
Artisanal small-scale mining: a poisoned golden ticket for women's empowerment?

A differences-in-differences approach in Burkina Faso

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Chapter 1. Introduction

“Expansion of freedom is viewed (...), both as the primary end and as the principal means of development. Development consists of the removal of various types of unfreedoms that leave people with little choice and little opportunity of exercising their reasoned agency. The removal of substantial unfreedoms (...) is constitutive of development” (Sen, 1999, p.12).

The so-called southern countries have access to plenty of the world’s richest oil and mineral reserves (Humphreys, 2009). More specifically, this is the case in Burkina Faso, where gold mining accounted for 67% of exports value in 2010 (Zabsonré, Agbo, & Somé, 2018). With an agricultural vocation and 41% of the population living under the national poverty line (World Bank, 2018), evidence has suggested that the gold exploitation can raise people’s living standards in Burkina Faso (Bazillier & Girard, 2020; Zabsonré et al., 2018).

However, natural resources abundance may not improve living standards and even undermine economic performance, especially with poor institutions (Mehlum, Moene, & Torvik, 2006; Sachs & Warner, 2001). A low regulated and informal sector such as mining is likely to see, among other things, child labor (Ahlerup, Baskaran, & Bigsten, 2020; Santos, 2018; Zabsonré et al., 2018), violent conflicts (Côte, 2013; Lujala, Gleditsch, & Gilmore, 2005), and low environmental preservation (Aragón & Rud, 2015; Chuhan-Pole, Dabalen, & Land, 2017 ; Werthmann, 2017). While the economic literature on gold mining has focused primarily on its implications at the household level, concerns about women’s status have been less addressed.

Although this issue is relevant globally, it remains urgent in sub-Saharan Africa, particularly in Burkina Faso, which ranks last¹ on the Gender Inequality Index and the Human Development Index (UNDP, 2018). Despite the ratification of international and regional instruments for the protection of women in Burkina Faso, patriarchal attitudes, discriminatory practices, and stereotypes contribute to the maintenance of women’s inferior status and promote domestic violence (INSD, 2012).

For several decades now, women's empowerment raised global awareness in political and social sciences. Although the concept of empowerment is vague, and each discipline has its definition, one can generally understand it as “the process by which women gain power and

¹ Burkina Faso is in 183rd place for these two indicators out of 189 countries (UNDP, 2018).

control over their own lives and acquire the ability to make strategic choices” (UN, 2002, pp. 1). Among other elements², women's empowerment includes their right to have and determine choices; their right to have access to opportunities and resources; their right to have the power to control their own lives, both inside and outside the home (UN, 2002).

In the economic literature, attention has focused on how increasing women's relative economic resources within the household enables them to gain bargaining power and thereby participate more in household decision-making (Agarwal, 1997; Doss, 2013; Doss & Senauer, 1994; Duflo, 2003). To this end, among other things such as education and assets ownership, income and employment are essential factors that affect women's bargaining power (and thus their empowerment).

Consequently, this master's thesis aims to analyze these two issues by evaluating whether women's empowerment in Burkina Faso can be improved through the employment and income generated by the artisanal and small-scale mining (henceforth, ASM). Arthur-Holmes and Abrefa Busia (2020) have already analyzed qualitatively the case of women and their direct involvement in artisanal mining in Ghana. This work aims to quantitatively deepen the mechanisms and causal relationships between the occurrence of ASM and women's empowerment.

In this respect, I use a representative sample of the population in Burkina Faso from the Demographic Health Survey database and a map of the small-scale gold mines. Estimations are made using a differences-in-differences strategy where I compare individuals living near and far from mines in rural areas. I do not directly evaluate people's involvement in mines, but I instead analyze their geographical exposure to mining exploitation. The underlying assumption of such reasoning is that people living near mining sites are more likely to be affected by the implications of the arrival of ASM rather than people living far from it. Then, to detect any form of discrimination against women, I compare the estimations between women and men.

Moreover, I only consider rural areas as most of the workers in ASM are rural dwellers and urban areas encompass many other economic opportunities. If urban areas are included, catching the effects of ASM's exposure becomes more complex as other economic opportunities are part of the game.

² Such as women's sense of self-worth; their right to have and to determine choices and their ability to influence the direction of social change to create more just social and economic order, nationally and internationally (UN, 2002).

While one might have hoped that this new economic opportunity would benefit women such as found by Arthur-Holmes and Abrefa Busia (2020), the results suggest that they lose out on empowerment and are more exposed to domestic violence. The dominant position of men is reinforced as men are more likely to enjoy the economic benefits that mining can bring and as women's contributions to the households are undervalued.

This thesis is structured as follows. Chapter 2 aims to set the context and review the existing economic literature on gold mining and women's empowerment. In this chapter, the assumptions and hypotheses are formulated given the evidence in the literature. Chapter 3 presents the data used for the quantitative analysis and describes the variables. Next, chapter 4 starts by reviewing the previous empirical method used in the gold mining literature and then discusses the current empirical strategy. Chapter 5 presents the evidence of the causal relation between ASM and women's empowerment. Finally, chapter 6 concludes, and presents possible extensions to this research and policy recommendations.

Chapter 2. Context and Literature Review

This chapter reviews the existing economic literature on gold mining exploitation and women's empowerment. The first section sets the context and describes the mining operations. The following two sections deal with the economic mechanisms resulting from the emergence of the ASM exploitation. The fourth section discusses the evidence and theories related to women's bargaining power and domestic violence. Furthermore, according to the existing evidence in the literature, two assumptions and four hypotheses are presented. The assumptions are not tested but are necessary to formulate the hypotheses actually tested.

2.1. Background

2.1.2. Historical Context

Current artisanal gold mining in Burkina Faso began in the northern part of the country around 1980, during a drought that affected several West African countries (Gueye, 2001; Werthmann, 2009, 2017). During these years, drought severely impacted the rural economy and gold panning emerged as an alternative source of income (Gueye, 2001). Then, the activity started to reach the south and western parts of the country at the end of the 1990s (Werthmann, 2009).

Since the 2000s, this sector has generally become even more important in Sub-Saharan Africa but particularly so in Burkina Faso where, this activity represented 67% of all export value in 2010 (Zabsonré et al., 2018) while 6% in 1998 (Bazillier & Girard, 2020). This was mainly caused by a boom in the price of gold, as shown in Figure 1.

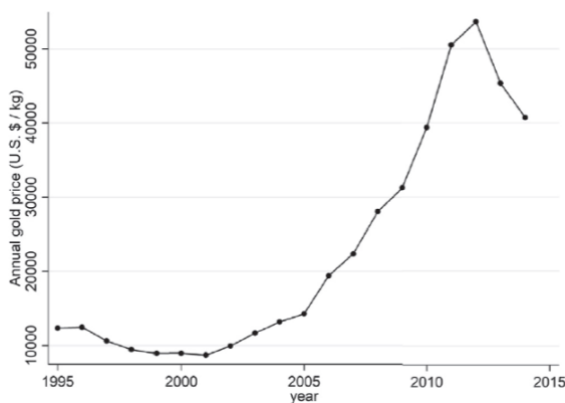


Figure 1. Evolution of the gold price, 1994–2014 (Bazillier & Girard, 2020).

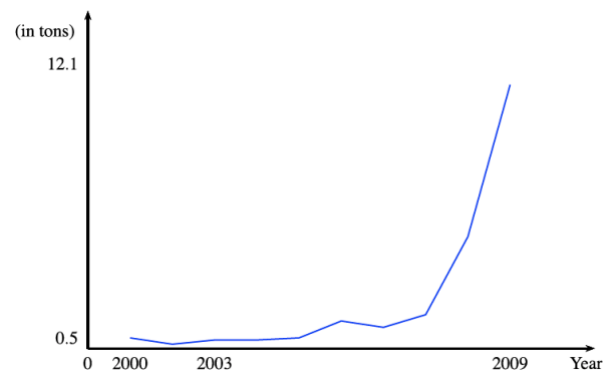


Figure 2. Evolution of gold production in Burkina Faso, 2000-2009 (Zabsonré et al., 2018)

As Burkina Faso is a price taker on the international gold market, fluctuations in the price of gold directly determine the profits of gold mining activities (Bazillier & Girard, 2020). Consequently, the amount produced (see Figure 2) and the revenue generated increased substantially as world gold prices rose the profitability (Bazillier & Girard, 2020; Zabsonré et al., 2018).

2.1.2. Gold Mining: Definitions and Characteristics

In order to describe gold mining exploitation in general, one should distinguish between industrial and artisanal (and small-scale) gold mining. Industrial mines can be characterized as capital-intensive and high-tech branches of international companies (Bazillier & Girard, 2020; Zabsonré et al., 2018). Industrial mines usually have formal contracts with skilled workers (Bazillier & Girard, 2020).

Next to industrial mining, artisanal and small-scale mining is a traditional and labor-intensive activity (Bazillier & Girard, 2020). In 2014 in Burkina Faso, the industrial mining sector reported employing 6,464 people (ITE, 2016), while, in 2014, artisanal mining was a crucial livelihood for 3,200,000 people, equivalent to 18% of the country's population (UN, 2016). As further detailed below, ASM constitutes an activity for mainly two different groups: (1) farmers who are also involved in mining during the dry season and (2) itinerant miners and full-time gold miners (Hilson, 2009; Werthmann, 2009).

According to the Burkinabe mining code³, *artisanal mining* is defined as “the set of operations that extract and concentrate mineral substances such as gold, diamonds and other gems from primary and secondary outcropping deposits and recover the marketable products thereof using manual and traditional methods and processes. It does not use equipment or mechanical energy and is not based on the identification of a deposit”. *Small-scale mining* includes artisanal mines and those using semi-industrial processes based on the primary discovery of a deposit.

In practice in ASM exploitations, gold miners descend with ropes in narrow shafts that can be down to 100 meters deep to extract the potentially gold-bearing ore. Then, back at the surface, the ore is worked and screened to extract the gold (Drechsel, Engels, & Schäfer, 2018).

³ This was retrieved from *Le Code Minier Du Burkina Faso* available here: <https://www.droit-afrique.com/uploads/Burkina-Code-minier-2015.pdf>

Another important characteristic of the ASM is the counter-seasonal⁴ phenomenon that peaked during February and March (Bazillier & Girard, 2020). There are two main reasons for this. Firstly, mining occurs when there is nothing left to do in the fields (Jacques et al 2005). Secondly, the peak of the rainy season⁵ puts artisanal mines at risk of collapse and landslides (Bazillier & Girard, 2020).

According to Bazillier and Girard (2020), ASM activities meet the characteristics of common property management. Property rights are “exercised (at least) collectively by members of a group. (...) Several pivotal people have claimed over a share of the resources, and they are constantly re-negotiating. Newcomers will always be able to take part in the production process” (Bazillier & Girard, 2020, pp.4). In addition, these organizations rely on relatively well-functioning non-written informal regulations. After investigating 60 mining sites in Burkina Faso, Jaques, Zida, Billa, Greffié, and Thomassin (2006) asserted that they are endowed with well-defined structures and high degrees of organization.

Alongside the property right characteristic, there is rivalry in consumption: one cannot exploit what has been dug by one’s neighbor. Unlike a public good, gold provides utility only to the individuals who seek it. Bazillier and Girard (2020) argue that newcomers can participate because there is no long-term planning and anticipation of site depletion. However, the access to the most productive wells is restricted and occurs via relationships (Arnaldi di Balme & Lanzano, 2013). Nevertheless, as discussed below (see section 2.2.2), many conflicts are present around the mines, which sometimes could prevent the participation of all the miners. Finally, ASM is also characterized by investment failure. While small groups can organize themselves to extract minerals with basic tools, coordination fails when it is necessary to strategically plan the speed of extraction or make more significant investments to drive production more efficiently (Bazillier & Girard, 2020).

2.1.3. Conclusion

With the external shock in the gold price, gold exploitation became more profitable than before. As a result, Burkina Faso experienced an increase in its gold exploitation. There can be different types of gold exploitation: industrial, small-scale, and artisanal. Although I have only access to data on small-scale mining, the physical border between small-scale and artisanal

⁴ In contrast, agriculture is a seasonal activity and mainly occurs during the rainy season.

⁵ Rainy season in Burkina Faso is between May to mid-October.

mining is likely to be blurred⁶ (Bazillier & Girard, 2020). Therefore, the focus of the thesis is stressed on artisanal and small-scale mining. Finally, this phenomenon is mainly counter-seasonal and occurs when there is nothing to do in the fields. The next section aims at analyzing the economic implications at the market level arising from the gold boom exploitation.

2.2. Economic Implications at the Market Level

2.2.1. Labor Market Effect

Due to the ASM's labor-intensive nature, it is expected that each mining-created job in ASM interacts with a different one in the local labor force in order to fulfill miners' needs. These goods and services range from taxi drivers and water supply to prostitution (Hilson & Hirons, 2011; Werthmann, 2017).

According to Bazillier and Girard (2020), 18% of the Burkinabe population depends on ASM for their livelihoods (estimations for 2014), while around 7% of the total population are directly getting into gold panning in Burkina Faso (estimations for 2011) (Thiombiano, Thiombiano, Maradan, Zein, & Ouedraogo, 2011). Although these estimates are for different years, they are both after the gold boom and suggest that more people depend on it than are directly involved. In South America and African countries, several studies analyzed this local labor multiplier effect resulting from the mining sector, and in that respect, the effects are mitigated.

In South America, the effects seem to be positive. Aragón and Rud (2013) found that the demand shock for local inputs⁷, acting as a labor demand shock to the local economy (Moretti, 2010), increases the income in the service sector surrounding one of the largest mines in the world located in Peru, compared to places farther away. This rise in income is, in turn, paralleled by an increase in household consumption and a poverty reduction. However, Aragón and Rud (2013) suggested that the increase in local revenue and public expenditure associated with a resource boom do not translate into higher household income. Similarly in Peru, Loayza, Teran, and Rigolini (2013) documented a positive relationship between measures of living standards (such as poverty, consumption, and literacy) and mining production. However, government transfers associated with mining revenues have a minor impact on poverty reduction. In

⁶ This argument is further explained in section 4.1.

⁷ Due to the growth in gold production.

Columbia, areas near a gold mine site have a lower unemployment rate than to those without (Santos, 2018).

Regarding the African continent, Kotsadam and Tolonen (2016) provided evidence that industrial mine openings appear to create new employment opportunities outside agriculture, and the effects are differentiated by gender. The gender perspective is further discussed in section 2.3.2. Considering industrial mining and ASM in Burkina Faso, Zabsonré et al. (2018) found that the headcount ratio and the poverty gap decrease more in producing regions than in non-producing regions. The average per capita expenditure is 12% higher than in non-producing ones.

Yet, after reviewing 52 studies, Gamu, Le Billon, and Spiegel (2015) indicated that industrial mining is likely to be more associated with exacerbating poverty, while artisanal and small-scale mining has a positive effect on poverty reduction. This last argument is in line with results found by Bazillier and Girard (2020) for Burkina Faso. The latter documented that industrial mines, a low-labor intensity sector, do not improve local economic conditions: the efficiency gained from the privatization of the gold resources by industries does not translate into a gain for the local workforce. Instead, ASM increases household consumption by 15% (Bazillier & Girard, 2020). Whereas artisanal mines raise local consumption, their contribution to the state revenue is somewhat smaller than those of industrial mines, both in relative and absolute terms. Nevertheless, by considering the consumption effect for households near ASM, the contribution of ASM to the Burkina Faso economy represents 158% of the contribution of the industrial mines.

Box 1. Assumption 1 - at the Market Level

The boom in gold prices implies greater profitability in mining for the local population, which impacts the employment structure of the rural economy.

2.2.2. Conflicts, Informality, and Corruption

A strong informality characterizes ASM. In Burkina Faso, of the 1,000 existing mines (Drechsel et al., 2018), 159 have a permit (Thiombiano et al., 2011). As a result, around 1 million Burkinabe are involved in informal and illegal mining (Thiombiano et al., 2011).

Mines also have a reputation for being places where drug addiction, crime, violence, and prostitution prevail (Werthmann, 2009). These elements are not without consequences for the populations. For example, it has been reported that the influx of male workers into the mines in South Africa has led to significant epidemics of HIV (Rees, Murray, Nelson, & Sonnenberg,

2010). In addition, the exploitation of natural resources can lead to violent conflicts and civil war (Lujala et al., 2005), such as between local populations and internal migrants attracted to mining areas (Côte, 2013).

Resources can also be a tempting target for predatory political groups and lead to corruption (Ahlerup et al., 2020). Knutsen, Kotsadam, Hammersmark, and Wig (2016) found that once the mines open, the area becomes more corrupt. Indeed, compared to non-mining areas, mining revenues encourage and enable local officials already present to demand more bribes. This evidence is not surprising after discussing above that the public gains from mining activity are not reflected in the increase in household living standards (Aragón & Rud, 2013; Loayza et al., 2013), although the analyzed areas of income transfers and the existence of bribes are different.

2.2.3. Negative Environmental Externalities

Gold mining exploitations also have a terrible reputation for preserving the environment (Bazillier & Girard, 2020). Artisanal gold miners use metal detectors to find gold deposits and cyanide in addition to mercury to extract the gold (Chuhan-Pole et al., 2017 ; Werthmann, 2017). Mercury and cyanide have cumulative harmful effects on human and animal health and on the quality of soils and water sources (Chuhan-Pole et al., 2017 ; Werthmann, 2017). Although both substances are banned in Burkina Faso, they are widely used (Werthmann, 2017). In addition to the usage of the toxic substance, mining causes other environmental issues such as “devastated landscapes, characterized by huge holes (artisanal shafts can be up to 130m deep) and underground galleries, destruction of fields and cover vegetation, and illegal cutting of trees that serve as support beams in the extraction shafts” (Werthmann, 2017, p. 422). Moreover, many rubbish and toxic waste, including plastic bags, batteries, and motor oil, are discharged into nature (Sawadogo, 2011).

Given these destructive environmental realities preventing healthy living conditions, mining practices are not without consequences for agricultural labor productivity. In Ghana, Aragón and Rud (2015) found that pollution from large mining sites has resulted in a decrease of 40% of the total factor productivity of households living close to them. This externality is particularly important in rural areas where agriculture remains an important means of livelihood. Indeed, the loss of agricultural productivity hampers the income of farmers and rural populations (Chuhan-Pole et al., 2017).

The results are ambiguous regarding the impact of mining and pollution on health. On the one hand, the positive impact of gold mining on incomes may increase the ability of households

to live in healthy conditions. Parker, Foltz, and Elsea (2016) found that a reduction in mining activities due to law restrictions increases the mortality of children. This increase in infant mortality is explained by the decrease in mothers' consumption of child health goods and services (Parker et al., 2016). Continuing in this vein, Bazillier and Girard (2020) reported no adverse effects on health. They even documented a marginally significant amelioration in children's health consistent with the income effect of artisanal mines outweighing any pollution effect. However, the health proxy used lacks precision since they consider whether the children were sick or injured during the 15 past days. In addition, the p-value obtained exceeds the 10% level. As a result, with that variable, nothing can be said about the long-term effects that might result from the exposure to the mine's activities.

On the other hand, given the existing evidence on toxic exposure around mines discussed at the beginning of the section, the negative impact on health can be important. Using data from 44 different developing countries, von der Goltz and Barnwal (2014) suggested that, living near mines is associated with increased stunting in young children and anemia among young adult women, despite a substantial increase in wealth. Similarly, in Chile, Rau, Reyes, and Urzua (2013) suggested that pollution can harm cognitive outcomes and educational attainment leading to a significant loss of income in adulthood. They showed that the critical levels of lead and other heavy metals in children's blood living near a mineral waste deposit negatively impact their educational outcomes and income in adulthood.

2.2.4. Conclusion

At the market level, it can be noted that the expansion of labor-intensive artisanal mining activity has led to the creation of additional jobs than mining work. In doing so, the areas near the mines seem to benefit the local population in terms of employment and income (although public revenues from mining are less likely to be translated into economic gains for the local population). Nevertheless, mining exploitations are informal and can generate conflicts. In addition, mining practices degrade the environment, and evidence have tended to suggest the negative impacts of pollution on health and productivity. After analyzing the impact of mines at a more global level, the following section aims to describe the mechanisms at the household and individual levels.

2.3. Economic Implications at the Household and Individual Levels

2.3.1. Decisions of Mining Participation

Two main narratives attempting to explain people's motivations in ASM have been identified (Hilson, 2009; Werthmann, 2009).

The first, often supported by donors, argues that agents move to ASM because they seek to make wealth (Hilson, 2009), or emancipate themselves (Werthmann, 2009, 2017). Mining offers career opportunities and a new way of life for the *fortune-seekers*. They migrate to ASM in order to improve their social status, invest in housing (Grätz, 2009), or have the opportunity to purchase consumer goods that are rarely available in remote, agricultural villages (Werthmann, 2017). Young people consider mining areas as an initiation phase, a way to break free from the authority of elders and the constraints of custom (Werthmann, 2017). As a result, mining generates an heterogeneous environment where people from different skills and backgrounds interact (Zabsonré et al., 2018). Nevertheless, this involvement type only applies to a minority of situations (Hilson, 2009).

Most people are involved in ASM because they face precarious financial situations and are desperate to escape poverty (Maponga & Ngorima, 2003; Werthmann, 2017). Participants in mining continue to rely mainly on agricultural activities but use ASM during the dry season (Bazillier & Girard, 2020; Werthmann, 2009) as a *diversification strategy*⁸ providing additional income to farming (Banchirigah & Hilson, 2010; Hilson, 2012; Maconachie, 2011; Siegel & Veiga, 2010). They have been forced to diversify their income to survive in a liberalized market and to lower riskier returns from subsistence agriculture (Ahlerup et al., 2020; Hilson, 2016).

A long-term perspective on development suggests that poverty reduction is associated with mobility from rural areas and agriculture to non-agricultural settings (Beegle, De Weerd, & Dercon, 2011). This argument can be carried over to the case of ASM, where both motivations are intrinsically stimulated by increasing income and living standards.

Decisions to move from subsistence agriculture to the mines stimulated by increased income may, by extension, reflect the theories on migration. More specifically, the *fortune-seeker* and the *diversification strategy* motivations can reflect the level at which the decision to move (or in our context to participate in the mine) is made. Those levels of decisions align with

⁸ In contrast, industrial mining generally involves wealthy investors motivated by the prospect of long-term returns (Gamu et al., 2015).

the unity of analysis that exists respectively for the different economic migration models. The *fortune seeker's motivations* are in line with the *classical and neoclassical models of migration*, such as those developed by Lewis (1954) or Todaro (1969), where the migration decision is made at the individual level. In contrast, the *household diversification strategy* aligns with the *new economics of migration*, where the migration decision is taken at the household level (Taylor & Martin, 2001). As we will see later, migration as such will be a problem in our estimation. For this reason, we can understand the concept of migration below as a short-term labor mobility in agriculture to a non-agricultural activity.

Fortune and emancipation seeker motivation is more based on an individual decision so as in *the classical and neoclassical models*. Lewis' model suggests that an unlimited supply of labor in the traditional sectors of less developed countries could be absorbed by capital accumulation and savings in an expanding modern sector (Lewis, 1954). In our case, the traditional sector can be understood as agriculture, while the expanding modern sector is ASM. Todaro (1969) argues that each potential migrant individually decides whether or not to move - in our case, to the areas around the gold mines, based on the objective of maximizing expected income. The expected income of the gold mining area in a given location is the product of the wage and the probability that a potential migrant will succeed in getting a job around or in the mine.

In contrast, the second motivation, i.e., diversification and poverty-driven, is more in line with *the new economics of migration*. The latter views migration decision as occurring within the household: family members are assumed to collaborate to maximize expected income and also to relax constraints related to the absence of credit, insurance, and other markets (Stark & Bloom, 1985). Stark (1982) argued that a rural household in developing countries wishing to invest in new technology or move from low-income family production to commercial production does not have access to credit or income insurance. By placing a family member in the migrant labor market, this household is investing in a new financial intermediary in the person of the migrant. Rural households bear the costs of supporting migrants at the outset. In return, once migrants are established in the labor market, they provide subsistence for their households in the form of remittances and insurance. In brief, migration is seen as part of a livelihood strategy for the original household: the latter diversify their economic activities outside the traditional agricultural sector to secure other sources of income by sending their members to work for short periods (Deshingkar & Farrington, 2009)

Since the motivation of most of the people involved is poverty-driven, we can consider that the decision-making mechanisms to participate in the mines, in line with the *new economics of migration*, are first made at the household level.

Box 2. Assumption 2 - at the household level

Since mining is a counter-season activity, a rural household may use ASM as a diversification strategy to generate additional income from agriculture.

2.3.2. Different Individual Involvement Types

Once the household decides to participate in ASM, different individual participations occur within it. These are children's, women's, and men's involvement.

Children's Participation and Education

In Burkina Faso, Schipper, de Haan, and van Dorp (2015) estimated that 30-50% of the labor force in ASM are children. Moreover, according to the International Labor Organization, child labor in mining is increasing in Africa and Asia⁹. The gold mining boom and its increase in profitability can produce two opposing effects on child labor. The first is a *substitution effect* (schooling is substituted for work), and the second is an *income effect* (an increase in income decreases the opportunity cost of schooling).

With the increase in mining profitability, parents are more likely to send their children to work in the mine rather than in school¹⁰. The latter mechanism is the *substitution effect*. Santos (2018) and Ahlerup et al. (2020) found the substitution effect with an increase in the price of gold. Consistent with this view, school enrolment also declines. Consequently, they reported a negative impact on school performance. Apart from being forced to work in the mines by their parents, children may also realize themselves that their prospects for wage employment are limited, even with an education (Werthmann, 2017). As a result, many choose to work in the mines, where incomes are often higher than in other areas and where the income goes directly to them rather than being passed on to parents or other relatives (Werthmann, 2017).

The second effect that could arise is the *income effect*. As shown by Duflo (2001), the additional income generated by a boom in natural resources can be used to decrease the opportunity cost of schooling. As a result, their children can spend more time at school. This effect was found by Zabsonré et al. (2018), where the average per capita expenditure positively

⁹ <https://www.ilo.org/ipec/areas/Miningandquarrying/lang--en/index.htm>

¹⁰ Child labor does not prevent schooling (Hilson (2010); Potter and Lupilya (2016).

affects schooling and negatively affects child labor. However, they also found that gold extraction, in general, directly increases child labor.

Women's and Men's Participation in and around ASM

According to Werthmann (2009) and Arthur-Holmes and Abrefa Busia (2020), activities in mining camps follow the “gendered patterns typical for the wider society”. There are several reasons why women are generally excluded from working in the mining shafts. Some said that menstrual blood on bodies might “chase away” the gold (Werthmann, 2009). Others mentioned that women are easily scared and may fall into the pits by accident (Werthmann, 2009). As a result, direct participation in mining is generally done by men, while women's participation is mainly indirect. Indeed, women are widely overrepresented in the sales and service sectors (Hinton, 2006; ILO, 1999), such as, among others, coking, providing food, and being merchants (Werthmann, 2017).

This gender perspective has been empirically tested in the case of industrial mining by Kotsadam and Tolonen (2016). The authors showed that mine openings induce a switch from agriculture to service for women while men move to skilled manual jobs. In addition, women's labor force participation rates decrease with the opening of the mines, while they increase for men. These structural changes seem to persist after mine closure, at least for women. After mine closure, men return to the agricultural sector, but this is not the case for women. Instead, they leave the labor force¹¹. As discussed in section 2.2.1., these results suggest an employment boost at the local level in Africa, but with permanent adverse effects on women's labor force participation.

Box 3. Hypothesis 1 - at the Gender Level

With ASM acting as a new opportunity for the rural households during the dry season, they experience a labor reallocation of their members, affecting men and women differently.

2.3.3. Conclusion

There are two main narratives regarding the decision mechanisms of participation in ASM in the literature. One is rooted in an individual decision to emancipate him or herself and the other, the main one, occurs at the household level to generate additional income to that of

¹¹ Kotsadam and Tolonen (2016) estimated that more than 90,000 women obtain a job in the service sector as a result of industrial mining in their communities and that more than 280,000 women leave the workforce.

agriculture. Once the decision, at the household level, to participate in ASM is taken, different individual involvement types occur. Next to child labor, adult participation is gendered, with women predominating in the service sector and men directly in mining shafts. The following section aims to analyze what this gendered participation can produce in women's empowerment.

2.4. Women's Empowerment and Domestic Violence

This section moves away from the description of the gold mining context to investigate the channels through which ASM will impact the balance of power, especially women's empowerment, inside the household, and the effects arising on domestic violence. First, this section presents how income and employment with ASM may empower women. Then, variables used to measure women's empowerment are discussed. Finally, the impact on domestic violence resulting from a change in the power balance inside the household is investigated.

2.4.1. Employment, Income, and Women's Empowerment

Several models depict how decisions are made within a household. The unitary model considers household members sharing the same preferences and behaving as single decision-makers (Doss, 2013). However, this model is poorly supported empirically and in real life (Agarwal, 1997; Alderman & et al., 1995). Instead, the collective models consider each individual with his or her rational preferences, and household choices are assumed to result from a negotiation procedure where each member uses its bargaining power (Duflo & Udry, 2003; Lundberg, Pollak, & Wales, 1997). The latter is a function of existing external options available for the participants, including independent wealth (wage, nonwage income, parental wealth) and other factors that impact the welfare of individuals outside the relation, such as the legal structure of marriage (Doss, 2013; S. Kishor, 2000).

Therefore, based on economic theories of bargaining models, it was pointed out that women's economic role outside the home, ownership of property, and education should increase their bargaining power and their decision-making ability within the household to direct allocations and situations towards their preferences (Antman, 2014; Doss, 2013; Doss & Senauer, 1994).

Putting it in our context, this new type of employment around or in ASM and the resulting income for which other rural jobs cannot offer are factors that are important for increasing

women's external options and, therefore women's bargaining power (Arthur-Holmes & Abrefa Busia, 2020; Doss, 2013). Those two determinants of bargaining power, employment, and income are discussed below regarding their intrinsic natures in the studied context.

On the one hand, working outside the home can provide bargaining power by acquiring social and other skills needed to navigate the work environment. These skills can translate into increased bargaining power within the home (Doss, 2013). The acquisition of these skills is especially true in the ASM context, where women are involved in a more heterogeneous environment than subsistence agriculture. Through their participation around the mines, women may be in contact with mainstream media and emancipatory ideas (although it was stressed that this type of participation was not the main one).

On the other hand, the work itself can also increase women's overall workload and place them in dangerous or difficult situations due to the tasks or work environment (Doss, 2013). This argument is all the more important in the case of mines, where the environment is conducive to conflict, prostitution, and informality (see section 2.2.2). Yakovleva (2007) argued that while women benefit from their participation in illegal ASM in Ghana, their work environment puts their lives at risk and exposes them to health problems. In the Democratic Republic of Congo, King, Kelly, and Perks (2014) reported that some women experience exploitation and abuse at mining sites. Women are used as sex slaves by rebel groups and are forced to work on mining sites. These working environments weaken women physically and mentally by undermining their bargaining power.

Furthermore, because of their involvement, women may also risk of acquiring a bad reputation (Werthmann, 2009), which may also reduce their bargaining power. This effect was effectively found in the study of Arthur-Holmes and Abrefa Busia (2020). They reported that some men disregarded their wives' ideas and opinions regarding household decisions because they disapproved of their wife's work. Other husbands have also prevented their wives from pursuing those activities due to their bad reputation. Consequently, the potential beneficial effect of women's participation in mining is not met or, even worse, is diminished.

Finally, even though the time women spend on the market and non-market activities (domestic work, child care) is significant, the work done by women is undervalued because it generally yields no monetary income or because it is specifically carried out by women themselves (Agarwal, 1997). Increasing women's access to work, but whose contribution is perceived to be undervalued, may negatively affect women's empowerment. Systematically undervaluing women's contributions reinforces their low status. (Agarwal, 1997).

In short, both employment and income can improve women's bargaining power. However, women's bargaining power can also be hindered or diminished due to the nature of employment and income (such as a non-healthy work environment or the undervaluation of women's contribution to households).

Box 4. Hypothesis 2 - Factors influencing Bargaining Power

As this new opportunity impacts men and women differently, it is expected that the bargaining power of those who benefit from the positive insights of two of the influencing factors i.e., work and income, will be improved.

2.4.2. Measuring Women's Bargaining Power

It is not easy to directly perceive the bargaining power (Doss, 2013). As a result, different measuring methods, either directly or indirectly (inferential), have been identified in the literature. Even if it is common to use the inferential approach for the strength of the causality, we will rely on the direct approach due to data availability.

Moreover, to identify the bargaining power of men and women within a relationship, the necessary condition is to reject the unitary model and to consider that they have different preferences. If their preferences do not differ systematically, the impact of women's bargaining power will be underestimated and unlikely to be well understood (Doss, 2013).

Inferential approach

When the factor influencing women's bargaining power significantly impacts a specific outcome resulting from the bargaining process, it is inferred that women prefer that outcome (Doss, 2013).

For instance, Doss (2006) showed that women endowed with more bargaining power¹² in Ghana increased monthly expenditures on food and education. When men had higher assets share, spending on education and food was lower. Similarly, using quasi-experiments in Ivory Coast, Duflo and Udry (2003) exploited rainfall shocks impacting crop yields on separate plots between husbands and wives. They found that higher rainfall shocks for women plots, associated with higher women income and thus increased women's bargaining power, shifted households' expenditures towards food. In these studies, it is inferred that thanks to their increased bargaining power, women can direct the allocation of resources in the direction they prefer (Doss, 2013).

¹² Through a higher share of assets own by women including land, savings and business assets (Doss, 2006).

Direct Approach

The approach consists of directly looking at the impact when the bargaining power is raised on the extent of participation in decisions. Presumably, measuring who decides first or mainly in household choices reveals who (of the woman or the man) can meet his or her preferences (Friedberg & Webb, 2006).

Allendorf (2007) demonstrates that women's land ownership increases the probability of women's participation in household decision-making, such as having the final say on their own health care and making decisions for large household expenditures.

Although they did not use an empirical analysis, a similar situation can be found when women were directly involved in mining sites. Arthur-Holmes and Abrefa Busia (2020) argued that before their involvement in the mines, some women did not have the power to decide what food to prepare for their households because it was done by the men. With the cash income from their ASM activities, women can now decide what food to prepare for their partners and the rest of the household. However, when husbands provide the money for household food needs, men have more power or influence over the meal prepared.

Box 5. Hypothesis 2. bis - Decisions-Making

The greater the bargaining power of an individual, the greater the participation in the decision-making process.

However, one should be aware that those models may fail to consider the complexity of gender relations inside the household level (Agarwal, 1997; Katz, 1997). Individuals may not be fully aware of their own preferences and tastes or be equal in their ability to enter into the bargaining process (voice) or to leave (exit) (Katz, 1997). For instance, women may make the decisions but still be constrained or in conflict with their husbands' preferences (Doss, 2013). Hence, examining the link between violence and women's empowerment is discussed in the next section.

2.4.3. Domestic Violence and Women's Empowerment

The link between women's empowerment and domestic violence can be analyzed through two main lenses. The first is related to the household bargaining models (discussed above) and, the second is more in line with the sociological theory. On the one hand, women's empowerment can directly affect their well-being by reducing the violence they face. On the other hand, violence can occur when women's empowerment is inconsistent with social and patriarchal norms.

Marital Dependency and Household Models

It has been shown that the fewer resources women have, the more dependent they are on their husbands, and the more likely they are to experience physical violence from their husbands than women with lower dependency (Gelles, 1976; Kalmuss & Straus, 1982). In other words, a woman who has few outside options is more likely to be entrapped and tolerate a situation where she is beaten.

Furthermore, in societies where women cannot leave a violent marriage, especially in low-income countries, low empowerment and spousal violence together may form a vicious circle, making it difficult to discern the direction of causality (Bhattacharyya, Bedi, & Chhachhi, 2011; Sunita Kishor & Johnson, 2004). Violence can, in turn, impede women's ability to empower.

Conversely, when women's outside options are raised, their tolerance for violence decreases, as they need less financial support, and can therefore negotiate a better situation for themselves or just leave. Men are therefore limited in the amount of violence they can commit without triggering the end of the relationship (Gibson-Davis, Magnuson, Gennetian, & Duncan, 2005; Tauchen, Witte, & Long, 1985).

In the state of Kerala in India, Panda and Agarwal (2005) found that women's ownership of housing and farmland increases women's overall empowerment and protects them from physical or psychological abuse. In another Indian State, Uttar Pradesh, women's engagement in paid work and owning property ownership reduce the likelihood of experiencing physical violence (Bhattacharyya et al., 2011). In both cases, results suggest that increasing women's economic security, which reduces their willingness to tolerate violence by providing credible exit options, helps to deter domestic violence.

Challenging Gender Norms

Because domestic violence is culturally specific and linked to social and gender norms, the channel through which women's empowerment impacts domestic violence can be more complex. Indeed, violence can occur when women's empowerment is inconsistent with patriarchal norms. For instance, the increase in women's participation in the labor market challenges the male norm of solely contributing to family resources (Nock, 2001).

It has been shown that when the women's earnings or their education exceed those of their male partners, women are more likely to experience violence (Hornung, McCullough, & Sugimoto, 1981). Similarly, Macmillan and Gartner (1999) showed that men use violence to control their partners when women are involved in paid employment while they are not. By

analyzing nine low-income countries¹³, Sunita Kishor and Johnson (2004) reported that women paid in cash (compared to non-working women), were more likely to have experienced physical violence in their lifetime. Those arguments are incredibly consistent in societies where patriarchal gender persists, such as Burkina Faso (INSD, 2012; Werthmann, 2017), while they become less likely if the partner has more egalitarian views on gender norms (Atkinson, Greenstein, & Lang, 2005).

A more extreme case suggests that in India, an increase in women's rights is associated with an increase in wife-beating and suicide rates for both men and women related to family problems (Anderson & Genicot, 2015). This evidence could be interpreted as a communion of the two main lenses theorizing the use of violence. On the one hand, a situation, where women become more empowered than men may become unbearable for men. On the other hand, empowered women suffer more from violence, as this woman's status may not coincide with patriarchal gender norms. As a result, the incidence of family conflicts explodes, even leading to the suicide of women and men.

In any case, violence is a sign of conflict inside the households. As the balance of bargaining power is expected to shift, we should observe an impact on domestic violence.

Box 6. Hypothesis 3 - Domestic Violence

Although we cannot predict its direction, an impact on domestic violence is expected due to a shift in the balance of bargaining power.

2.4.4. Conclusion

When women's economic perspectives are increased, such as participation in ASM and the resulting income, they can gain some bargaining power and can thereby influence the household allocation of resources. Nevertheless, those factors can also have a counter effect on women's bargaining power due to the nature of their work or income. As bargaining power is difficult to perceive directly, two methods are widely used. The current thesis uses the direct method by looking at women's decision-making participation. Focusing only on the impact on women's power may hide other resulting dynamics such as violence. Although women's empowerment and violence may form a vicious circle, two opposing perspectives depict the direction of the causality of empowerment on domestic violence.

¹³ They made a statistical analysis of 9 countries with DHS Data. These are: Cambodia, Colombia, the Dominican Republic, Egypt, Haiti, India, Nicaragua, Peru, and Zambia (Sunita Kishor & Johnson, 2004).

Chapter 3. Data Description

The previous chapter reviewed the existing literature related to ASM and women's empowerment. In addition, the hypotheses to investigate the research question, i.e., the impact of ASM's exposure on women's empowerment, were formulated. As the aim is to verify them quantitatively, the description of the data and the variables used are provided in this chapter. The latter is structured as follows. First, I briefly describe the DHS Program in which the data are retrieved and its objectives. Second, explanations of how the datasets are combined into one and its composition are provided. The third section describes the variables used and provides a summary statistics table.

3.1. DHS Program Description

What?

The DHS Program has collected and analyzed nationally representative household data. It has more than 400 surveys in 90 countries containing primarily health and nutrition information. There are two types of DHS surveys: standard and intermediate. The standard DHS dataset contains large samples of between 5,000 and 30,000 people and is usually collected every five years. As the name implies, intermediate surveys are collected between two waves of the Standard DHS and have smaller questionnaires (ICF, 2022). In Burkina Faso, four waves of standard DHS surveys have been collected, i.e., in 1993, 1998, 2003, and 2010 (INSD, 1994, 2000, 2004, 2012).

Why?

The surveys aimed to estimate numerous socioeconomic, demographic, and health indicators at the general population level and the subpopulations of women aged 15 to 49, children under 5, and men aged 15 to 59 (ICF, 2022). The data collected will then facilitate the implementation and monitoring of policies and programs in population and health and, more generally, of policies to improve living conditions. In addition, the data across countries are collected with a similar methodology to be comparable at the international level and over time (INSD, 2004, 2012).

How?

Generally, the survey process has four stages and can take up to two years and a half. Locally, an agency implements and directs the survey with technical assistance from the DHS

Program. In the first stage, they design the sample and questionnaires. The second phase is mainly devoted to training interviewers. In the third step, the data are edited, tabulated, and the report writing begins. The last step focuses on data and reports dissemination, data use, and analysis made (ICF, 2022) in our case by *Institut National de la Statistique et de la Démographie* of Burkina Faso (INSD).

As mentioned above, the direct approach of the DHS Program is to collect data that are comparable across countries. To do this, standard questionnaire templates have been developed. There are three basic questionnaires in DHS surveys: a household questionnaire, a women's questionnaire, and a men's questionnaire. In addition, the content of these documents has been adapted to the realities of Burkina Faso (ICF, 2022). The women's questionnaires encompassed, among other things, information on various demographic indicators, in particular fertility rates, child mortality, and maternal mortality. They also collected data on women's status and economic activity, knowledge, attitudes, and opinions about domestic violence (ICF, 2022). The men's questionnaires are more individual and structured around the following topics, among others: socio-demographic characteristics of the respondents, contraception, and employment (ICF, 2022).

Two-Stage Stratified Samples

To acquire a representative sample of the Burkinabe population, they performed a two-stage stratified sample design. Each of the country's 13 regions was separated into urban and rural parts to form the strata. The sample was drawn independently in each stratum (INSD, 2004, 2012).

The first stage aims to select clusters or enumeration areas¹⁴ throughout the national territory. These were drawn¹⁵ from the enumeration areas established during the General Census of Population and Housing (INSD, 2004, 2012).

In the second stage, they randomly selected households from a list of all households in each cluster. 7,130 rural households were selected in 2003 (INSD, 2004) and 10,340 rural households in 2010 (INSD, 2012). All women aged 15-49, usually living in the selected households, were

¹⁴ For the rest of the analysis, we will use the term cluster.

¹⁵ These clusters were selected through a systematic draw with probability proportional to the number of households in each clusters (INSD, 2004, 2012). In other words, the larger the size of the cluster, the greater its chance of being included in the sample.

interviewed. In addition, a subsample of one in two households (in 2010) and one in three households (in 2003) of men aged 15-59 were also surveyed by INSD (2004, 2012).

3.2. Database Construction

This section explains how the two different data sources were combined into the main dataset. The first source includes the distance between the cluster where the individual lives and the mining sites. The second source is the two samples, women and men, from the DHS database.

3.2.1. Distance ASM to DHS Clusters

The distance allows us to assess the level of exposure of individuals to mines. Unlike standard DHS, data on the distance separating each individual according their identifying cluster, and existing small-scale mining are not publicly available¹⁶. The description of the distance calculation below is from Guirkingner and Stoeffler (2021).

To obtain the distance between the closest mine and the cluster DHS, Guirkingner and Stoeffler (2021) used the location and timing of gold mining permits and the approximate GPS location of the clusters where the interviewed household lived. GPS location of the clusters is given in the DHS database. For privacy reasons, GPS locations can be randomly shifted up to 10 kilometers. For the location and timing of gold mining permits, the Ministry of Mines provided Guirkingner and Stoeffler (2021) with these permits' location and start date (and renewal date). The location of small-scale mining is known since it requires a permit to be exploited. Once a mine is discovered, it rarely has a license at that moment. However, once the mine reaches a size of around 100 gold diggers and works without a permit, a national mining society intervenes in the existing activity and asks for a license. Then a deliverance of a license requires three months and gives the property right of the mine to the society. Although gold miners are not hired by the mining company and therefore remain independent, they must provide a portion of their income to the company. After that, the license obtained must be renewed every two years.

With this information, Guirkingner and Stoeffler (2021) calculated the distance from each DHS cluster to the nearest mine for each DHS wave.

¹⁶ I got access to distance computation through my thesis supervisor, Professor Guirkingner.

3.2.2. Two Samples from DHS

First, to accurately detect any form of discrimination inside the household and compare estimations between women and men, data from the women's and men's samples are mainly used. Directly from the DHS website, the data for each year are structured in seven files corresponding to each unit of analysis: i.e., households; women; each household member; children under five years of interviewed women; all births for interviewed women; men and finally men and women declared to be married and living together.

Second, since the gold boom in Burkina Faso started around 2004 and 2006 (Bazillier & Girard, 2020), the two last waves of DHS surveys are used here i.e., 2003 and 2010. These allow for an ideal comparison before and after the gold boom. As mentioned in Section 2.1., the main idea is that the price of gold is the primary determinant of profit in artisanal mining activities as it directly affects miners' expected earnings (Alvarez, Coué, & Patrick, 2016). When the price of gold increases, it may become profitable for households to switch activities or increase their labor supply to benefit from new earnings opportunities (Bazillier & Girard, 2020). Moreover, even for a fixed labor supply, the money that gold miners get for their gold will be a function of the price of gold, meaning that they can spend more and generate more local economic activity (Bazillier & Girard, 2020).

Third, about the months of the year when the interviews were conducted (see Table 1), it is essential to note that interviews were mainly conducted during the agricultural season (i.e., the rainy season between May to October) and, therefore, outside the mining season.

<i>month of interview</i>	<i>Woman Sample</i>			<i>Man Sample</i>		
	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
May	80	0.38	0.38	47	0.62	0.62
June	208	0.98	1.36	77	1.02	1.65
July	1817	8.58	9.94	699	9.29	10.94
August	4061	19.17	29.11	1473	19.57	30.51
September	5174	24.43	53.54	1794	23.84	54.34
October	4919	23.22	76.76	1626	21.61	75.95
November	3394	16.02	92.78	1215	16.14	92.09
December	1529	7.22	100.00	595	7.91	100.00

Table 1. Frequencies of Observations by Month of Interviews

Finally, to obtain a combined dataset of both sources, observations in these two separated samples are merged to the mine-cluster distances (according to their identifying cluster). A cluster contains several observations. More precisely, each 2010 cluster is merged with the mine-to-cluster distances calculated for the existing mines in 2010. In the same way, each

cluster of 2003 is also merged with the distances of 2010. Indeed, for the 2003 samples, I use the distance of 2010 since before the gold boom, mining was not widespread in the country, and therefore the clusters were far from the mines. Further explanations of that choice are provided in section 3.3.1.

3.3. Data Description and Summary Statistics

As we want to assess the differences in individuals' exposure to mining sites (before and after the gold boom) on women's empowerment, the first section describes the dependent variables, namely exposure to mining and the variation over time. Next, I present the three different categories of independent variables, in line with the searched impacts formulated in the hypotheses. These are employment, decisions, and violence-related.

The employment dependent variables category is used to verify *Hypothesis 1 and 2*. These last ones advocate respectively that ASM implies a labor reallocation inside the household affecting men and women differently, and the one who benefits from it will see his or her bargaining power increase.

Then the decision-making variables are used for checking *Hypothesis 2.bis* suggesting that the higher the bargaining power the higher one's participation in decision-making.

Finally, to test *Hypothesis 3*, saying that as the bargaining power changes, one should observe an impact on domestic violence, I employ perception of domestic violence variables.

Next to the description of the variables, a summary statistics table is provided in Table 2 and commented on when necessary. It should be noted that the majority of the available variables are qualitative variables. To exploit them in a regression analysis framework, qualitative variables encompassing several categories are split into binary variables for each category.

DEFINITIONS		Women Sample, N = 21,182					Men Sample, N = 7,526				
		OBS	MEAN	STD. DEV.	MIN	MAX	OBS	MEAN	STD. DEV.	MIN	MAX
MINES VARIABLES											
distin2010	distance in kilometers between the cluster and SSM, existing in 2010	20,308	37.939	25.759	.417	162.13	7,188	38.523	27.108	.417	162.13
mine_20	1 if respondent lives < 20 kms from a mine	20,308	.261	.439	0	1	7,188	.271	.445	0	1
goldboom	1 if observation is in 2010	21,182	.553	.497	0	1	7,526	.644	.479	0	1
EMPLOYMENT DEPENDENT VARIABLES											
working	1 if respondent is currently working	21,176	.869	.338	0	1	7,525	.877	.329	0	1
work_past	1 if respondent worked in the past 12 months	21,182	.026	.158	0	1	7,524	.070	.255	0	1
empl	1 if respondent is employed in agriculture of self-employment sector	21,182	.691	.462	0	1	7,523	.801	.400	0	1
no_work	1 if respondent is currently not working	21,175	.106	.308	0	1	7,523	.054	.225	0	1
EARNINGS TYPE DEPENDENT VARIABLES											
cash	1 if respondent is paid in cash	18,931	.202	.401	0	1	7,119	.144	.351	0	1
kind	1 if respondent is paid in kind	18,931	.149	.356	0	1	7,119	.132	.339	0	1
no_pay	1 if respondent is not paid	18,931	.568	.495	0	1	7,119	.469	.499	0	1
DECISION-MAKING DEPENDENT VARIABLES											
health_care	1 if woman is at least involved in decisions about her own health care	19,426	.187	.389	0	1					
w_health_care	1 if woman is deciding alone about her own health care	19,426	.013	.257	0	1					
o_health_care	1 if partner/husband is making alone the decision for woman's health care	19,426	.812	.390	0	1					
large_purchase	1 if woman is at least involved in decisions about large household purchases	19,426	.189	.392	0	1					
w_large_purchase	1 if woman is deciding about large household purchases	19,426	.062	.240	0	1					
o_large_purchase	1 if partner/husband is making alone the decision for large household purchases	19,426	.809	.393	0	1					
visit_family	1 if woman is at least involved in decisions about visits to her relatives	19,426	.392	.488	0	1					
w_visit_family	1 if woman is deciding alone in decisions about visits to her relatives	19,426	.234	.424	0	1					
o_visit_family	1 if partner/husband is making alone the decision for visits to woman's family	19,426	.606	.489	0	1					
VIOLENCES DEPENDENT VARIABLES											
beat_goingout	1 if respondent answered that violence is justified if she goes out without telling partner/husband	21,173	.456	.498	0	1	7,526	.226	.418	0	1
beat_children	1 if respondent answered that violence is justified if she neglects children	21,171	.464	.499	0	1	7,526	.244	.429	0	1
beat_argue	1 if respondent answered that violence is justified if she argues with partner/husband	21,171	.470	.499	0	1	7,525	.241	.428	0	1
beat_sex	1 if respondent answered that violence is justified if she refuses to have sexual relations with partner/husband	21,173	.330	.470	0	1	7,526	.169	.374	0	1
beat_burn	1 if respondent answered that violence is justified if she burns the food	21,169	.204	.403	0	1	7,525	.119	.324	0	1
dom_v	1 if respondent answered that violence is at least justified in one of the 5 situations above	21,178	.615	.487	0	1	7,526	.398	.489	0	1
CONTROLS											
d_lit	1 if respondent can at least read parts of a sentence	21,163	.093	.290	0	1	7,526	.217	.412	0	1
mv012	current age of the respondent	21,182	29.404	9.648	15	49	7,526	32.156	12.795	15	59
mv136	number of household members	21,182	8.772	5.229	1	53	7,526	7.672	4.580	1	34

Table 2. Summary Statistics

3.3.1. Mine and Period Independent Variables

To assess the mining exposure after the gold boom, I created one dummy variable taking the value of one when we are in 2010 and another dummy taking the value of 1 when the individual lives in the cluster located within 20 kilometers of a mine.

As far as the mining exposure is concerned, it is important to note first that in Guirkingner and Stoeffler's (2021) dataset, the distances from each cluster to the small-scale mine sites are specific to each year's licensed mines. The gold boom exploitation started between around 2004 and 2006 in Burkina Faso; before that period, there were no major mining activities. This is illustrated in Figure 3, where we can see that distances in 2003 are more spread than distances in 2010. Otherwise said, more clusters lived close to mining sites in 2010 than in 2003.

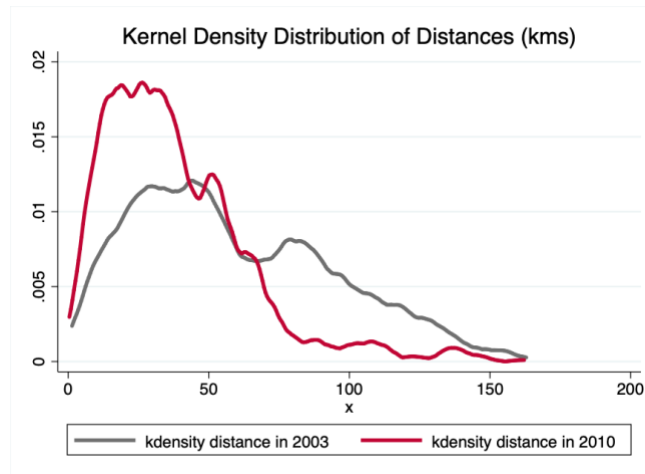


Figure 3. Kernel Distribution of Distances in kilometers in 2003 and 2010.

Therefore, for the remainder of the analysis, I will rely solely on the distance for 2010, reflecting the year after which mining activity changed. By doing so, I have a constant spatial treatment before and after the gold boom allowing me to constitute the control and treated groups. From Table 2, we can see that for both years women and men are located, on average, 38 kilometers from a mine.

Next, it is necessary to discuss the cutoff size that separated the treated groups, individuals living within 20 kilometers of a mine, and control groups (the others). On the one hand, more minor cut-off points rapidly reduce the sample of untreated individuals (i.e., those who are considered to be relatively not exposed), making it more difficult to identify effects. On the other hand, too high a cutoff includes too many individuals in the treatment groups, which biases the coefficient of interest (Knutson et al., 2016). In the literature, there is no consensus on the buffer size. Aragón and Rud (2013) defined the treated households within a 100 kilometers radius, while Kotsadam and Tolonen (2016) and Parker et al. (2016) used 20

kilometers. Bazillier and Girard (2020) used a 10 kilometers cut-off distance to consider illegal mines' spillovers close to registered ones. Considering the argument of the latter, the mean distance in 2010 and the fact that the clusters can be moved 10 kilometers for privacy reasons (see section 3.2.2.), I decided to rely on a 20 kilometers buffer for the treated households. In this way, individuals living within 10 kilometers of a mine (who are likely to be particularly affected by the mine) (Guirkingner & Stoeffler, 2021) and the illegal mines' spillovers (Bazillier & Girard, 2020) are most certainly included in the estimation.

3.3.2. Employment Dependent Variables

Three categories of dependent variables related to the individual's employment situation will be used. The first one is related to the timing of the occupation. The second category is associated with the main individual's occupation. Finally, the last category encompasses the type of earnings the individuals receive from their occupation.

Timing of Occupation

The first is a dummy variable that takes the value of 1 if the respondent has an occupation when the interview is conducted. In other words, the dummy variable takes one if the respondent positively answered the following question: "*En dehors de votre travail domestique, avez-vous travaillé au cours des sept derniers jours ?*" (INSD, 2004, pp. 444, 2013, pp. 451). From Table 2, we can see that, on average, around 87% of men and women are currently working in a different occupation than domestic tasks. The second is a dummy variable taking the value of 1 when the respondent has done any work in the last 12 months (preceding the interview)¹⁷. 70% of men have worked in the past while only 26% of women have.

Respondent's Occupations

Regarding the respondent's occupation, eight different variables representing the various pre-defined sectors of activity are created. These are: not working, clerical, sales, agricultural or self-employment, services, household, domestic work, skilled manual, unskilled manual, professional/managerial, and others¹⁸. Those occupation categories come from a classification made by the authors of DHS and are mutually exclusive. Indeed, they grouped the respondents' activities according to their answers to the following question: "*Quelle est votre occupation,*

¹⁷ I.e., positively answered the following question, "*Avez-vous fait un travail quelconque au cours des 12 derniers mois ?*" (INSD, 2004, pp. 444, 2013, pp. 451).

¹⁸ This sector of activity occupation groups the types of occupations that could not be classified and the respondents who do not know the answer to that specific question.

c'est-à-dire quel genre de travail faites-vous principalement ?” (INSD, 2004, pp. 444, 2013, pp. 451).

From Table 2, when looking at the mean, we can see that the agriculture and self-employment sector is the main sector of activity. More men than women have agriculture and self-employment as their main activities.

Earnings Types

Three dummy dependent variables take the value of 1 if the respondent is paid in cash, paid in kind, or not paid at all for their work. The case where the respondent is paid in cash *or* in-kind is excluded since we cannot differentiate those two different types and the resulting implications. From Table 2, we can already note that around 90% of women and men are currently working, while 56% of women and 46% of men, are not paid. Nevertheless, women earn more in cash than men, while for the in-kind payments, the mean is similar between the two genders.

3.3.3. Decision-Making Participation Dependent Variables

Three variables reflecting daily decision situations measure women's participation in decision-making. Due to data availability, only women's answers are exploited. Although we discussed in chapter 2 that looking at decision-making could be biased due to the complexity of gender relations, this variable allows us to directly evaluate whether the women consider that she is entitled to make decisions. From the point of view of the Brazilian pedagogue, Paulo Freire, true empowerment cannot simply be given by external actors, particularly not by those who are a part of the oppressive structure (Freire, 1990). Similarly, from a feminist perspective, “empowerment is more than simply opening up access to decision-making; it must also include the processes that lead people to perceive themselves as able and entitled to occupy that decision-making space” (Rowlands, 1995, pp. 101). Therefore, we are not measuring a situation where the power is given to women.

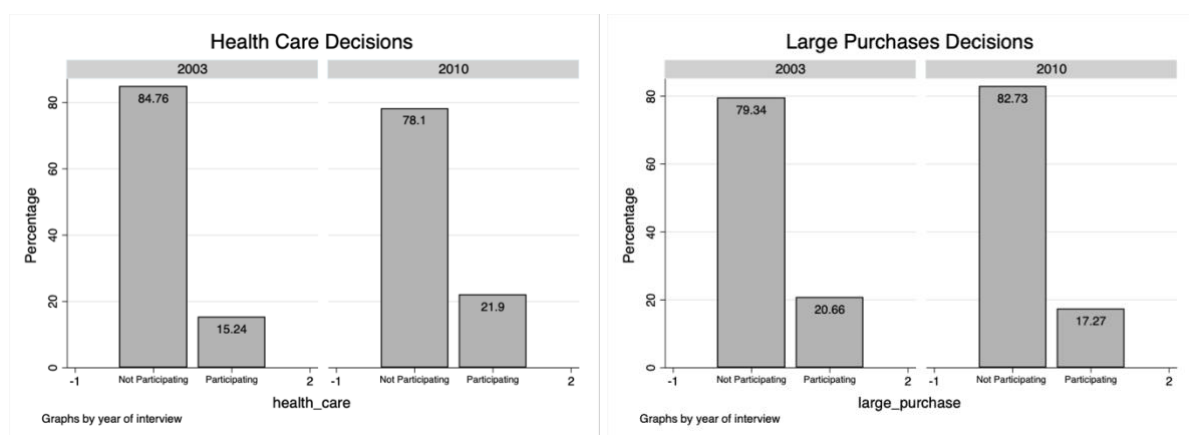
During the interview, women were asked “*Qui prend habituellement les décisions concernant...*” (INSD, 2004, pp. 445, 2013, pp. 452). – their health care, the large household purchases, and the visits to her family and relatives. According to these questions, five possible answers were available to them: respondent alone; respondent and partner; respondent and another person, partner alone, and someone else.

For each of the three daily situations, I first created a dummy variable taking the value of 1 when women can at least participate in the decision. In other words, the dummy variables take

the value of 1 when the interviewed women answered *respondent alone*; *respondent and partner*; *respondent and another person*. By creating these dummies, I can evaluate a situation in which the woman is at least involved in the final decision that affects her directly or indirectly versus a case where she is not involved. However, a limitation of this perspective is that if she is deciding with another person (be it her partner or another person), this dummy does not tell us how much weight is given to her in the decision-making process and, therefore whether her participation can effectively lead to direct the choices in the direction of her preferences.

To overcome this first limitation, another binary variable takes the value of 1 when the woman decides alone. Suppose we consider that participating alone allows her to direct the outcome in a way closest to her preferences (which is not always the case, however, see section 2.4.2.), then deciding alone is a stronger mark of bargaining power. It is also important to note that deciding alone may not represent greater bargaining power. Indeed, men may simply delegate these day-to-day decisions and increase the mental burden on women. Also, there may be asymmetric information where women do not have all the information they need (while men might) to maximize their preferences. However, as two out of three situations implied decisions regarding outcomes that affect women's welfare directly (i.e., decisions for her own health care and visits to her family), it is interesting to investigate when the woman is able to decide alone. In addition, a third binary variable is taking the value of 1 if the partner/husband alone makes the decision.

Figure 4 depicts the evolution of women's participation when they are at least involved in the decision process between the two years (i.e., 2003 and 2010).



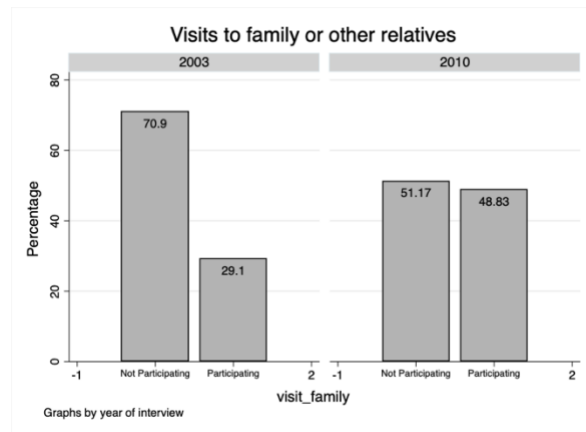


Figure 4. Distributions of Women’s Participation in Decision-Making Regarding Daily Situations.

Consistent with the summary statistics table and Burkina Faso's lowest ranking in the Gender Inequality Index (UNDP, 2018), Figure 4 depicts a situation where women are mainly not participating in decision-making. One exception is for the visits to her family situation - wherein in 2010, almost the majority of women are deciding. In addition, we can also notice an improvement in women’s participation in decision-making from 2003 to 2010 for decisions regarding their health care and family visits but not for significant purchase decisions. With a two-sample t-test, we can say that the evolutions between the two years are statistically significant.

3.3.4. Domestic Violence Dependent Variables

In terms of domestic violence, the variables used to measure the perception about the justification of using violence (and not the experienced actual violence¹⁹). Interviewers asked women and men whether they consider that the use of violence toward women is justified in different daily situations. These are: a woman goes out without telling her partner/husband; a woman neglects children; a woman argues with her partner/husband; a woman refuses to have sex with her husband, and finally, a woman burns food.

Five different dummies dependent variables are created, reflecting the five different situations. An additional variable is created to account for a situation where the women or men consider that violence is justified *at least* in one of the five situations. All the domestic violence dependent variables take the value of 1 when the respondent answered that the use of violence is justified *or* when he or she answered “don’t know”. I have indeed introduced the latter because this indecision about the justification of violence leaves the door open for its use.

¹⁹ Data regarding experienced domestic violence was not available for both years.

Moreover, one can interpret the justification of violence use variables in two distinct ways: as a measure of the actual *experienced domestic violence* and as the *level of women's empowerment*.

On the one hand, data on actual experienced domestic violence could be biased due to underreporting²⁰, such as being ashamed to declare it (INSD, 2012). Instead, the perception that women and men have regarding the use of violence can be used as a *proxy for the actual experienced violence*. In their analysis of nine countries²¹, Sunita Kishor and Johnson (2004) showed that rates of experienced violence are even higher for women who agree with wife-beating than among women who do not agree.

On the other hand, the level of approval of domestic violence by men and women indicates their opinion about women's roles and rights (Jejeebhoy, 1998). Indeed, these questions explore the level of acceptance of certain norms that gives men power over women by subordinating women's rights to men's (Sunita Kishor & Johnson, 2004). In a sense, this reflects an acceptance of unequal gender roles and a lack of awareness of women's rights to safety and bodily integrity (Sunita Kishor & Johnson, 2004). Therefore, a woman who agrees to be beaten may be considered less empowered than a woman who rejects this norm. In the last DHS report, they documented a negative correlation between women's empowerment (through more involvement in decision making) and the fact that they believe that domestic violence is justified against them (INSD, 2012).

From the evolutions between the two years depicted in Figure 5, we can see that women's perceptions of using violence is much higher than men's, even if the violence perceptions decreased between those two years. These estimations are not surprising when we know that women are taught (from an early age) to tolerate and even accept domestic violence (INSD, 2012). Again, with a two-sample t-test, we can say that those differences are statistically significant.

²⁰ However, during the data collection DHS Program implemented a special strategy to obtain information regarding experienced domestic violence (INSD, 2012).

²¹ They made a statistical analysis of 9 countries with DHS Data. These are: Cambodia, Colombia, the Dominican Republic, Egypt, Haiti, India, Nicaragua, Peru, and Zambia (Sunita Kishor & Johnson, 2004).

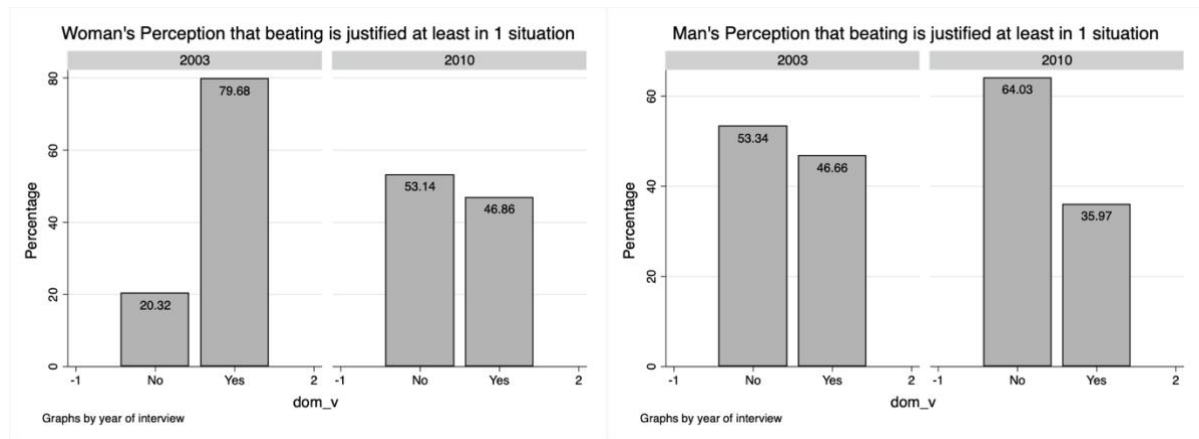


Figure 5. Distributions of Woman's and Man's Perceptions for Justification of Violence

The summary statistics show more details on the five different violent situations (but not between the two years). A little less than half of the women, on average, find that the violence is justified for the first three situations. Fewer women, on average, consider it justified if she refuses to have sex and if she burns food. Nevertheless around 60% of women consider that beating is justified at least in one of the 5 situations.

3.3.5. Controls

In order to best estimate the causal relationship, different control variables are used. These are the respondent's current age²² at the time of the interview, the number of household members, the religions, and the level of literacy. Regarding the level of literacy, the respondent was asked during the interview to read. In function of the respondent's performance, the interviewer evaluates it as "*cannot read; able to read-only parts of the sentence; can read the whole sentence*". I created a dummy variable taking the value of 1 if the respondent could read parts of the sentence or read the entire sentence and 0 for the rest.

3.4. Conclusion

In this section, I first described the two databases sources (i.e., two DHS samples and the map of the mines). Then I presented the variables, mainly binary, to assess the impact of mine exposure on women's and men's employment, women's participation in decision-making, and women's and men's perceptions of violence. The next chapter discusses the method used to exploit these variables.

²² During the interview, the interviewer asks for the same thing in two different ways in order to report a consistent age. This was done by asking about the month and year of their birth and the age at their last birthday. This is

Chapter 4. Empirical Strategy

Now that we have described all the variables, this chapter aims to first review the previous empirical strategies used in gold mining. Then, the current empirical strategy is discussed.

4.1. Review of the Empirical Methods

The differences-in-differences estimation is used in the majority of the literature analyzed. Ahlerup et al. (2020) use one difference estimator comparing producing areas and non-producing. Bazillier and Girard (2020), Zabsonré et al. (2018), Kostadam et Tolonen (2016), Aragon and Rud (2013), and Santos (2018) compared areas exposed and not exposed to mines before and after the gold boom.

Methods	Authors	Outcomes	Results
Qualitative Analysis	Holmes and Busia (2020) <i>Ghana</i>	decision-making and dynamics	positive impact for women
Simple Difference	Ahlerup, Baskara, and Bigsten, 2020 <i>Africa</i>	educational attainment	negative impact
DID ²³	Bazillier and Girard (2020) <i>Burkina Faso</i>	yearly consumption	positive impact on consumption
	Zabsonré, Agbo, and Somé (2018) <i>Burkina Faso</i>	average per capita expenditure	positive impact
		head count ratio & poverty gap	negative impact
		child labor	positive impact (but not significant)
	Knutsen, Kotsadam, Hammersmark, and Wig (2016) <i>Africa</i>	corruption	positive impact on corruption
	Kotsadam and Tolonen (2016) <i>Africa</i>	female employment in service sector	positive impact on gender inequality in term of access
	Aragon and Rud (2013) <i>Peru</i>	income	positive impact
		consumption	positive impact
		poverty reduction	positive impact
IV	Santos (2018) <i>Colombia</i>	school attendance	negative impact
		child labor	positive impact

Table 3. Summary of the Empirical Methods used in the Gold Mining Literature

²³ DID stands for differences-in-differences

Arthur-Holmes and Abrefa Busia (2020) have resorted to qualitative interviews to collect first-hand information on women artisanal miners' household relations/decisions and bargaining power. The authors have grouped the responses into the same themes to analyze the information. The thematic analysis technique was therefore used to identify recurring themes in the data that were consistent with the study objectives. While the methodology cannot be used to establish causality, it enables a better understanding of women's empowerment when directly involved in mining sites.

Ahlerup et al. (2020) rely on a simple difference method with a dummy variable if the respondent's district had at least one gold mine when they were 12 years old. They use a district fixed effect in order to be able to control for any geographical features that may be systematically related to educational outcomes and the presence of gold mines. Gold mines may be less likely to be discovered or profitable in remote areas, and the level of education may be lower in the latter due to lower investment (Ahlerup et al., 2020). They also introduce ethnic group fixed effects to control for any systematic correlation between the education levels of different ethnicities.

For the differences-in-differences method, all the authors rely on a space treatment and a time variation, allowing them to compare pre- and post- treatment effects.

One issue regarding Bazillier and Girard's (2020) method is that they considered households as treated as if they were relatively close to *every* artisanal mines registered at any point in time. With this information, they know that artisanal mining has taken place at some point in these registered locations, but they do not know precisely when. Therefore, some households may be considered as treated after the gold boom (and artisanal dummy), whereas no mining activity actually occurred in these places at the time.

This problem of treatment imprecision is not encountered in other studies. Indeed, instead of relying on one or two years after the gold boom and every registered mines, Kotsadam and Tolonen (2016) identify directly whether a mine was active or inactive. They are able to do so thanks to information about past industrial mines, or future industrial mines and yearly information on production levels (from Raw Materials Data). Similarly, Aragón and Rud (2013) use the intensity of the mining activity (over time) by relying on the mine's demand for local input and the distance to the mines. Santos (2018) exploits also the regional production capabilities and the change in international gold prices.

Relying on a differences-in-differences estimation is conditional on checking the parallel trend assumption. There is no formal way to test whether the outcome analyzed in mining and non-mining areas would have followed a similar trend in the absence of gold extraction. One common way to check it is to see whether the trends of the control and treatment groups were the same in the pre-treatment period (Gelade, 2021). Bazillier and Girard (2020)²⁴, Kostadam and Tolonen (2016)²⁵, and Aragon and Rud (2013)²⁶ check and verify the parallel trend assumption, while the other authors who use a difference-in-difference method, i.e., Santos (2018) Knutsen et al. (2016) and Zabsonré et al. (2018) do not.

Although differences-in-differences strategy controls for unobserved characteristics between the treated and controls groups and therefore genuinely assesses the treatment's impact, two common caveats are remaining regarding their causal estimations. These are selective migration and the non-random location of the mining sites. First, if individuals around the mines are positively selected, the impact of the mines on the outcome variable consumption would not be the result of the mining exploitation but rather the effect of a population change. Second, if the treatment is not randomly applied, i.e., that mines do not appear randomly, the impact on the outcome variable would not be the result of the mines but, for instance, due to a higher supply of labor.

In their cross-African countries analysis, to address both issues, Ahlerup et al. (2020) introduce a district and an ethnic fixed effects to control for the suitability of the different ethnicities' settlement areas for mineral resources or their propensity to migrate to mining districts.

As far as selective migration is concerned, Bazillier and Girard (2020) and Aragón and Rud (2013) show that mines had no impact on the absolute number of residents in households and the characteristics of these households, such as sex or level of education. Therefore, such persistence of household characteristics in the face of the mining boom is inconsistent with the

²⁴ Bazillier and Girard (2020) show that household consumption in the control and treatment groups are effectively parallel, and household consumption was even significantly lower in 1998 and 2003. The trend of the treatment group starts to diverge only after 2003 and becomes higher than the control group in 2006, the time at which the gold boom happened.

²⁵ Kotsadam and Tolonen (2016) show that, before the opening of a mine, the treatment group follow a similar trend of the control group in the service sector employment, but with lower level for the treatment group. Once the mines open, the trend of employment in the service sector for the treatment group started to diverge but after 10 years, this trend goes back to the situation where no mines were open. This is due to the fact that mine exploitation length in their sample is on average 10 years.

²⁶ Aragón and Rud (2013) showed that before the demand for local input started to increase, the treatment and control groups behave in parallel way.

self-selection of specific (for instance, more productive) individuals into migration to mining places. Kostadam and Tolonen (2016) and Santos (2018) restrict the sample to individuals who have never migrated and reach similar conclusions as the unrestricted samples.

Regarding the non-random location of the mining sites, Kostadam and Tolonen (2016), Bazillier and Girard (2020), and Santos (2018) provided different strategies to solve that issue²⁷.

Kostadam and Tolonen (2016) are concerned that mining areas are emerging due to labor force availability and structure. They can overcome this issue directly in their empirical model by not only comparing far and near places to mining but also by comparing places before and after the opening of a mining site. Accordingly, they can control the characteristics that may influence the selection of a mining area.

Bazillier and Girard (2020) are more worried about the nature of the data they exploited and fear an over declaration of the more prominent and the most productive mines. This would bias the results since the data on the location of mines would be non-random. However, the authors argued that the frontiers between legal and bigger mines (those declared and, in their possession) and illegal, smaller mines (generally non-identified) are blurred. Several reasons are provided. First, ASM is a short-lived phenomenon and gold diggers are mobile. Even when ASM is registered, the operations may occur outside the delimited area. Second, an entrepreneur interested in registering artisanal mining will follow (illegal) gold miners to apply for and obtain a formal authorization to gain a monopoly on the commercialization of the gold they extract (Di Balme & Lanzano, 2013). Registered and illegal mining activities are thus likely to be close to each other in space or time. For those two reasons, the risk of unreported smaller operations is not a big issue.

Santos (2018) is concerned that initial mining production and location reflect decisions of economic agents (such as the expectations of future gold price), and the latter might, in turn, be correlated with his dependent variables (the allocation of children's time into schooling and working). To overcome that problem, he uses the water supply as an instrument that influences the receipt of the treatment i.e., being close to a mining area. Regarding the instrument relevance, water supply measured by the availability of natural water sources (such as rivers) is essential in modern gold mining production processes. Consequently, a municipality with more water supply today has a higher probability of producing gold tomorrow (Santos, 2018).

²⁷ Aragon and Rud (2013) only analyzed one big mining site.

However, the instrument exogeneity condition is not as obvious. Indeed, it is likely that water supply influences agricultural production and thereby influences child labor. Although he introduces controls for variables correlated with a water supply and the outcome variable (such as the soil quality for agriculture), his instrument exogeneity condition seems to be limited.

Conclusion

Although Ahlerup et al. (2020) control for observable characteristics such as ethnicities and districts, there might have remained unobserved differences between the control groups, and treated groups especially since they are analyzing the entire African continent. Relying on a simple difference does not allow to control for such unobserved differences, while the differences-in-differences strategy does. The latter is the primary method used in the papers analyzing gold mines (both in Africa and South America). Regarding the strength of the strategy for the differences-in-differences method, the method used by Santos (2018) seems ambitious due to a partial failure of instrument exogeneity. Aragón and Rud (2013) and Kotsadam and Tolonen (2016) remain convincing due to their precise treatment. Aragón and Rud (2013) were able to do so because they have focused on “only” one of the largest gold mines in the world located near a city in Peru. As far as Kotsadam and Tolonen (2016) are concerned, they analyzed the industrial mines, which are more easily tracked due to their legal activity. On the contrary, for their ASM results, Bazillier and Girard (2020) have not had the chance to obtain such precision due to the nature of artisanal small-scale mining and their difficulty in being indexed.

For this thesis, as many authors did for analyzing the causal impact of mines, I decided to rely also on differences-in-differences and, more precisely, on a method close to the one from Bazillier and Girard (2020) as their context is ultimately the same as mine. It constitutes indeed the best methodology regarding the data I have and the country’s and activity’s context. The following section aims to justify, describe and discuss that choice.

4.2. Empirical Strategy

4.2.1. Description

As I have access to two existing sources of variations (one spatial and one temporal) and repeated cross-section data, estimation by differences-in-differences is the most suitable method to assess the causal impact of gold mining on women’s empowerment. Before digging

into the method's description, two components at my disposal i.e., the repeated cross-sectional data and the existing variations useful for the method are detailed.

First, with cross-sectional data, if individuals are randomly drawn from the same population, then the individuals in the previous cross-section can be used as surrogates for the individuals in the treatment and control groups in the next cross-section (Stock & Watson, 2003). In other words, as observations for both years were selected through a random procedure from the same population i.e., population of Burkina Faso (as explained in 3.1.), they are both representatives of the same population. In that way, observations from 2003 can be considered as a surrogate for observations in 2010.

Second, the two existing variations are the following. The spatial variation allows us to compare two groups: the treated group, including households living close to the mining site, and the control group, living relatively far from those. This implicitly assumes that households living close to mining sites are more exposed to mine exploitation (either directly or indirectly) than households living far from it. The other variation is temporal. This variation compares the outcome variables before and after the gold boom price. As discussed above, during the 2000s, and especially between 2004 and 2010 in Burkina Faso (Bazillier & Girard, 2020), gold prices experienced a boom which directly impacted the activity since the latter became more profitable for people working in ASM.

Therefore, using a differences-in-differences method allows comparing the change in the outcomes prior to and after the gold boom (time variation) for people living close to mining sites and for those living far from them (spatial variation). Accordingly, I can directly estimate the impact of the mines on the outcome variables by controlling for differences in characteristics between the treated and the control group (Stock & Watson, 2003). In other words, the coefficient of interest assessing the impact of the mines does not measure the effect of any other factors than the exposure to mining activity (i.e., there is no correlation between the explanatory variables and the error term).

More formally, I propose the following equation:

$$Y_{ivt} = \beta_0 + \beta_1(\text{goldboom}_t * \text{mine}_v) + \beta_2(\text{mine}_v) + \beta_3(\text{goldboom}_t) + \sum \gamma_j X_{jit} + u_{ivt} \quad (1)$$

where i denotes the individual, v the DHS cluster and t the time period.

In (1), Y_{ivt} are the outcome variables, i.e., employment, decision-making, violence. goldboom_t takes the value of 1 if we are after the gold boom, i.e., in 2010, and 0 if we are before the gold boom, i.e., in 2003. mine_v takes the value of 1 if the individual lives in a cluster

within 20 kilometers of a mine and 0 if the cluster is located far away from a rural mining site. X_{jit} for $j = 1, 2, \dots$ are controls for age, literacy, number of rural household members, and religion.

$\beta_1(\text{goldboom}_t * \text{mine}_v)$ is the differences-in-differences estimator i.e., the average change over time in Y for individuals in the treatment group minus the average change over time in Y for those in the control group.

u_{ivt} are robust and cluster (at DHS cluster level) standard errors. As every individual within a cluster has the same distance to the mines²⁸, relying on clustered standard errors allows for autocorrelation within the cluster itself while treating the errors as uncorrelated across clusters (Stock & Watson, 2003). Robust standard errors are used to deal with heteroskedasticity.

4.2.2. Validity of the Empirical Strategy

This section aims at discussing the validity of the empirical strategy discussed above and based on the previous caveats of the authors who also analyzed gold mining activity.

First, using a differences-in-differences strategy is conditional on the randomness of the treatment allocation, i.e., being exposed to mining sites. It could be that the location of mining exploitations is correlated with the error term due to specific characteristics different than the abundance of the random resource. In that case, it would imply that the treatment, living close to a mining area, is not “as-if” randomly assigned. As a result, the differences-in-differences estimator would be biased (Stock & Watson, 2003). One solution would be to include region-fixed effects. However, the mining sites in the dataset are not numerous within the regions. As a result, regions-fixed effects capture a large part of the heterogeneity in exposure to mines. Therefore, it becomes more difficult to detect the impacts, if there are any. Faced with the advantages and disadvantages of including region-fixed effects, I have decided to present the results including them in the Appendix.

Secondly, using a differences-in-differences strategy is conditional on verifying the parallel trend assumption showing that the outcomes variables, treated and non-treated, would have behaved similarly without the mine treatment. This shows us that it is indeed the gold mines that impact the variables of interest and no other potential factors. As described in the previous section, one common way to check it is to see whether the trends of the control and treatment

²⁸ This is so because the distance is calculated between the GPS location of the mines and the GPS location of the cluster.

groups were the same in the pre-treatment period (Gelade, 2021). Another similar way to verify it is to run a placebo test whereby applying the treatment X period earlier; one should obtain a non-significant impact (Gelade, 2021). As the data in the previous DHS wave (i.e., 1998) are unavailable, the parallel trend assumption will not be verified. Nevertheless, although they have looked at the consumption, Bazillier and Girard (2020) provided evidence for the existence of a parallel trend in the same context as ours (i.e., same country and periods).

The third potential bias deals with selective migration. Indeed, one cannot control for significant population movement of households or individuals who migrated to work primarily in the mine. This would be especially true if those involved in the mines had motivations such as emancipation from the authority of elders and the constraints of custom. In this case, mining areas attract people who want to, for instance, break free from patriarchal norms and seek women's empowerment. Consequently, the impact of ASM on decisions and domestic violence would be biased since it would include individuals with emancipation values that are correlated with women's empowerment.

However, evidence suggests that selective migration in our context should not be too important. First, as Hilson (2009) has argued, the latter motivations are not the majority of the people involved in mining (see 2.3.1.). Second and as discussed in the previous section Bazillier and Girard (2020) in Burkina Faso and Aragón and Rud (2013) in Peru provided suggestive evidence that the ASM boom did not induce any significant selective flows of population. Therefore, based on the evidence from Burkina Faso, we can assume that there is no significant population movement to areas close to mining sites in Burkina Faso.

Box 7. Assumption 3 - Selective Migration

Based on the previous non-evidence for selective migration in Burkina Faso for the same period, we assume that there is no significant selective migration to areas near mining sites.

Finally, one advantage compared to Bazillier and Girard's (2020) empirical strategy is that we consider all the active mines, i.e., those who have a permit in 2010 and not all registered mines over time. This allows for more precision since places considered as treated by the gold boom dummy (and artisanal dummy) own a permit (and therefore were active) at that time.

Chapter 5. Results

This chapter presents the main results obtained on how ASM, as a new economic opportunity, affects men and women in the following dimensions: employment, women's and men's bargaining power, domestic violence, and as an extension, women's health.

5.1. Employment and Structural Changes Around ASM

This section aims to verify *Hypothesis 1* and *Hypothesis 2* by exploring how the arrival of ASM changes the traditional rural economic occupation pattern. More specifically, this section examines who, the men or the women, can benefit from ASM in terms of factors (employment and income) that influence the bargaining power. The section is structured as follows. First, we analyze the impact of ASM on seasonal activity, by examining the impact on the currently working variable and on the variable containing the possibility of having worked in the past 12 months (and thus including the mining season). Then, we investigate how ASM impacts the different sectors of occupation. Finally, the impact of ASM on the probability of earning different income types is investigated.

5.1.1. Seasonality and Types of Employment

Seasonality

Table 4 documents a positive impact of ASM on the probability to have worked during the 12 months preceding the interview and a negative impact on the probability to be currently working.

Table 4. The Effects of ASM on Seasonal Employment

Dep. Var.:	Working		Worked	
	(1) Women	(2) Men	(3) Women	(4) Men
goldboom	-0.112*** (-6.70)	0.301*** (11.38)	0.030*** (5.21)	-0.193*** (-8.56)
mine_20	0.020** (1.97)	0.128*** (3.24)	-0.004** (-2.01)	-0.088*** (-2.72)
Goldboom*mine_20	-0.027 (-0.83)	-0.123*** (-3.07)	0.023 (1.51)	0.084** (2.54)
N	20283	7187	20287	7186

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Although the coefficient is not significant for women, columns 1 and 2 report that men and women are currently less likely to work during the agricultural season. Indeed, ASM reduces the probability of currently working by 2.7 percentage points for women while 12 percentage points for men. Once we consider the probability of having worked in the past 12 months and therefore include the possibility of having worked during the mining season (columns 3 and 4), the impacts become positive for both genders. While the coefficients for women are again not significant, we can see that, on average, men tend to have worked more in the past compared to women. Indeed, the estimated impact of ASM on the probability of having worked in the past 12 months increases by 2 percentage points for women while this effect increases by 8 percentage points for men.

Those results are consistent with the fact that mining is a counter-seasonal activity (in line with *Assumption 2*) as we observe a negative impact on the probability of currently working while a positive impact on having worked in the past 12 months. In addition, the results suggest that, although mining and agriculture are not occurring in the same season, people and more specifically men, may give up some activities during the agricultural season when they work in mines.

Occupation Types

In addition to the evidence of the seasonal work, we investigate any impacts on a reallocation between men and women due to the arrival of ASM. In this respect, we look for the existence of any impacts on the distribution of women's and men's labor in the different sectors of activity. Tables 5 and 6 report overall non-significant results.

Table 5. The Effects of ASM on Women's and Men's Occupation (part 1)

Dep. Var.:	Services		Sales		Professional Managerial		Clerical		Domestic Work	
	(1) Women	(2) Men	(3) Women	(4) Men	(5) Women	(6) Men	(7) Women	(8) Men	(9) Women	(10) Men
goldboom	-0.002** (-2.27)	-0.015*** (-3.66)	0.027* (1.94)	0.026*** (3.39)	0.000 (0.30)	0.006 (1.44)	-0.001 (-1.19)	0.001 (0.39)	-0.002* (-1.94)	-0.013*** (-3.80)
mine_20	0.001 (0.93)	-0.008 (-1.13)	-0.031* (-1.96)	0.005 (0.61)	-0.001 (-1.16)	0.004 (0.62)	0.003 (1.01)	0.003 (0.72)	-0.002 (-1.45)	-0.005 (-1.25)
Goldboom *mine_20	-0.001 (-0.82)	0.008 (1.12)	0.025 (1.05)	0.001 (0.07)	0.004* (1.96)	-0.006 (-0.87)	-0.004 (-1.06)	-0.004 (-0.77)	0.002 (0.92)	0.006 (1.30)
N	20282	7185	20282	7185	20282	7185	20282	7185	20282	7185

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Table 6. The Effects of ASM on Women's and Men's Occupation (part 2)

Dep. Var.:	Agriculture & Self-employment		Skilled work		Unskilled Work		Not Working		Others work	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men
goldboom	-0.187*** (-7.32)	0.029 (1.48)	0.068*** (6.00)	0.022*** (3.81)	0.000 (0.60)	0.002*** (2.88)	0.081*** (5.06)	-0.109*** (-9.05)	0.008** (2.48)	0.010*** (4.22)
mine_20	0.049** (2.08)	0.045* (1.65)	-0.003 (-0.39)	-0.005 (-1.18)	-0.000 (-1.32)	-0.000 (-0.83)	-0.017* (-1.76)	-0.040* (-1.85)	-0.000 (-1.05)	-0.000 (-0.32)
Goldboom *mine_20	-0.015 (-0.34)	-0.050 (-1.41)	-0.013 (-0.93)	0.020 (1.55)	-0.000 (-0.21)	-0.003*** (-3.01)	0.005 (0.17)	0.040* (1.82)	-0.001 (-0.36)	-0.006 (-1.61)
N	20289	7185	20282	7185	20282	7185	20282	7185	20282	7185

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Although the results are non-significant, few comments are provided. Column 1 and 2 of Table 6. reports the non-significant negative impact of ASM on the probability of working in the agriculture and self-employment sector. This result might be surprising, given the employment patterns around the mines. It would be expected that these two sectors (unfortunately combined as one in the data set) are the main sectors of activity around the mines. Moreover, the only significant coefficient is for men regarding the probability of having unskilled work. This result is surprising if one believes that this category includes mining work. But it may also be that mining work is categorized as self-employment and agriculture²⁹.

From Tables 5 and 6, it is important to highlight that the variables at my disposal do not allow me to precisely describe ASM's effects on detailed changes in terms of employment activities. This is particularly due to the form and content of the variables. It would have been interesting, for example, to look at the impact of ASM separately on agriculture and self-employment. If we had been able to differentiate between these two sectors of activity, we would have been able to see to what extent and who stays in agriculture and who becomes self-employed at the time the interviews were conducted. However, these two activities are grouped together in one category.

²⁹ We do not have information in which category the mining activity has been classified in the DHS dataset. Nevertheless, we will be more inclined to consider this activity to be included in the category of agriculture and self-employment. Indeed, as described in chapter 3, when the mining operation reaches a certain size, the property rights are assigned to a national company, but the gold miners are not employed by the company and are instead self-employed.

Moreover, this categorization of the economic activities of the respondents was made based on the following question “*Quelle est votre occupation, c'est-à-dire quel genre de travail faites-vous principalement ?*” (INSD, 2004, pp. 444, 2013, pp. 451). The latter is quite vague as it allows the respondent to declare his or her main activity (such as agriculture which would be all the truer given the timing of the interview) and also be involved in or around the mines during the mining season. Because of the way the question was asked, the variable cannot inform us of the indirect or direct participation in ASM.

Nevertheless, we can still draw some conclusions from the results shown in this first section. First, Tables 5 and 6 suggest that there has not been a long-term structural change in individuals' occupations. These results are similar to the results obtained by Bazillier and Girard (2020) who also looked at the impact of ASM on different categories of employment³⁰. Instead, the results in Table 4 suggest that individuals are more likely to have seasonal activities, consistent with greater involvement in mining activity.

Second, differences were obtained between women and men regarding the coefficients' significance. Indeed, we can state that men are more likely to have been working over the past 12 months but not currently. This suggests that men are more likely to work over the year and thus accounting for the mining season. **This validates *Hypothesis 1* advocating that ASM impacts men and women differently, with a reallocation of labor time across seasons.** Because men increase their overall labor supply but women do not, one may hypothesize that men have benefited more from the new economic opportunity (consistent with *Hypothesis 2*). Unfortunately, we do not have quantitative information on income, which would have helped us to verify this conjecture. We can however investigate the type of earnings obtained by men and women.

5.1.2. Types of Earnings

This section further investigates *Hypothesis 2* advocating that the one who benefits from the positive factors that mining can offer will see its bargaining power increased. The evidence in the previous section suggests that men tend to work more during the period accounting for the mining season. Here we analyze the impact of ASM on the different types of earnings: not paid, in-kind, and in-cash. As cash income is more fungible, it typically confers relatively more bargaining power than other types of earnings.

³⁰ However, Bazillier and Girard (2020) only analyzed the case of the household head.

Table 7. The Effects of ASM on Earnings Types

Dep. Var.:	Not paid		Kind		Cash	
	(1)	(2)	(3)	(4)	(5)	(6)
	Women	Men	Women	Men	Women	Men
goldboom	-0.019 (-0.54)	-0.134*** (-3.39)	-0.158*** (-5.97)	0.014 (0.51)	0.118*** (5.70)	0.022 (1.36)
mine_20	0.094** (2.04)	0.084 (1.57)	-0.041 (-1.08)	0.009 (0.25)	-0.041** (-2.49)	-0.005 (-0.26)
goldboom*	-0.220***	-0.217***	0.163***	0.039	0.015	0.051
mine_20	(-3.45)	(-3.12)	(3.33)	(0.77)	(0.47)	(1.59)
N	18097	6788	18097	6788	18097	6788

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Columns 1 and 2 of Table 7 report a significant and negative impact of ASM on the likelihood of not being paid for one's work. Regardless of the earning type, this suggests that around mining sites and after the gold boom, both men and women are more inclined to get an income.

Moving on to the next columns which consider the case where individuals are paid in kind, we can see that the impact of ASM is highly and positively significant for women. Women's exposure to mining sites increases the probability of being paid in kind by 12 percentage points. Whereas for men, the effect is not significant and the magnitude is smaller. As already highlighted in chapter 2 (section 2.4.1.), women's in-kind contributions are undervalued, which do not allow them to empower. For the in-cash payments and hence a situation providing the higher economic power, column 5 and 6 reports a non-significant impact for both genders³¹.

From Table 7, we can say that women are more likely to earn money in kind (highly significant), while for men, the impact is non-significant. Even if the results do not allow us to directly validate the second hypothesis that it is men who benefit from ASM, we can infer that women are weakened by their in-kind contribution to households perceived as under-evaluated (Agarwal, 1997). Similarly, ASM decreases women's outside options, as being paid in kind is

³¹ Nevertheless, if we consider a 15% of significance level, men are 5 percentage points more likely to be paid in cash. Whereas for women, we cannot trust this coefficient since its probability of being equal to zero is high (p-value is equal to 0.64).

restricts the scope of action compared to cash. Therefore, by deduction, **we can say that ASM tends to reinforce the dominant (and pre-existing) position of men, which validates Hypothesis 2.**

5.1.3. Conclusion

This section was designed to investigate the first two hypotheses. In short, ASM did not cause a long-term change in rural activities, but the results suggest that people living around mines have seasonal activities. The section also provides evidence of differences between men and women regarding access to this opportunity. The differences are twofold. First, in line with *Hypothesis 1*, in the past 12 months, and hence accounting for the mining season, men worked more, whereas the impact on women was not significant. Second, women are more likely to be paid in kind. As the being paid in kind implies less power vis-à-vis men, men are reinforced in their dominant position, which validates *Hypothesis 2* by deduction.

5.2. Women's Decision-Making

After investigating the factors (employment and income) that influence the bargaining power, this section aims to directly assess the bargaining power. In this regard, we evaluate *Hypothesis 2.bis* by looking at women's and men's participations in decision-making. Since the results so far suggest that ASM has benefited men more than women, we expect a negative impact on women's decision-making participation. Overall, Table 8 reports such evidence.

Table 8. The Effects of ASM on Women's Participation in Decision-Making

Dep. Var.:	Her Health Care		Large Purchases		Visits to Her Family	
	(1)	(2)	(3)	(4)	(5)	(6)
	Joint	Alone	Joint	Alone	Joint	Alone
goldboom	0.046**	-0.008	-0.056***	-0.084***	0.207***	0.160***
	(2.53)	(-0.77)	(-3.06)	(-7.55)	(9.63)	(7.90)
mine_20	-0.003	-0.018*	0.049**	-0.003	0.036*	0.031
	(-0.15)	(-1.86)	(2.09)	(-0.24)	(1.89)	(1.63)
Goldboom	-0.037	-0.013	-0.069**	-0.004	-0.090**	-0.044
*mine_20	(-1.28)	(-0.98)	(-2.28)	(-0.24)	(-2.22)	(-1.17)
N	18683	18683	18683	18683	18683	18683

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Columns labeled “Joint” concerned situations where women participate in the decision with either her partner or another person. The latter report negative impacts of ASM on women’s participation in daily situation decisions. Coefficients are statistically significant except regarding decisions for her health care (which nevertheless provides a negative impact). The decision where the woman is less likely to participate is for the visits to their family. ASM decreases women’s participation, on average, by 9 percentage points. For the large purchase decisions, ASM decreases women’s participation by 6.9 percentage points. This effect is consistent with the evidence suggesting that women are more likely to receive income in kind than men. Non-monetary contributions give them less decision-making power over large purchases, which are assumed to be made in cash.

Regarding the situation where the women are deciding alone, all coefficients are non-significant. This suggests a non-existing impact of ASM on woman’s individual decision-making. As seen in chapter 3, descriptive statistics showed that this situation was rare. Therefore, it is not surprising to find such results. The case where the partner is deciding alone regarding each of the three situations is reported in table A.3. in the Appendix. There we can see that the coefficients have a positive and significant sign, suggesting that ASM has a positive impact on the likelihood that men are the primary decision-makers in situations concerning women.

In short, as ASM negatively impacts factors influencing women’s bargaining power, women are less likely to participate in decision-making. In contrast, **men who seem to benefit from ASM, are more likely to participate in decision-making, confirming *Hypothesis 2.bis*.**

5.3. Domestic Violence

After providing evidence for the negative impact on women’s bargaining power, this section aims to analyze the effect of ASM on women’s and men’s perceptions of using violence through the two types of interpretations. These are the proxy for actual experienced violence, and the measure of women’s empowerment. As discussed in chapter 2, the direction of the impact was impossible to predict since the literature reports the possibility of several dynamics on violence when the level of women’s empowerment changes.

5.3.1. Women's Perceptions

Overall, Table 9 documents a positive effect on women's perception that violence is justified against themselves.

Table 9. The Effects of ASM on Domestic Violence against Women (Women's Perceptions)

Dep. Var.:	(1)	(2)	(3)	(4)	(5)	(6)
Beating is justified	At least in 1 situation	Goes out	Neglects children	Argues	Refuses to have sex	Burns the food
goldboom	-0.322*** (-17.08)	-0.248*** (-12.91)	-0.289*** (-15.17)	-0.297*** (-14.09)	-0.239*** (-14.01)	-0.230*** (-15.50)
mine_20	-0.061*** (-3.01)	-0.053** (-2.16)	-0.049** (-2.23)	-0.097*** (-4.02)	-0.096*** (-4.38)	-0.064*** (-3.34)
Goldboom	0.035	0.033	0.016	0.061*	0.040	0.066***
*mine_20	(0.96)	(0.92)	(0.47)	(1.68)	(1.28)	(2.59)
N	20285	20280	20279	20277	20280	20276

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Although the coefficients are all positive, they are only significant when the woman is arguing with her partner and when she burns the food. Women's perception of the justification of violence increases in both cases by 6 percentage points. Adopting the two types of interpretations, further interpretations are provided.

First, given the positive coefficients, we can state that women perceive acts of violence as more often justified, perhaps because they are more exposed to violence. Moreover, stating then that violence is justified can be a way to endure it by reducing cognitive dissonance. In other words, as women are aware that they do not have other outside options (as found previously), one way to make the violent situation bearable and reduce the psychological tension would be to make the violent acts seem as justified.

Second, consistent with previous findings, the results here suggest that women accept unequal gender roles and agree with the right of men to physically and sexually dominate. As a result, women are less empowered than women who reject these rights (Sunita Kishor & Johnson, 2004). From a general point of view, the significant estimates for the situation where a woman perceives that being beaten is justified if (1) she burns food and (2) argues with her partner suggest that violence is justified concerning (1) her actions and (2) her freedom of thought. Women consider that if they express a different opinion from men (thus using their

freedom of thought), usually leading to an argument, the probability of considering the violence as justified is the highest.

In both types of interpretations, those results are in line with the dynamics related to *marital dependency*, discussed in chapter 2. Women are more likely to tolerate violence due to fewer outside options (Gelles, 1976; Kalmuss & Straus, 1982). **The results confirm Hypothesis 3, as an impact on domestic violence is found due to a change in the balance of bargaining power within the household.** Nevertheless, it is important to recall that women's low empowerment and domestic violence together, highlighted here may also form a vicious circle (Bhattacharyya et al., 2011), making it difficult to determine the causality.

5.3.2. Men's Perceptions

If we now adopt the men's perspectives (reported in Table A.6. in the Appendix), the results become all non-significant and their signs vary. Nevertheless, by taking up the two possible interpretations concerning the justification of using violence, we can provide some comments on the men's perspectives.

Regarding the proxy for *experienced violence*, we could say that the results on the women sample are probably more reliable, as perpetrators of violence may be less likely to report their wrong-doing than victims. Regarding the women's *level of empowerment*, those non-significative results may hide two countervailing effects. On the one hand, since men are the ones who have been empowered, they feel that the use of violence is more justified. On the other hand, having been exposed to a more heterogeneous environment around the mines and a higher exposition to mainstream media (see section 2.3 in chapter 2) their values may have changed. Therefore, men are less inclined to accept that violence towards women is justified.

5.4. Extension: Effects on Women's Health

While the main focus of this work is on women's bargaining power and domestic violence, it may be interesting to analyze the impact of ASM on women's health. As discussed in chapter 2, the literature provides evidence for non-healthy living conditions around the mines³². Furthermore, given the previous results, it would be optimistic to believe that women near the mines are in good health. A previous study in India found that women who had experienced

³² Although the impacts of ASM on health found by scholars are ambiguous.

physical abuse by a family member were significantly more likely to be underweight (BMI<18.5) (Ackerson & Subramanian, 2008).

The analysis in terms of their health is quite limited here since we focus only on two dimensions: anemia and underweight. *Anemia*³³ is a severe health problem resulting from poor nutrition, infections, or chronic diseases (INSD, 2004, 2012). Similarly, extreme variances in weight cause adverse health consequences. A chronic energy deficiency³⁴ is associated with higher mortality and morbidity (INSD, 2004, 2012). The focus here is on weight deficiency measured by a critical *Body Mass Index*³⁵.

As expected, Table 10 reports a negative impact on women's BMI index (or a positive impact on the probability to have a critical BMI) and a non-significant one on their anemia levels³⁶.

Table 10. The Effects of ASM on Women's Health and Household Assets Index

	(1) High Anemia	(2) Low BMI	(3) Assets	(4) Assets
goldboom	-0.025 (-1.30)	-0.072*** (-5.25)		0.112* (1.92)
mine_20	0.012 (0.52)	-0.020 (-1.09)	-0.180*** (-9.41)	-0.086 (-1.05)
Goldboom*	0.010	0.054**		-0.111
mine_20	(0.33)	(2.30)		(-1.03)
N	8705	14746	20308	20289

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

Column 2 reports that women living near mining sites have a 5-percentage point increase in the likelihood of having a critical BMI index. Some comments and interpretations are provided regarding this impact.

³³ Here the dependent variable is a dummy variable taking the value of 1 when the level is considered to be "moderate" or "severe" (INSD, 2004, 2012). This categorization was carried out directly in the field where, after collecting the blood sample, it was submitted to the anemia test (INSD, 2004, 2012).

³⁴ In contrast, overweight and obesity are risk factors for diabetes, heart disease, hypertension, and some forms of cancer (INSD, 2004, 2012).

³⁵ BMI is directly provided in the dataset. A dummy variable is created and taking the value of 1 when the woman is considered to be underweighted, i.e., with a BMI less than 18.5 (INSD, 2004, 2012).

³⁶ This could be due to the high missing observations for this variable.

First, it is not surprising to obtain such results after highlighting the negative evidence of women's decision-making power and a positive one on domestic violence. It would have been interesting to compare women's BMI to men's BMI to see whether women are discriminated against or, alternatively, if the whole household is experiencing poor health conditions. However, men's BMI was unavailable. Suppose that all the household is experiencing bad health conditions. In that case, women's BMI could be explained not only by their low empowerment but also by living in a dirty environment, as reported in the literature. Polluted water and soil lead to lower agriculture yields (Aragón & Rud, 2015) conducting to critical consequences, such as being underweight, for the population relying mainly on agriculture.

Second, this result tends to contradict one of the suggestions made in the literature that the positive impact of gold mining on income should generally increase households' ability to live in healthier conditions (Bazillier & Girard, 2020). Here, the evidence instead suggests that ASM exacerbates women underweight. Since we have not had the opportunity to measure household income as well as that of its members, we must be cautious in making such a statement. Nevertheless, we still have access to a household wealth index in the DHS dataset. This index of household economic well-being was constructed by the DHS program using data on household assets such as ownership of certain consumer goods (television, radio, or car) and specific housing characteristics (availability of electricity, type of water supply, and type of toilet) (INSD, 2004, 2012). With that variable, we can try to investigate whether ASM exacerbates women's underweight due to higher deprived situations. If this is true, *Assumption 1* suggesting that mining activity is profitable would be weakened.

Column 4 in Table 10 documents a negative but non-significant impact of ASM on the assets wealth index and column 3 provides a negative correlation between living close to a mine, and the assets wealth index. Although correlation does not prove causality, the coefficient in column 3 suggests that people living closer to mines have a lower assets index than people living far from it. However, the assets index is a variable of stock of wealth that is cumulative over a lifetime while income and consumption are short-term measures of wealth. Comparing assets index between two years is likely to compare a mix of the stock of wealth and flux of wealth (income and consumption). With that correlation, we cannot conclude that ASM impoverished mining areas since the assets wealth index captures pre-existing condition³⁷, whereas a flux of income or consumption would allow the causality to be attributed to mines.

³⁷ Or otherwise said, the assets wealth index is a cumulative stock of wealth over the lifetime.

Instead, those results might suggest that mines might have appeared in poorer areas as the stock of wealth is negatively correlated with mining. If this is true, then what is ultimately captured is not so much the impact of the mines, as the treatment is not randomly assigned, but rather the poverty of the people living around the mines. Nevertheless, as describe in the following section, once we introduced region fixed effects, the conclusions remain the same.

5.5. Robustness Checks

As robustness checks, I also estimated all the above regressions with region-fixed effects and with continuous treatment. The results can be seen in the Appendix, where for each category considered, a table containing the fixed effects and the continuous treatment is presented. In both cases, the results are broadly confirmed. They are presented in Appendix A.1., A.2., A.4., A.5., A.6., A.7.

As expected in the empirical strategy description (chapter 4), once we introduce region-fixed effects, some results become non-significant as it eats part of the exposure heterogeneity to the mines.

In addition, I have also estimated everything with a continuous spatial treatment. In other words, instead of using a dummy variable for the spatial treatment, I considered the natural logarithm of the distance. The natural logarithm compensates for the non-linearity in the exposition to mines and reduces outliers. Indeed, the impact is expected to be high when looking at individuals near mines whereas no impact could be reported for individuals located far away. Using a continuous treatment reinforces the causal link by exploring the intensity of the treatment rather than a comparison between a treated and a non-treated group (Meyer, 1995). In our case, the intensity of the treatment is the “intensity” separating households and gold mines. The higher the treatment intensity (and thus the distance between the mine and the household), the lower the exposure and the effects of the mine. As a result, the Tables in the Appendix, with a continuous treatment, report coefficients with an opposite sign than estimations with dummy treatment.

Finally, the estimations presented here are more general in scope since they are based on the “all” women’s sample. To avoid bias, I also restricted my analysis to a smaller sample of women in couples and the findings do not change. For the sake of conciseness, these results are not reported.

Chapter 6. Conclusion

Is artisanal and small-scale mining (ASM) a golden ticket to women's empowerment?

With representative samples of the population of Burkina Faso (from the Demographic Health Survey (DHS) database), I provided a causal estimation of the impact of mine exposure on women's empowerment. The evidence here suggests that the ticket is poisoned as they lose independence, are more likely to experience violence, and be in poor health.

To provide such evidence, we first explored in chapter 2 the channels through which ASM could impact women's empowerment and domestic violence. The first sections of that chapter described the context of mining and its implications at the market, household, and individual levels. The following section focused on factors that could improve women's empowerment, such as employment and income. In addition, evidence regarding domestic violence when the balance of power inside the household shifts was discussed. Based on the literature on the gold mining phenomenon and women's empowerment, the hypotheses for the thesis were established. These are:

- (1) *At the gender level*: with ASM acting as a new opportunity for the rural households during the dry season, they experience a labor reallocation of their members affecting men and women differently;
- (2) *Factors influencing bargaining power*: As this new opportunity impacts men and women differently, it is expected that the bargaining power of those who benefit from the positive insights of two of the influencing factors i.e., work and income, will be improved;
- (2. bis) *Decision-making participation*: The greater the bargaining power of an individual, the greater the participation in the decision-making process;
- (3) *Domestic Violence*: Although we cannot predict its direction³⁸, an impact on domestic violence is expected due to a shift in the balance of bargaining power.

To verify the hypotheses quantitatively, a description of the data used and the creation of the different variables was provided in chapter 3. Then, the fourth chapter was dedicated to the empirical strategy to assess a causal link between ASM and women's empowerment. It started first by reviewing the empirical methods used in the previous papers. Then, I described the current method, a differences-in-differences estimation, and discussed its validity.

³⁸ This is due to the ambiguous nature of the link between domestic violence and women's empowerment.

Finally, chapter 5 presented the results obtained. The first section analyzed the factors influencing women's bargaining power, namely income and employment. The results suggested that ASM affects men and women differently, increasing the probability of men working during the mining season, while estimations for women were non-significant. This validated *Hypothesis 1*. In the next section, I showed that women are more likely to receive in-kind income (while non-significant impact is found for men), providing women less power and outside options. Therefore, consistent with *Hypothesis 2*, it was inferred that ASM increases male dominance and power. Since the impact of ASM on factors influencing women's bargaining power was negative, the following section presented a negative impact of ASM on women's participation in decision making. In contrast, the effect is positive for men, validating *Hypothesis 2. bis*. Next, as the balance of bargaining power within the household is altered, I documented that exposure to mine increased by 6 percentage points the likelihood that women perceive violence as justified. This result is in line with *Hypothesis 3*. The final section provided an extension on women's health and suggests that women are more likely to be underweighted around mine sites. The results presented are robust to several checks such as continuous treatment, a reduced sample, and the addition of region-fixed effects.

Although gold mining could improve household welfare by raising income (Bazillier & Girard, 2020), the results provide negative evidence on women's welfare. The current evidence contributes to the literature as no papers have analyzed so far empirically and on a representative scale of the Burkina Faso, the case of women's empowerment in the context of gold mining. Based on a qualitative method for analyzing data collected in one village in Ghana, Arthur-Holmes and Abrefa Busia (2020) provided positive evidence for women's empowerment when they were directly involved in mining and got in-cash income.

Nevertheless, a major missing variable in this study is income or consumption at the individual and household levels. Income or consumption at the individual level could have reinforced the hypothesis that ASM benefits men and not women by potentially showing that men, because of their direct involvement in the mines, would have a higher income than women. Moreover, given the negative correlation between the asset index and living closer to mines, we would have wanted to check the impact of ASM on the flux of wealth such as income or consumption at the household level. Indeed, the results presented here suggest that at least one household member is losing some welfare while previous evidence suggests that ASM benefits the household income. As a result, we would have wanted to verify with the current data, whether ASM would have benefited households. In this case, we could see whether the negative

evidence of women's well-being is due to poor household conditions (as mines are more likely to be located in poor areas). Or, on the contrary, if the mines have a positive impact at the household level but it is women who are effectively discriminated against in their access to this new economic opportunity.

Second, as I am not measuring directly the individual's involvement in mines, the mechanisms of labor reallocation inside the household are relatively imprecise. Having access to data on direct involvement in mines as well as a more precise categorization of the occupation sectors (and for instance a category for agriculture and another for self-employment) would help to define the mechanisms of a diversification strategy and to better understand who is involved in and around mining. This will reinforce the exploration of unequal access to this new opportunity as already suggested in the case of industrial mines (Kotsadam & Tolonen, 2016).

Finally, the negative results obtained here for women concern women aged between 15 and 49 years. As it has often been pointed out that older and widow women tend to have a precarious status (Chen & Dreze, 1992), it would be interesting and important to analyze their situation in the case of mines.

As a general policy recommendation, women's access to employment should be improved, thereby increasing women's external options and empowerment. Consistent with the economic theories of women's empowerment, the results here suggest that a woman who has no or less access to employment and income is penalized for her well-being (Antman, 2014; Doss, 2013; Doss & Senauer, 1994). In addition, as the work itself can also be a barrier to women's empowerment, policies should also pay particular attention to the position of women in the sector. Accordingly, emphasis should be placed on the gender dynamics and struggles, such as lack of legal and economic rights but also health risks, that women face in the sector and that prevent the realization of their bargaining power within the household (Arthur-Holmes & Abrefa Busia, 2020).

This would already start by formalizing the mining sector both in the academic sphere and in the public sphere. Indeed, for a long time, ASM has been ignored or little discussed in the economic literature and the public area, causing a lack of understanding of ASM dynamics³⁹.

³⁹ Due to the informality, it is difficult to have accurate estimates (O'Driscoll, 2017). As already discussed, Bazillier and Girard (2020) method is less precise than for legal and easily listed mines. This makes it more difficult to address the problems such as the informality, and instability, surrounding ASM.

Consequently, it has resulted in ill-suited and weak public policies (Hilson, 2016; Hilson & Hirons, 2011).

With more attention, it would be possible to eliminate informality and allow for the implementation of policies that are consistent with the reality. Formalization coupled with strong and appropriate policies would not only alleviate the situation for women but also for the more than one hundred million people in the world who depend on ASM (WorldBank, 2009).

As an example of a practical and academic solution, the DHS program should specify the mining sector category. Although the program is intended to make comparisons across countries and therefore keeps the occupation categories fairly general, it could create an additional category of mining occupation given the magnitude of this activity worldwide and precisely in Sub-Saharan Africa and South America. This would allow a better understanding of the mining phenomenon.

In addition, the DHS Program should collect additional data on older women. Although the precarious situation of older women is a general problem, it would be important to analyze it in the mining context.

To echo Sen's words, it is urgent to further consider women's rights and freedom as an essential component of development in Burkina Faso.

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Appendix to the Results

Appendix 1. Region Fixed Effects and Continuous Treatment: Seasonal Employment

	Region Fixed Effects				Continuous Treatment			
	Working		Worked Past		Working		Worked Past	
	(1) Women	(2) Men	(3) Women	(4) Men	(5) Women	(6) Men	(7) Women	(8) Men
goldboom	-0.089*** (-5.51)	0.350*** (14.67)	0.024*** (3.91)	-0.224*** (-11.00)	-0.175*** (-3.00)	0.039 (0.51)	0.074*** (3.36)	-0.009 (-0.15)
mine_20	0.010 (0.72)	0.114*** (3.39)	-0.008* (-1.86)	-0.080*** (-2.88)				
Goldboom*mine_20	-0.025 (-0.83)	- 0.095*** (-2.65)	0.025 (1.62)	0.056* (1.87)				
l_dist					-0.021*** (-3.31)	- 0.068*** (-3.00)	0.001 (1.02)	0.047*** (2.70)
goldboom*l_dist					0.017 (0.98)	0.069*** (2.98)	-0.011** (-2.00)	-0.048*** (-2.75)
N	20283	7187	20287	7186	20283	7187	20287	7186

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix 2. Region Fixed Effects and Continuous Treatment: Earnings Types

	Region Fixed Effects						Continuous Treatment					
	Not paid		Kind		Cash		Not Paid		Kind		Cash	
	(1) Women	(2) Men	(3) Women	(4) Men	(5) Women	(6) Men	(7) Women	(8) Men	(9) Women	(10) Men	(11) Women	(12) Men
goldboom	-0.010 (-0.33)	- 0.200*** (-5.59)	-0.152*** (-6.37)	0.036 (1.31)	0.117*** (6.41)	0.037** (2.00)	-0.480*** (-3.52)	- 0.930*** (-6.23)	0.176 (1.51)	0.061 (0.54)	0.176*** (2.91)	0.228*** (3.44)
mine_20	0.033 (0.85)	0.014 (0.27)	-0.026 (-0.81)	0.022 (0.61)	-0.022 (-1.37)	0.002 (0.12)						
Goldboom*mine_20	- 0.153*** (-2.59)	-0.115* (-1.82)	0.131*** (2.90)	0.012 (0.25)	0.002 (0.07)	0.024 (0.78)						
l_dist							-0.061** (-2.12)	- 0.092*** (-2.70)	0.023 (0.85)	-0.009 (-0.33)	0.034*** (3.54)	0.007 (0.68)
Goldboom *l_dist							0.119*** (3.10)	0.218*** (5.14)	-0.085*** (-2.64)	-0.010 (-0.32)	-0.017 (-0.93)	- 0.056*** (-3.09)
N	18097	6788	18097	6788	18097	6788	18097	6788	18097	6788	18097	6788

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix 3. The effects of ASM on the probability that Man is deciding alone

	(1) Her Health	(2) Large Purchases	(3) Visits to her family
goldboom	-0.047*** (-2.60)	0.054*** (2.93)	-0.210*** (-9.83)
mine_20	0.003 (0.15)	-0.048** (-2.07)	-0.036* (-1.87)
Goldboom*mine_20	0.038 (1.29)	0.070** (2.32)	0.088** (2.19)
N	18683	18683	18683

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix 4. Region Fixed Effects and Continuous Treatment: Decision-Making

	Region Fixed Effects			Continuous Treatment		
Dep. Var.: Joint Participation	(1) Her Health	(2) Large Purchases	(3) Visits to her family	(4) Her Health	(5) Large Purchases	(6) Visits to her Family
goldboom	0.030* (1.69)	-0.037** (-2.26)	0.208*** (9.28)	-0.044 (-0.80)	-0.264*** (-4.42)	-0.071 (-0.82)
mine_20	-0.013 (-0.60)	0.038 (1.64)	0.044* (1.87)			
Goldboom*mine_20	-0.007 (-0.25)	-0.049 (-1.61)	-0.077** (-2.00)			
l_dist				-0.011 (-1.02)	-0.044*** (-3.72)	-0.031*** (-2.91)
Goldboom*l_dist				0.023 (1.53)	0.057*** (3.41)	0.075*** (3.15)
N	18683	18683	18683	18683	18683	18683

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix 5. Region Fixed Effects and Continuous Treatment: Domestic Violence (Women)

	Region Fixed Effects						Continuous Treatment					
	(1) At least in 1 situation	(2) Goes Out	(3) Neglects Children	(4) Argues	(5) Refuses to have sex	(6) Burns the food	(1) At least in 1 situation	(2) Goes Out	(3) Neglects Children	(4) Argues	(5) Refuses to have sex	(6) Burns the food
goldboom	-	-	-	-	-	-	-	-	-	-	-	-
	0.349*** (-18.86)	0.274*** (-14.59)	0.314*** (-16.68)	0.305*** (-14.66)	0.249*** (-14.33)	0.216*** (-14.24)	0.237*** (-3.43)	0.166** (-2.39)	0.218*** (-3.43)	0.166** (-2.32)	0.180*** (-2.79)	0.142*** (-2.70)
mine_20	-0.018 (-0.94)	-0.018 (-0.82)	-0.009 (-0.45)	-0.055** (-2.54)	- 0.063*** (-3.20)	-0.044** (-2.51)						
Goldboom *mine_20	0.007 (0.21)	0.001 (0.02)	-0.011 (-0.36)	0.033 (1.01)	0.023 (0.78)	0.045* (1.86)						
l_dist							0.034*** (2.90)	0.032** (2.20)	0.028** (2.30)	0.050*** (3.31)	0.049*** (3.72)	0.020 (1.62)
Goldboom *l_dist							-0.023 (-1.19)	-0.022 (-1.14)	-0.021 (-1.15)	-0.036* (-1.74)	-0.016 (-0.85)	-0.021 (-1.43)
N	20285	20280	20279	20277	20280	20276	20285	20280	20279	20277	20280	20276

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix 6. The Effects of ASM on Domestic Violence against Women (Men's Perceptions)

Dep. Var.: Beating is justified	(1) At least in 1 situation	(2) Goes Out	(3) Neglects Children	(4) Argues	(5) Refuses to have sex	(6) Burns the food
goldboom	-0.039 (-1.22)	-0.075*** (-3.13)	-0.055** (-2.16)	-0.028 (-1.14)	-0.065*** (-3.22)	-0.081*** (-4.00)
mine_20	-0.001 (-0.04)	-0.013 (-0.49)	0.003 (0.10)	0.001 (0.02)	0.000 (0.01)	0.002 (0.08)
Goldboom *mine_20	-0.001 (-0.02)	0.012 (0.31)	0.011 (0.27)	-0.033 (-0.74)	0.002 (0.07)	-0.026 (-0.87)
N	7188	7188	7188	7187	7188	7187

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix 7. Region Fixed Effects and Continuous Treatment: Health and Assets Index

	Region Fixed Effects		Continuous Treatment	
	(1) High Anemia	(2) Low BMI	(3) High Anemia	(5) Low BMI
goldboom	-0.037* (-1.81)	-0.071*** (-5.09)	-0.004 (-0.07)	0.122*** (2.70)
mine_20	0.025 (1.00)	-0.024 (-1.29)		
Goldboom*mine_20	-0.006 (-0.18)	0.047** (2.05)		
l_dist			-0.006 (-0.45)	0.023** (2.38)
Goldboom*l_dist			-0.005 (-0.30)	-0.053*** (-4.14)
N	8705	14746	8705	14746

Note: All columns include individual level controls (age, ability to read, the number of household members, their religion). Robust standard errors are clustered at the cluster DHS level. t statistics in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01