to take family planning decisions. Additionally, (5) the pollution effect could cause increases 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. There is an overall drop in fertility according to Appendix Table 19 Panel A, and it is mostly driven by a drop in fertility among the non-migrant population. To further explore this, additional fertility related outcomes are explored in Apendix Table 19. We see that women in mining communities have slightly lower total fertility, and lower ideal fertility. 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).

5.3 Sensitivity analysis and heterogeneous effects

In this section we will explore the extensive and intensive margin effects in two different strategies; first, using the intensity of local mining, second by using the gold price. Then follows a general sensitivity analysis, where we explore different specifications such as control variables, fixed effects, time trends, clustering and a simple difference in means method. Following, we will see the results from spatial randomization tests and the section finishes with corrections for multiple inference testing.

Effects on the Extensive Margin

The baseline results allow us to understand the extensive margin effects of one mine opening. We are interested in knowing how these extensive margin effects differ with the number of mines, which I will refer to as 'intensity' of mining. We can capture the intensive margin of mining using the gold price. We expect a mine to produce more when the price is high, and by the value per ton extracted will be higher. This can trickle down to the economy, for example, through increasing employment and higher wage rates. We prefer this strategy to using the production volumes, as the reporting standards differ across companies (InterraRMG, 2013).

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

$$Y_{icdt} = \beta_0 + \beta_1 deposit_c + \beta_2 deposit \cdot active_{ct} + \beta_3 intensity_{ct} + \gamma_t + \alpha_d + \delta_{kt} + \varepsilon_{icdt} \tag{5}$$

Table 7 show the results for regressions with an intensity variable. The intensity variable captures if there are more than one active mine close-by. 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 health care for self or 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. For each additional mine beyond the first, the

Table 7: Effects on the Extensive Margin: Intensity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	agri-	service	barriers to	accepts	bargaining		mortality	
	culture	sales	health care	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

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, survey month, country, district and country-year. Column 6-8 controls for mother's age, mother's education, urban location, as well as fixed effects for birth year, birth month, country, 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.

effect decreases further. Note that only a small number of individuals have more than one active mine close by, and maximum 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.

Effects on the Intensive Margin

To estimate the intensive margin effects, we use the gold price. 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 financal asset, it is predominantly in the shape of pure gold or high-carat jewelry[12] 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 have already seen in Figure 1, that the world price of gold increased rapidly during the time period, in parallel to the establishment of many new gold mines in Africa. As explained above, the gold price is strictly exogenous to local population characteristics.

Because of this, we can use the gold price to overcome any concerns that the activity of a mine varies with local changes. 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 regression thus looks like:

[12]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)

$$Y_{icdt} = \beta_0 + \beta_1 deposit_c + \beta_2 deposit \cdot goldprice_{ct} + \beta_3 goldprice_t + \alpha_d + \delta_{kt} + \varepsilon_{icdt} \tag{6}$$

In addition, 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:

$$\begin{aligned} Y_{icdt} = \; & \beta_0 \\ & + \beta_1 deposit_c \\ & + \beta_2 deposit \cdot active_{ct} \\ & + \beta_4 deposit \cdot goldprice_{ct} \\ & + \beta_5 deposit \cdot active \cdot goldprice_{ct} \\ & + \beta_6 goldprice_t \\ & + \alpha_d + \delta_{kt} + \varepsilon_{icdt} \end{aligned} \tag{7}$$

The results for these two strategies are presented in Table 8 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. In Panel B, we use the strategy outlines in Equation 7. A higher gold price causes less labor market participation (marginally significant), less agriculture, more service and sales employment (Column 3) and less acceptance of domestic violence (Column 6), and less infant mortality (Column 8).[13]

In Table 9 I do an instrumental variables approach where I use the gold price interacted with a deposit as an instrument for an active mine. The gold price is a good candidate as an instrument, since there are theoretical reasons to believe it be both valid and relevant. Relevant since the gold price drives gold production, but there is little risk of the world price of gold being driven by the local industrial-scale production. The instrument could arguably be valid since it is likely that the gold price affects local community development in Africa only gold production. The first stage result is presented in Table 9. The effects are similar in directions, and we find that women have better access to health care, less likely to accept domestic violence, except infant mortality which is positive and insignificant.

However, this section remains preliminary. There are some concerns regarding the strategy, the instrument validity, and interpretation. The instrument must be scaled to facilitate interpretation.

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

Table 8: Effects on the Intensive Margin: 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	health care	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	0.21	0.433	0.164	0.564	0.399	0.501	0.324	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

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. Column 8 controls for mother's age, mother's education, urban, and fixed effects for birth year, 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.

Alternative Specifications

Appendix Tables 12, 13 and 14 show the main 8 outcome variables across 11 different specifications. The first three columns show a parsimonious specification without controls (1), or with just age and education controls (2). Column 3 is the baseline specification but without urban control, and Column 4 the baseline specification. Adding an urban control does not change the results much, except for access to health care in Table 13 which is only significantly estimated with the control. 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.

Columns 10 and 11 show results if we add an 'active' dummy for far away, and a simple difference in means. Treatment, in this case mine opening, was phased in differentially across the areas considered. In the baseline specification, I split the sample into three groups across the 100km radius circles drawn around each mine. First, I draw the 15km radius circle from closest mine center point. Then I distinguish a subset of this group, by constructing an indicator for active mine, which is one if any mine within 15km is active in the year considered. The third group is 15-100km. For this

Table 9: Instrumental Variables Approach: Using the World Price of Gold to Estimate Female Empowerment and Infant Mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		occupation		earns	barriers to	accepts	bargaining	infant
	no work	agriculture	services	cash	health care	violence	power	mortality
Panel A. IV								
active mine	-0.033	-0.016	0.039	-0.017	-0.032	-0.088	0.018	0.020
(IV)	(0.023)	(0.041)	(0.025)	(0.045)	(0.036)	(0.000)	(0.035)	(0.028)
N	52,720	52,720	52,720	35,020	31,485	30,693	27,482	34,229
R^2	0.183	0.341	0.144	0.327	0.231	0.306	0.272	0.028

Panel B. First Stage	active*deposit at survey year	active*deposit at birth year
gold price*	0.090***	0.079***
deposit	(0.004)	(0.005)
F-stat		

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, and country-year. Column 8 controls for mother's age, mother's education, urban, and fixed effects for birth year, birth month, district, and country-year. Annual gold price comes from Raw Minerals Group and is available from 1992 to 2011. Active*deposit is instrumented with the annual gold price and the deposit measure.

group, it is assumed that the operational status of the mine does not matter since the true treatment effects do not reach beyond 15 kilometers. Any time trend variables will now be taken care off with the year and country-year fixed effects. If we remove this assumption that a mine has no effects beyond the treatment distance that we decided with the non-parametric estimation earlier, we need to add a dummy for active, but far away. This dummy captures if there is any active mine within 100km from the sample cluster. 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.

Appendix Tables 12, 13 and 14, Columns 10, show the results using this difference-in-difference specification. We might want to look at the effects of active, since this measures the spillovers across the larger geographical area. Including the extra dummy do 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 indicate that there are economic spillovers that affect labor markets further away than our baseline distance, but that changes to infant mortality is only found close to active mines. If we expect that there are spill-overs, beyond the treatment distance, that affects our control group we will underestimate the treatment effects. In Appendix Table 20 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.

The main strategy is a difference-in-difference strategy. We want to double check our results with a simple difference estimation. Columns 11 in the same tables 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.

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, clerical categories, making up in total roughly 10% of the labor force).

Table 17 presents the marginal effects. The effects have the same directionality as the baseline results, magnitudes are slightly bigger and all coefficients but the one for 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.

Spatial Randomization Placebo Test

I previously used the world price of gold to remove endogeneity concerns regarding the timing of opening of a new mine. We may also think that the mine location is a potential source of endogeneity - perhaps mines open in communities that have certain characteristics. To explore such potential concerns, I conduct a pseudo test where I randomize the mine location. In Figure 6 and Figure6 the mine location has been moved randomly by a distance up to 50km. The mine has kept its de facto opening year.

The figures shows the distribution of treatment effects 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). Since the mine is moved up to 50km, and the estimated treatment area reaches up to 15km, the specification will induce some overlap between the actual caption area and the pseudo caption area. Despite, the likelihood that parts of the actual treatment is captured in the randomization, the large part of the density distribution is to the left

Figure 5: Marginal Effects from Multinomial Logit

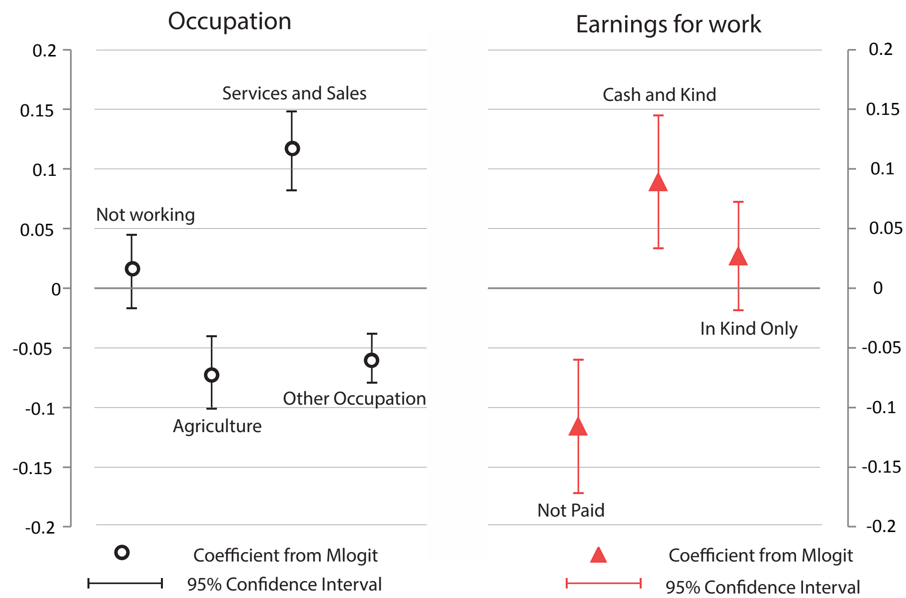


Figure 5 shows marginal effects calculated from two multinomial logit regressions. The first regression is sector of occupation, and the second regression earnings for work. Both regressions are using the baseline specification with 15km distance dummy. The specification includes controls for urban, education, age, district fixed effects and year fixed effects. The Appendix Table 17 presents the main coefficients.

of the estimated positive treatment effect for services (Figure 6) and right of the treatment effect for accepting domestic violence (Figure 6). The overlap in caption area may create the small skewness of the density from zero treatment effect, as expected.

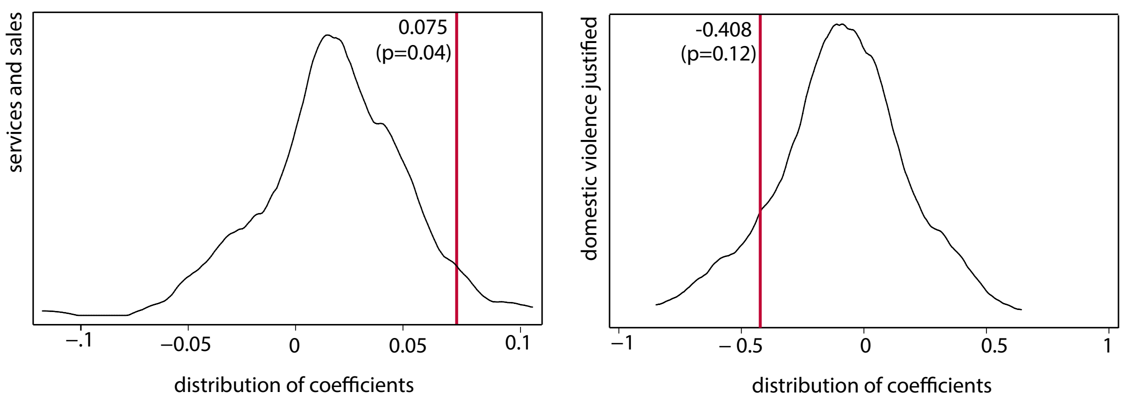
Multiple Inference Hypothesis Testing

The women's empowerment outcomes consist of three main sets of outcomes: attitudes toward domestic violence, barriers to health care and her decision making power in household decisions. The three clusters of indicators are indexes constructed from a wider set of variables. To avoid issues with multiple inference testing, I have chosen to construct simple indices, ranging from zero to one, if a woman agrees with the statements. The indices are made up of those variables that have more than 27k respondents. This excludes decision making power over daily purchases and husband's salary that have 19,072 and 9,516 observations each[14].

The original data structure is presented in Table 18, Panel A, B and C. If we run an individual regression for each indicator, the risk of observing a significant result due to chance increases. If $\alpha = 0.05$ and as for domestic violence, there are 5 outcomes, the risk of getting a significant result

[14] Results for baseline specification including these two are available upon demand. Including daily purchase increases the coefficient size, but the coefficient remains insignificant. Given limited overlap between the different variables, it is not feasible to include all five indicators.

Figure 6: Spatial Randomization Placebo Test



Figures 6 shows results from re-estimation of the baseline specification but with mine location removed up to 50km from original mine location. The likelihood of a woman working in the service sector (baseline specification) showing the density from 600 randomizations and the initial estimate, and the likelihood of a woman accepting domestic violence (count).

by chance is calculated by:

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

There are a few ways of overcoming this. We can restrict the hypotheses that we test by using an index (which is the preferred method). We can also correct for family wise standard errors (more here). The Bonferroni correction redefines the significance cut-off level to $\alpha/n = 0.05/5 = 0.0025$, a more conservative level than before. I present the Bonferroni corrected p-values in the Table 18.

We have reason to believe that the answers for women correlate across the indicators within each of the three clusters for female empowerment, so I run seemingly unrelated regressions for the three sets of empowement measures. The results are presented in Appendix Table 18. The magnitudes are similar for the LMP specification (Panel Aa, Ba, and Ca), and the seemingly-unrelated regressions (SUR) (Panel Ab, Bb, and Cb), but slightly stronger using SUR. Additionally, the coefficient for money is now significantly estimated and with a larger magnitude.

In addition, I do 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 13 Panel A, B and C. The results have the same direction as the baseline but with bigger coefficients.

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 21shows 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 interactions between rainfall in levels and the presence of an active mine are insignificant in all birth trimesters. Further analysis, using more detailed data, outght to be done before we conclude that there are no heterogeneous effects on infant mortality with exposure to pollution.

6 Conclusions

The large-scale gold mining industry is rapidly expanding in Africa. This is happening while we, as 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 can bring new types of employment for women. 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. Women in mining communities are 23% less likely to state a barrier to health care and are 20% less likely to accept domestic violence. Infant mortality more than halves and the drop is larger for girls than for boys. A high gold price may mean more production and/or higher wages to miners, leading to more trickle down of economic effects into these 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, migration, and withstand a spatial randomization placebo test.

The main effects, such as the 9pp increase in service sector jobs, is large compared with effects from the randomized control trial literature where different interventions aiming at increasing non-farm, outside of household, income generating activities, estimate effects along 2.4pp to 6.8pp (Attanasio et al., 2012; Bandiera et al., 2014; Jensen, 2012). Using the Ghana Living Standards Measurement Survey, I estimate that the worth of a service sector job for a woman. Women in Ghana working in services and sales have a 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 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 strech beyond the labor markets. One pressing issue, especially in some of the study countries, is intimate partner violence. Intimate partner violence in prevalent everywhere in the world. 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 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 GPD annually. This is through its direct health costs, through losses to current and future income, physical and psychological costs for women and children. In this paper, we estimate that women's acceptance rate of violence decreases, from a almost shockingly high mean (almost 1 in 2 women thinks violence is justified), with 20%. If a 20% reduction in acceptance of domestic violence leads to a 20% decrease in the prevalence of violence, the economic gains are potentially huge. The monetary gains of such a potential decrease in violence are far beyond the scope of this study.

Despite concerns that revenues from mining are unfairly 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 main counterfactual in this study is 'no mine', and I estimate the average impact of a large gold mine. As policy makers we can 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.

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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 Rozensweigh and Schultz (1982). A primary care giver gets utility from the following function

$$U = U(X, Y, H) \tag{8}$$

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

$$H = F(Y, Z, E, \mu) \tag{9}$$

where Z is health market inputs, such as health care, 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

$$I = XP_x + YP_y + ZP_z \tag{10}$$

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

$$I_{disp,w} = s(I_w + I_m) \tag{11}$$

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:

$$s = F(I_w, I_h, (I_w/I_h)) \tag{12}$$

That is s is determined by the absolute income of each partner, and the relative share. I assume that s increases with the husbands's income from the absolut 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, 2013).

Table 10: Child Health

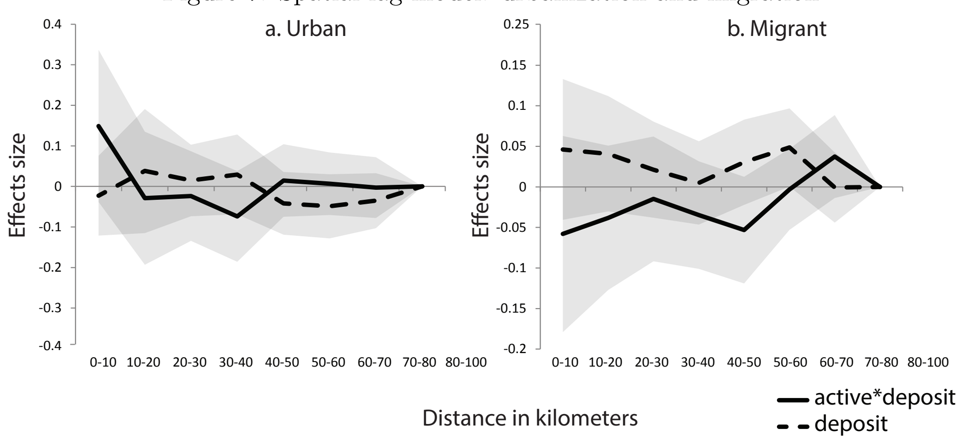
Positive	Negative
hh income effect ($I_w + I_h$)	opportunity cost time (P_y)
woman's income (I_w)	environment (E)
bargaining power (s)	
health care (P_z)	

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 health care 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 7: 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.

Table 11: Summary statistics: all outcomes

Variable		Mean	Std. Dev.
barriers to health care			
distance	... is a barrier to seek health care	0.910	0.285
money	... is a barrier to seek health care	0.922	0.268
permission	... is a barrier to seek health care	0.877	0.340
final say			
health care	has final say on health care	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 visist	has final say on family visits	0.406	0.491
food	has final say on food	0.543	0.498
# final say	number of agreed statements	0.971	1.148
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
Observations		57.685	

Table 17: Marginal Effects from Multinomial Logit

Panel A: Occupation				
	Not working	Agriculture	Service and Sales	Other
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)
Panel 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)	

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 5.

Table 12: Alternative specifications: Occupation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	nothing	controls	controls	baseline	FE	FE	FE	trend	clusster	diff	diff
Panel 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)	
Panel 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)	
Panel 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)	
Panel 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 13: Alternative specifications: Female empowerment

	(1) nothing	(2) controls	(4) controls	(3) baseline	(5) FE	(6) FE	(7) FE	(8) trend	(9) cluster	(10) diff-diff	(11) diff	(12) PCA
Panel 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)		
Panel 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)		
Panel C: Choice set (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 14: 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	clust	diff	diff
Panel 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)	(0.022)	(0.023)	(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)	(0.019)	(0.019)	(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
Panel 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
Panel 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)	(0.025)	(0.026)	(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)	(0.025)	(0.025)	(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 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: Urbanization

	(1)	(4)	(6)	(8)	(10)	(12)	(14)
VARIABLES	not working	agriculture	service and sales	cash	barriers to access health care	accepts domestic violence	household bargaining power
active * deposit	0.048	-0.071	0.105***	0.038	-0.106**	-0.112**	0.020
	(0.033)	(0.052)	(0.028)	(0.045)	(0.047)	(0.045)	(0.050)
deposit	-0.073**	0.033	-0.036	-0.013	0.041	0.069	-0.033
	(0.034)	(0.051)	(0.023)	(0.034)	(0.036)	(0.042)	(0.039)
urban * active * deposit	-0.005	0.002	-0.065	-0.201	0.192***	0.154*	-0.124
	(0.058)	(0.101)	(0.055)	(0.128)	(0.065)	(0.083)	(0.077)
urban * deposit	0.013	-0.089	-0.007	-0.059	-0.056	-0.102**	0.074*
	(0.052)	(0.079)	(0.048)	(0.120)	(0.047)	(0.051)	(0.041)
urban	0.078***	-0.316***	0.226***	0.176***	-0.089***	-0.052***	0.023**
	(0.009)	(0.014)	(0.011)	(0.016)	(0.016)	(0.015)	(0.012)
N	55,944	55,944	55,944	35,020	31,485	30,693	27,482
R^2	0.197	0.403	0.164	0.357	0.240	0.344	0.286

*** 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, survey month, country, district and country-year fixed effects.

Table 16: Occupation on intensive and extensive margin and wage rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	worked (12m)	worked (7d)	hours (7d)	agriculture	service and sales	mining	ln wage	ln hh 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*woman	0.052	0.061	-3.458	-0.054	0.115**	-0.035	0.836**	
	(0.037)	(0.042)	(3.377)	(0.058)	(0.056)	(0.064)	(0.373)	
deposit*woman	-0.009	-0.030	-1.567	0.069*	-0.037	-0.108**	-0.637**	
	(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	5,056,792

*** 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 18: Intrahousehold bargaining power: All variables estimated with LPM and SUR

	(1)	(2)	(3)	(4)	(5)
		she has a final say on (how to spend on)...			
Panel A	healthcare	large purchase	daily purchase	family visit	husband wage
a. LPM					
active*deposit	0.014	0.017	0.056	0.022	-0.026
	(0.056)	(0.049)	(0.050)	(0.058)	(0.068)
Bonferroni p					
b. SUR					
active*deposit	0.013	0.006	-0.007	0.027	
	(0.034)	(0.036)	(0.038)	(0.038)	
N	27,582	27,565	19,072	27,505	9,516
		a husband has the right to beat the woman if she...			
Panel B	burns food	refuses sex	argues	neglects kids	goes out
a. LPM					
active*deposit	-0.002	-0.124***	-0.093*	-0.117***	-0.086**
	(0.042)	(0.035)	(0.049)	(0.041)	(0.039)
Bonferroni p					
b. SUR					
active*deposit	0.011	-0.123***	-0.093***	-0.106***	-0.077**
	(0.027)	(0.029)	(0.031)	(0.031)	(0.031)
N	31,423	31,038	31,396	31,426	31,455
	is ... a barrier to seeking health care?				
Panel C	distance	money	permission		
a. LPM					
active*deposit	-0.112**	-0.020	-0.032*		
	(0.053)	(0.026)	(0.017)		
Bonferroni p					
b. SUR					
active*deposit	-0.146***	-0.086***	-0.043*		
	(0.031)	(0.032)	(0.024)		
N	31,485	31,488	31,486		

*** 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, survey month, country, district 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 justfity 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 health care for herself. The questions are "is money/distance/permission a hinder to seek healthcare for yourself?"

Table 19: Observable characteristics of women and selective fertility

	(1)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	age	ever married	curr cohab.	divorced	no education	+ 3 yrs	no education	+ 3 yrs
Panel A. All women								
active * deposit	0.507	0.006	0.016	-0.003	-0.027	0.003		
	(0.382)	(0.017)	(0.019)	(0.008)	(0.021)	(0.020)		
active * deposit at age 14							-0.008	0.083
							(0.035)	(0.068)
deposit	-0.226	0.001	-0.004	-0.001	0.019	0.002	0.015	-0.110
	(0.345)	(0.015)	(0.017)	(0.007)	(0.018)	(0.018)	(0.034)	(0.068)
N	57,590	57,589	57,589	57,589	57,590	57,590	10,415	10,415
R^2	0.038	0.351	0.274	0.041	0.447	0.434	0.452	0.435
Panel B. Non-migrants								
active mine	1.128	0.003	-0.002	-0.001	-0.020	0.008		
	(0.824)	(0.037)	(0.042)	(0.019)	(0.040)	(0.035)		
deposit	-0.308	-0.002	-0.008	0.002	0.015	-0.001		
	(0.629)	(0.031)	(0.036)	(0.013)	(0.033)	(0.029)		
N	17,004	17,004	17,004	17,004	17,004	17,004		
R^2	0.084	0.442	0.367	0.059	0.500	0.499		
Panel C. 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

*** 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, survey month, country, 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: Changing the control group: drop individuals 15-30 or 10-30km away

	(1) service and sales	(2) barriers to health care	(3) accepts violence	(4) infant mortality	(5) mortality boys	(6) mortality girls
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

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, mother's education, urban, and fixed effects for birth year, birth month, district, country-year.

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

	(1) 12 months children	(2) 12 months boys	(3) 12 months girls
Panel A. All children			
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	0.102	0.092
mean of rain (trim)*active	0.001	0.001	0.001

*** 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, country, 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 health care	
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 health care 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: Heath effects of toxic waste from gold mining

Heavy metal	Arsenic	Cyanide
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
Source	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
Total		208,223