The Mining Industry in Sub-Saharan Africa: Impacts on Employment, Migration and Remittances

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Abstract

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This doctoral dissertation establishes a comprehensive overview of the impacts of the mining industry in Sub-Saharan in three different sectors: gender-specific effects on employment, change in subnational migration flows and subsequent impacts on households' welfare, and finally, the effects of remittances sent from mining regions on recipient households' expenditures.

Chapter 1 analyzes whether the mining industry has gender-specific labor allocation effects in local mining communities. I leverage spatial and temporal variation in mines location and production in 29 Sub-Saharan countries. Women are found to leave the labor market after a mine opens nearby, but that effect is mitigated by a small increase in employment in supporting

services. Inversely, men are able to increase overall labor supply, mainly in skilled and unskilled manual labor. However, mining policies recently implemented by producing countries, such as Minerals Development Funds, have the ability to mitigate the negative impacts on women's employment thanks to the reinvestment of royalties in the local community. Finally, I use the gold mining industry of Ghana as a case study to measure the role of pollution on mines' employment effects. I find that pollution accounts for 38% of the decrease in women's agricultural employment after a mine opens but doesn't significantly affect men. These negative labor effects could be overturned with effective environmental regulations.

Chapter 2 estimates the change in households' welfare and land prices in Ghanaian mining districts using both a theoretical and empirical model. In the former, I elaborate and calibrate a spatial general equilibrium model with spatial linkages in trade and migration to compute the change in welfare and agricultural land prices following a mine opening. This shock is represented by a shock in productivity, a change in the production function's parameters and a reduction in migration costs. The latter two changes are calibrated using households census, roads maps, and microenterprises surveys from Ghana. Following a mining shock, welfare increases by 1.3% on average in treated districts thanks to an increase in wages, which mitigates the spike of 11.5% in land rental rates. The empirical model, building on spatial and temporal variation in mining activity and an instrumental variable strategy, supports these findings. Finally, results indicate a significant change in indirect utility and land rental rates up to 200kms from the treated district and shed a new light on the mechanisms through which a mining boom can spread to nearby regions.

Chapter 3 takes a fresh look at the long-standing debate on the effects of remittances on households' welfare using Ghana as a case study. More specifically, this chapter studies the differential impacts on households' expenditures of two different types of remittances: remittances sent from mining regions of Ghana and those sent from abroad. Thanks to two different instrumental variable strategies, I am able to show that both types of remittances appear to alleviate the budget constraint of poorer households located in the lower quartiles of income distribution. In fact, they increase their total expenditures but also the fraction of expenses spent on education, food and non-food items. On the opposite, richer households who receive remittances do not reallocate expenditures, indicating non-binding budget constraints. I also analyze how domestic shocks alter these patterns. First, following a negative shock in gold prices (which might signal higher volatility in mining regions' revenue), mining remittances receiving households will smooth their consumption by reducing the increase in education and non-food items expenditures. On the other hand, following a national currency appreciation, international remittances receiving households will be able to significantly increase their total expenditures and experience lower food burden compared to other households. Thus, households receiving international remittances seem to be better protected against negative economic shocks as they are able to mitigate any negative effects on their expenditures, contrary to households receiving remittances from mining regions.

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1.1 INTRODUCTION

Natural resources represent an important source of wealth for many nations that use them as inputs for production or as an income source. Between 1970 and 1980, natural resources rents jumped from 0.6% of GDP on average worldwide to 6%[1]. The commodity bust-boom cycles that followed, respectively in the 80s-90s (where natural resources rents declined to 0.84% of GDP at the lowest) and the 2000s (where the same indicator increased again up to 5% in 2008) are a reminder of the high volatility of natural resources prices. An extensive literature has shown that development strategies overly dependent on natural resources production could result in unstable income streams (Eifert, Gelb, and Tallroth (2002); Brückner and Ciccone (2010); Isham, Woolcock, Pritchett and Busby (2005)) and decrease the ability to withstand global economic shocks, weakening the social fabric and political institutions ((Collier (2003); Acemoglu, Golosov, Tsyvinski and Yared (2012); Lei and Michaels (2014)). The main channels of transmission include rentier state theory, lower incentives to develop institutional capacity, higher commodities prices attracting rebel groups, and lower commodities prices leading to reduced economic growth. Another negative side effect of specializing in natural resources production is the lack of economic diversification and a poor industrial base, symptoms that can be explained using the Dutch Disease phenomenon. The latter was formalized by Corden and Neary (1982) as "the coexistence within the traded goods sector of progressing and declining, or booming and lagging, sub-sectors". As the price of natural resources increase, producing countries experience an accumulation of foreign

[1] World Bank data.

exchange and an appreciation of their national currency. This benefits national importers but hurts exporters other than those in natural resources (the booming sector). In developing countries, the contracting traditional traded sector is usually agriculture or low value-added manufacturing. Additionally, as real income increases, so does spending on tradable and non-tradable goods, which results in an increase in the relative price of non-tradable goods.

How minerals production could differently impact men and women has remained understudied in the literature. The goal of this paper is to estimate whether minerals production has gender-specific effects on sectoral labor allocation in neighboring villages surrounding extraction sites. In fact, there is empirical evidence that sometimes women tend to work in more brain-based activities while men will work in more brawn-based activities (Acemoglu, 1998). Thus, as the mining sector expands, there is a positive shock in male labor demand from the mines or from the infrastructure construction happening near extraction sites. Female workers might also benefit from the boom in natural resources as spending on non-traded goods increase as well as supporting services to mines. Employment could be created in supporting food production and other services (beauticians, waitresses, domestic workers, etc.). Also, if educated, women might find work as secretaries, nurses, or in retail for example. These new employment opportunities could increase returns to education, which might, in turn, entice parents to invest more in girls' education. On the other hand, an estimated 41%[2] of children under 15 years old in Sub-Saharan Africa are child laborers and often work in informal small-scale and artisanal mines (ASM). In consequence, effects of mining on children's welfare could go in both directions.

On another note, it has been shown that mining could have a negative impact on local agriculture mainly through pollution or displacement of the local population[3]. Women are particularly

[2] ILO, 2010.
[3] International Institute for Environment and Development, 2002.

vulnerable to the latter as they often do not own the land on which they work, hence they often receive less compensation (Eftimie, Heller, Strongman, 2009). Also, as the natural resources sector expands, the marginal product of labor in mining increases, which should be reflected in wages. As men switch work from agriculture to mining, they gain more status and eventually get greater bargaining power within the household. Conversely, women who work on the family's land plot see their contribution to the household's earnings and consumption reduced, which can decrease their bargaining power. Additionally, metal producing mines (gold, lead, mercury, coal, etc.) often release a significant amount of fumes into the atmosphere as well as toxic waste into underground and surface water sources. It has been found that mining pollution can have disastrous long-term effects on the environment, decreasing soil fertility, making local food production dangerous to consumption, and causing numerous birth defects along with negative health consequences for children's development (Hilson (2002); Hudson, Fox, and Plumlee (1999)). In the second part of this paper, I develop a case study using Ghana to decompose the effects of mine openings on gender-specific sectoral labor allocation between changes in labor demand and changes in pollution.

I first estimate the local effects of mines production on sector-specific labor force participation by gender. To do so, I build on Kotsadam and Tolonen (2016) who conduct a multi-country quantitative analysis exploiting spatial and temporal variations in mine production to study the local effects of minerals production on female employment. Using household survey data from DHS (Demographic and Health Surveys) and mining data from IntierraRMG, they matched households' locations to mines locations in 29 countries of Sub-Saharan Africa and estimate the effects of mine openings and suspensions on labor occupation. Their results indicate that while women workers go from agriculture to services jobs once a nearby mine starts producing, overall female employment decreases by 8%. I exploit the same identification strategy with spatial and temporal variation in mine production to estimate the labor and education effects of being close to a mine. I also use DHS household data but have a different data source for the mines: I use published data from Berman et al. (2017) who also use data from IntierraRMG and release a subset of their dataset. I find that women's probability of working decreases by 3.6% when a mine opens, a result driven by a 6.1% decrease in the probability of being self-employed in agriculture. However, female employment in supporting industries appears to increase as women's probability of working in services increases by 2.3% and mitigates slightly the general loss in employment. On the opposite, the impact of local mining is found to be more significant for male workers as their probability of working increases by 3.8%, a result driven by an increase in skilled and unskilled manual labor (two categories reflecting mining employment). On the opposite, men's self-employment in agriculture significantly decreases by 5.2%.

I complete three robustness tests for the baseline results. First, I restrict the sample to households located up to 200kms from mines to control for the possibility that households located far away from the mine are quite different from households located near the mine. Second, I estimate the baseline results using a different mine dataset: the "Africa Power Mining Projects Database", Arroyo (2014). This new dataset contains information on 274 large-scale mines in Sub-Saharan Africa, including location and years of inception and completion. I find similar results as the baseline results using this other dataset. Lastly, I estimate the effects of mining on female employment with a different econometric method where standard errors are estimated with a spatial HAC correction (Conley (1999); Hsiang, Meng, and Cane (2011)), allowing for cross-sectional spatial correlation within a 500km radius, as well as a location-specific serial-correlation over an infinite timeline. Given the fact that mines and villages are clustered into space, it could be that the effect of mines on employment spreads outside of the 20km radius determining mining communities.

I then estimate the effects of mine openings on women's earnings depending on multiple conditions: for the entire sample, whether the woman has a partner, if that partner is working and more specifically, if the partner is working in the mine (proxied by employment in unskilled or skilled manual labor). I find that women's log earnings decrease by 51% and that reduction is much stronger if the partner works for the mine. We can then expect a strong decrease in women's bargaining power in mining households. The impact of mine openings on earnings also depends on women's skill level as I find that the decrease is also stronger for unskilled women (those who never went to school), while women who completed secondary education have a marginal, yet insignificant, increase in earnings.

I then analyze whether native and migrant women fare differently when a mine opens. In fact, while native women might have experienced a destruction of livelihood from the mine construction (through land requisition for example) and have been forced to change profession, migrant women might have come to the area specifically to work in the mine or other services. They maybe have more experience than native women doing this type of work and thus might have more labor opportunities or know how to better take advantage of the mine-generated income opportunities. I estimate the effects of migration influx on native women's earnings. To do so, I first assess whether the mine acts a pull factor on farther labor markets by estimating the effects on sectoral employment of past price surges in the mine located at various kilometers from households: within 20km, between 20 and 100km, and between 100 to 200km. After a price surge, women located within 20km of the mine are more likely to work, particularly in unskilled manual labor. Inversely, women located between 20 and 100km and between 100 and 200km are less likely to work, also particularly in unskilled manual labor. It seems that women and men living far away migrate near a mine after a price surge to work as informal or formal miners.

In fact, it is important to note that the dataset only includes the location of large-scale industrial mines when matching mines to nearby villages; however, it could very well be the case that these villages are also located close to small-scale and informal mines. Indeed, illegal miners often dig the same ore deposits as nearby industrial mines but do so in extremely dangerous conditions due to the absence of extraction permits and the lack of financial resources needed to secure underground tunnels (in case of underground mining). Thus, the results presented in this paper should be interpreted as the effects of ore extraction, loosely defined, instead of as the effects of industrial mining.

I then analyze the effects of a policy change concerning mining companies' local involvement. Several countries (such as Mali, Senegal or Guinea) passed laws requiring mining companies to allocate part of their revenues to local infrastructure or community development. Laws are fairly similar across countries. Using all DHS surveys waves, I exploit temporal variation in the creation of these laws to estimate the effects on employment. I expect women and girls to benefit from these laws, either through better transport infrastructure and easier access to markets for women working in agriculture, or through potentially closer schools. A main limitation of this analysis is that I cannot control for the effective application of the law and try to solve this problem using regional time trends.

Finally, I use Ghana as a case study to analyze the effects of their Mining Development Fund strategy, as well as the differential effects of mining labor demand and mining pollution on sectoral labor allocation. I take advantage of the country's vast river system and exploit the fact that the majority of mines in Ghana are located next to a river. I argue that households located within 20km north of the mine and upstream of the same river as the mine will be impacted by the labor demand shock coming from the mine opening. Households located within 20km south of the mine and downstream of the same river as the mine will be impacted by the labor demand shock and pollution. Taking the difference between total effects of mine opening for downstream households and upstream households allows me to estimate the effects of mine pollution on sector-specific labor allocation. In the Ghanaian context, I find that pollution aggravates the effects of mine openings on self-employment in agriculture by 38%, which inflates services and skilled manual labor employment by almost 10% and 14% respectively.

This paper is part of a large branch of literature analyzing the effects of natural production, and more particularly mining, on the economy. The majority of studies on mining focused on the impact of ore extraction on political competition (Shi and Xi, 2018), efficient extraction rates (Farrow (1985); Goldsmith (1974); Halvorsen and Smith (1984) and conflict outbursts (Berman et al. (2017); Guidolin and La Ferrara (2007); Dube and Vargas (2013)). However, studies on the impact of mining on gender inequality or female employment have remained scant (Kotsadam and Tolonen (2016); Reeson, Measham and Hosking, (2012); Black, McKinnish and Sanders, (2005)). This paper is the first to my knowledge to analyze the effects of mining on native women's welfare, to isolate the effects of mining pollution, and to analyze the impact of mining development funds on nearby communities. This paper also builds on the small but growing literature on Dutch Disease and gender inequality. Ross (2008) initiated the debate on the impact of Dutch Disease on gender inequality by using first-difference and cross-national estimations and data on oil production, female employment, and female political representation. He found that oil production reduces female non-agricultural labor force participation, which decreases their political empowerment. Additionally, Frederiksen (2006) designed a theoretical model of Dutch Disease and intra-household labor allocation and discussed the implications of various gender-based occupational segregation types. When sectors are gender-segregated, and women work in the non-traded goods sector, an increase in natural resources production will not change women's labor supply. However, when men and women are allowed to work in the same sectors, men relocate from the traded sector to the nontraded sector while women increase labor supply to the household. Frederiksen's model offers great intuition about the evolution of the local labor market after the opening of a mine in a resource abundant country, which I am going to empirically estimate in this study.

The rest of the paper is organized as follows: section 2 summarizes the literature on extractive industries and gender inequality, section 3 explains the empirical strategy and presents the data, section 4 presents the baseline results of the impacts on gender-specific labor allocation, earnings and migration when a mine opens, section 5 exposes the effects of local mining development funds, section 6 estimates the employment effects of mining development funds and mining pollution in Ghana, section 7 presents the robustness tests results for the baseline model, and section 8 concludes.

1.2 LITERATURE REVIEW

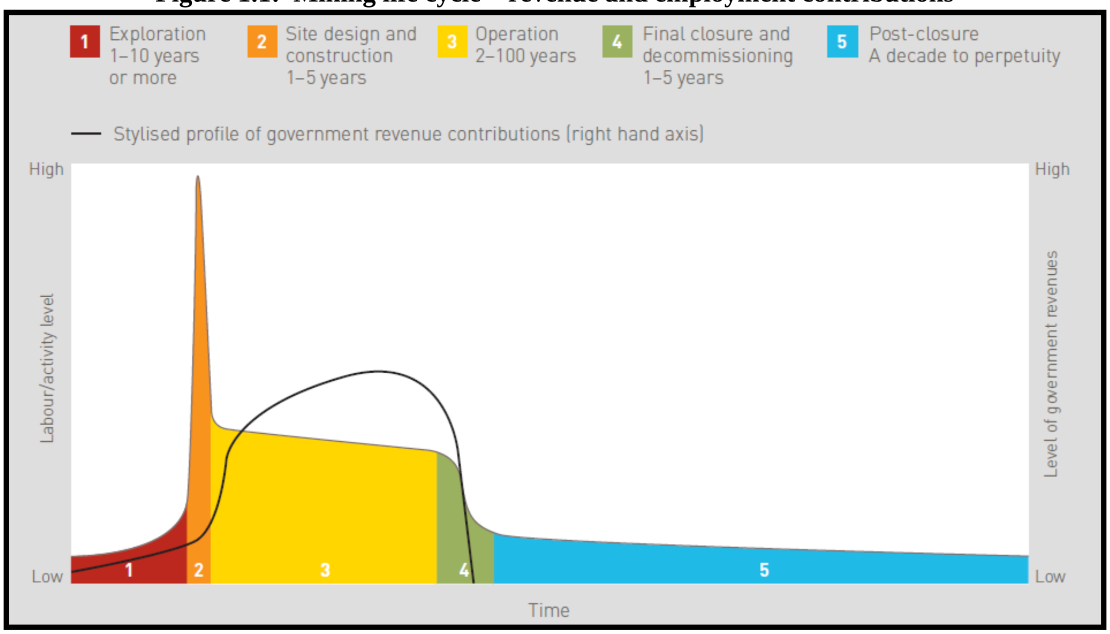
This paper analyzes the impact of mine openings on local labor markets and gender-specific labor allocation. Using household location and survey data from 29 countries in Sub-Saharan Africa and large-scale mines locations across the African continent, Kotsadam and Tolonen (2016) estimate local spillover effects of mine production on employment and sectoral, gender-specific, labor supply. The spatial and temporal variation in mine production allows them to build a difference-in-difference estimation strategy in which households located within 20km of a producing mine are compared to households located within 20km of a future mine to estimate the effects of a mine opening on local labor markets. I depart slightly from this strategy by designating mining communities as the villages located within 20km of a currently producing mine (active) and within 20km of a mine that will open in one to five years (inactive). I compare those "close to mine" villages to all the other villages in my dataset, then to other villages located up to 200km from the mine in a robustness test.

1.2.1 Extractive industries

Mineral and oil production, often considered a powerful source of revenue in the country they are found, can be met with enthusiasm or great suspicion and uncertainty by local communities. The capital flows to the region and new job opportunities often go hand in hand with disruptions caused by the construction of a mine or oil field, as well as pollution of land and water sources. Exploration occurs often in remote locations where local governments might lack the capacity to provide strong infrastructure and public services (International Institute for Environment and Development (2002)). However, some local communities, who might have legitimate questions about the operations or concerns about the change in their environment, expect to be involved in discussions between the government and the mining companies. In case of population displacement, a main source of apprehension for locals is the compensation scheme put in place which will depend on, among other factors, whether minerals found underground belong to the government or the person who owns the land, as well as the way crops value is computed. Mining companies have to take into account numerous variables to ensure the fair compensation of displaced individuals. The techniques taken by mining companies to minimize their environmental footprints are also going to be highly debated with nearby communities, whose main source of subsistence might come from small-scale agriculture and local ground water source (IIED, 2002).

In addition to compensation and environmental considerations, mining also has the ability to impact local and national labor markets. The International Council of Mining and Metals identifies three different types of employment possibly linked to a mine opening: direct employment in the mine itself (mining engineer or miner), indirect employment (workers employed by companies which supply services and goods to the mine), and induced employment (work in services and retail generated by the spending of people employed by the mine or its suppliers). Generated employment depends on the mine's life cycle, as shown in figure 1 below. Mines seem to have the biggest impact on local employment during the construction stage, thanks to the positive shock in unskilled manual labor demand to build roads and other infrastructure. The operational phase generates less direct employment and less unskilled employment but increases indirect employment over time.

Figure 1.1: Mining life cycle – revenue and employment contributions



Source: ICMM, « Role of Mining in National Economies », third edition

1.2.2 Gender inequality and women's employment

According to a report from the Extractive Industries group of The World Bank (2013), women may be less able than men to reap the full benefits of mine openings in their area because of their differences in human capital (stemming from unequal access to education), restricted access to economic opportunities (land ownership, limited access to certain occupations seen as "non-appropriate" for women, difficult access to remote agricultural markets), or low bargaining power within the household. Women are also more likely to bear the majority of costs and risks associated with minerals extraction as they remain involved in agriculture which can be negatively impacted by pollution after a mine opens (The World Bank, 2013). Jayachandran (2015) and Heath and Jayachandran (2017) examine the causes for increased female labor participation in developing countries and identify economic development as a possible cause for improved gender equality. The first explanation for this observation is that as the economy develops, it shifts away from brawn-based activities (where men have a comparative advantage) to services; home production becomes less labor intensive thanks to technology; and contraceptive methods and health centers become more easily accessible. The resulting increase in women's productivity pushes female labor force participation up as well as female education rate. Further determinants of the FLFP have been identified in the literature. Using the U-shaped curve between economic development and FLFP (initially identified by Boserup (1970)), Goldin (1995) suggests that as a country develops and its manufacturing sector develops, labor supply in manual work increases, leading women to withdraw from the labor market in some countries where they would suffer from social stigma for working in those non-traditional sectors. Women's participation in the labor market also depends on the household's earned and unearned income, as well as job opportunities outside the farm (Anderson and Eswaran (2009)). The latter provides higher outside options to women and helps them achieve greater bargaining power within the household as well as greater control over resources. Additionally, Anderson and Eswaran argue that unearned and earned income sources have different impacts on women's labor-leisure trade-off as earned labor income will have a greater impact on women's threats credibility. The structural changes in the labor market generated by mine openings might affect women's labor opportunities and bargaining power. Some labor demand shocks might be heavily gender oriented and significantly improve, or decrease, local women's welfare. For example, Heath and Mobarak (2015) analyzed the rapid growth of the Bangladeshi garment industry on women's welfare exploiting variation in distance to garment factories and years of exposure to the garment industry. They found that the probability of working increases by 12% for girls who were exposed to the garment industry between 10 and 29 years old compared to other girls in farther villages and decrease the risk of getting married by 28% for girls living in a garment-proximate village. However, even if the local labor market becomes more attractive, native women's labor participation and wages will be impacted by migration inflows. Morales (2017) uses migration patterns resulting from the Colombian civil war and an enclave instrumental variable strategy to show that migration inflow decreases natives' wages in the short-run. However, this effect tends to dissipate over time as natives will in turn emigrate but the negative effect on wages is strongest and robust in time for unskilled women, indicating that they are the most vulnerable group to changes in labor market conditions.

1.2.3 Extractive Industries and Gender Inequality

The majority of papers on natural resources production explore the structural change in the industrial mix or labor market, but very little work has been done so far on the impact on gender issues. Maurer and Potlogea (2017) analyze the impact of large oil field discoveries on female labor market outcomes in the U.S. oil-rich counties against control counties from 1900 to 1940. Using data on location and discovery timing of oil fields, coupled with individual-level US census data from IPUMS, they compare the evolution of female labor market outcomes in oil-rich counties relative to control counties following a difference-in-difference strategy. Oil production increases demand for male labor and wage, which increases marriage rate and could potentially decrease female labor force participation. However, as the oil sector expands, so does the services sector which increases female labor demand. As a result of those two opposing forces, the authors find that oil wealth has a zero-net effect on female labor force participation. Zavala (2016) finds similar results using Californian counties data from 1980 to 2010.

Ross (2008) studies whether oil production or Islam is responsible for the weak improvement in gender equality in MENA countries. He uses data on oil production (from the World Bank's environmental and economic indicators) and FLFP (from ILO) for all countries, from 1960 to 2002. To analyze the correlation between oil production and FLFP, he uses two strategies: a first-difference model with country fixed effects and then a cross-national model with a between estimator. Ross (2008) finds that oil, not Islam, is responsible for low FLFP and hypothesizes that oil production reduces the number of female workers in the labor force. Simmons (2016) also finds evidence of a lower FLFP in American regions with more resource wealth.

Finally, Kotsadam and Tolonen (2016) conduct a multi-country quantitative analysis of the local employment impacts for men and women of large-scale mining in the African continent with a geographic difference-in-difference estimation exploiting the spatial and temporal variation in mining. Women were found to go from agriculture to services, but female employment decreased by 8% as not enough jobs were created in non-traded sectors to compensate for the loss in agricultural jobs. Men were found to go from agriculture to skilled manual jobs and mines.

1.3 EMPIRICAL STRATEGY AND DATA

In the first part of this paper, I estimate the effects of mine openings on sectoral labor allocation for women and men. To do so, I use spatial and temporal variation in mine production to match the locations of currently producing, future and suspended mines to households' locations. Households are coded as living nearby a producing mine if they live within 20km of a mine with positive amounts of mineral extracted. Households are also coded as living nearby an inactive (future) mine if they live within 20km of a mine that will start producing in a future year. Finally, households are coded as living nearby a suspended mine if they live within 20km of a mine that already stopped producing during the year the household is interviewed. Finally, the main variable of interest in the baseline regressions is a dummy equal to 1 if the household is located within 20km of a producing mine or a mine that will open in one to five years (which corresponds to its construction time), since mines have the largest effects on employment up to 5 years before opening as presented in section 2.

1.3.1 Data on mines

I use a data extracted by Berman et al. (2017) from the longitudinal Raw Material Data (RMD) dataset. The latter provides information on 233 mines in Africa with yearly production levels from 1997 to 2010, along with multiple dummy variables indicating the years in which the mine is producing, whether the mine was producing between 1992 and 1996, and whether the mine was producing at any point since the start of RMD (1980). Out of 233 mines in Africa, 33% of the mines are located in South Africa. Even though South Africa is not included in our household survey data, there is evidence that workers from neighbouring countries (such as Swaziland, Lesotho, Mozambique, Zimbabwe, Botswana and Namibia) come to work in South African mines. Additionally, 12% of mines are in Zimbabwe and 6% in the Democratic Republic of Congo.

Furthermore, the type of mineral produced by the mine is also known. Out of 233 mines, 33% produce gold as their main mineral, 17% diamond, 14% coal, 12% copper, and 6% iron. The rest is composed of platinum, zinc, phosphate, nickel, aluminum, lead, tantalum, tin and silver. Among the five most produced minerals, copper (and iron) seems to require the most capital-intensive extraction method with a median capital intensity greater than $15,750/t on average in 2015[4] [5], where capital intensity is defined as the ratio of initial capital expenditure to production capacity.

1.3.2 Households Data

I exploit household DHS surveys (Demographic and Health Surveys) from 29 countries. Merging the individual recode datasets for all those countries and for all survey waves until 2010 (final year where I have information on mine production) provides information on 465,615 women with information on coordinates and employment, and which of these has a partner (a woman is defined as having a partner if she is married, or if she is not married but living with her partner). The women are aged 15 to 64 years old, were interviewed between 1990 and 2011, and live in 42,267 survey clusters and 247 sub-national regions.

Table 1 provides some summary statistics on the women and their partners composing our sample. On average, households live approximately 242 kilometers away from a mine (whatever its production status) and 321 kilometers away from a producing mine. Also, out of 465,615 women, 8,970 live within 20kms of an active mine or a mine that will open within 5 years, 1,095 live within 20kms from an inactive mine which will be producing in more than 5 years and 1,386 live nearby a suspended mine. Almost 63% of women in the sample are currently working, while 85.3% of partners are working. Women (and their partners) are working in only one of the following sectors: services, professionals, sales, self-employed in agriculture, employed in agriculture, domestic sector, clerical, skilled or unskilled manual labor. Of the women currently employed, 37.3% are self-employed in agriculture and 26% are employed in sales, while men work predominantly in self-employment in agriculture (40.5%) and skilled manual labor (15.5%).

[4] http://www.mining.com/web/global-copper-production-under-stress/

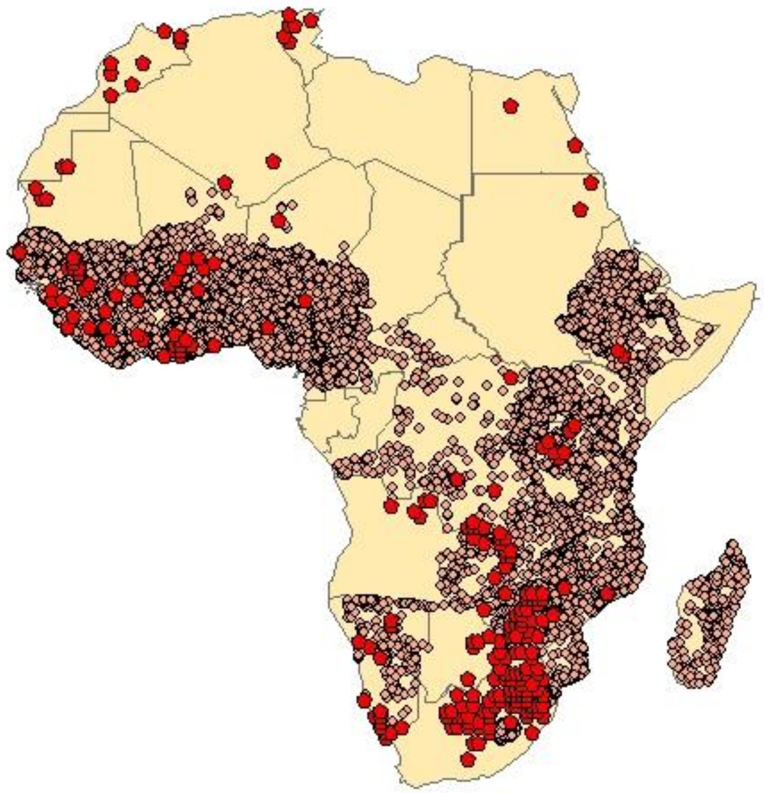
[5] http://www.amegroup.com/Website/FeatureArticleDetail.aspx?faId=236

Table 1.1: Summary Statistics

	Mine variables		
Distance	Distance to closest active or inactive mine (km)	242.5	210.4
Distance to active	Distance to closest active mine (km)	320.7	274.9
Active (20km)	At least one active mine < 20km	0.012	0.0001
Inactive (20km)	At least 1 inactive mine <20km, no active/suspended	0.001	0.0004
Suspended (20km)	At least 1 suspended mine < 20km, no active	0.002	0.0005
	Main dependent variables		
working	1 if respondent is currently working	0.628	0.0005
Services	1 if respondent is working in the service sector	0.056	0.0003
Professional	1 if respondent is a professional	0.047	0.0003
Sales	1 if respondent is working in sales	0.26	0.0006
Agric. (self)	1 if respondent is self-employed in agriculture	0.373	0.0007
Agric. (emp)	1 if respondent is employed in agriculture	0.079	0.0004
Domestic	1 if respondent is employed as a domestic worker	0.019	0.0002
Clerical	1 if respondent is employed as a clerk	0.013	0.0002
Skilled manual	1 if respondent is employed in skilled manual labor	0.073	0.0004
Unskilled manual	1 if respondent is employed in unskilled manual labor	0.056	0.0003
	Other dependent variables		
cash	1 if respondent is paid in cash	0.504	0.0008
Cash & kind	1 if respondent is paid both in cash and in kind	0.148	0.0006
Kind	1 if respondent is paid in kind	0.056	0.0004
Not paid	1 if respondent is not paid	0.291	0.0007
Seasonally	1 if respondent is working seasonally	0.331	0.0007
All year	1 if respondent is working all year	0.563	0.0008
Occasionally	1 if respondent is working occasionally	0.104	0.0005
	Control variables		
Urban	1 if respondent is living in an urban area	0.328	0.0007
age	Age in years	28.5	9.635
School years	Years of education	4.69	4.674
Christian	1 if respondent is Christian	0.132	0.0005
Muslim	1 if respondent is Muslim	0.237	0.0006
Nonmover	1 if respondent always lived in the same place	0.434	0.0007
	Partner information		
Partner	1 if respondent has a partner	0.657	0.0005
Partner working	1 if partner is currently working	0.853	0.0005
Partner services	1 if partner is working in the service sector	0.06	0.0004
Partner profess.	1 if partner is a professional	0.088	0.0004
Partner sales	1 if partner is working in sales	0.113	0.0005
Partner agric. (self)	1 if partner is self-employed in agriculture	0.405	0.0007
Partner agric. (emp)	1 if partner is employed in agriculture	0.087	0.0004
Partner domestic	1 if partner is employed as a domestic worker	0.011	0.0002
Partner clerical	1 if partner is employed as a clerk	0.02	0.0002
Partner skilled manual	1 if partner is employed in skilled manual labor	0.155	0.0006
Partner unskilled manual	1 if partner is employed in unskilled manual labor	0.062	0.0004
N		465,615	
N with partner		311,769	

Figure 4 displays the geographic location of households, mines and oil deposits across the continent.

Figure 1.2: Households and mines locations



1.3.3 Empirical strategy

Information on mine location, production years and geographical coordinates (obtained from Berman et al. (2017)) allows me to implement an estimation strategy similar to Kotsadam and Tolonen (2016) in which households are coded as living nearby an active mine if they live within 20kms of a mine that is producing during the year of the household's interview. However, following the evidence presented in section 2, mining is assumed to have a significant effect on employment not only during production but also during the construction phase. So for the main variable of interest, I construct a dummy equal to one if the household is living nearby an active mine or a mine that will become active in one to five years. Additionally, households are coded as living nearby an inactive mine if they live within 20kms of a mine that has not yet started production the year of the household's interview and will start producing in more than five years.

Finally, households are coded as living nearby a suspended mine if they live within 20kms of a mine which is not producing anymore. Households who live farther than 20kms of any type of mines form the control group (in the first robustness test, the control gorup is reduced to households living within 20km to 200km of mines).

The multiple survey waves in the DHS data, as well as the temporal and spatial variation in minerals production, allow for a difference-in-difference empirical strategy. The estimation relies on the assumption that households can seek employment at any mine located within 20kms: due to increasing transportation costs and diminishing mines footprints the farther we are from the household, it becomes increasingly costly to search for a job past the baseline distance of 20kms. Baseline regressions are estimated using the following model:

$$Y_{i,c,t} = \beta_1 close\ mine + \beta_2 inactive + \gamma_r + \gamma_t + \gamma_{r,t} + \delta X_i + \varepsilon_{i,c,t} \qquad (1)$$

where $Y_{i,c,t}$ is the sectoral labor occupation of individual i living in cluster c in year t. Close mine is a dummy variable equal to 1 if individual i lives within 20kms of an active mine or within 20kms of an inactive mine opening within one to five years (and which is thus considered to be under construction and to have a large impact on employment). β_1 gives the effect on labor occupation of living next to an actively producing mine, compared to households in the rest of the sample located farther than 20kms from an active or inactive mine. $\beta_1 - \beta_2$ gives the effects on employment of a mine opening by comparing households close to a producing mine and those close to an inactive mine that will open far enough in the future that it hasn't yet had any impact on the labor market. The model also includes region and year fixed effects to control for any regional or time characteristics that might influence the labor market, as well as a regional time trend. X_i is a vector of individual controls which include whether the person lives in an urban area, her age, whether the person completed secondary education, whether the household head is a man, and whether the person is of Muslim faith. Finally, standard errors are clustered at the survey cluster level.

1.4 BASELINE RESULTS

1.4.1 Mine openings effects on women and men sectoral employment

Using our entire household survey dataset comprising 465,615 women and the location of 233 mines, I identify women and their partner living within 20 km of a currently producing mine (active mine) or living within 20 km of a mine that has not yet started production the year of the survey but that started producing one to five years later (grouped in the variable close_mine). I also identify households living within 20 km of an inactive mine opening in more than five years (inactive mine variable). Panels a) and b) of Table 2 below provide the effects of living within 20 km of a mine and of mine openings on women's and men's employment respectively. In all regressions, region fixed effects are included to control for time-invariant co-determinants of mining and employment at the regional level, such as weak political institutions, lack of infrastructure, or lack of property rights enforcement that could benefit mining companies but harm local farmers. I also include year fixed effects to control for time-varying variables affecting both mining and employment (for example, a change in mineral prices) and regional time trends to control for time-varying determinants of mining and employment (for example, long-term local unrest in the region).

Mining activity appears to significantly increase both women's and men's probability of working by almost 3% compared to households located farther away than 20 km from any mine. However, when compared with households located near inactive mines opening in more than five years, mine openings decrease women's probability of working by 3.6% while significantly increasing men's by 3.8%. Sectoral labor allocation in the services industry is also significantly impacted and clearly gender-specific: women are 2.3% more likely to work in services after a mine opens, contrary to men who are 3.4% less likely to work in that sector. Given that only 5.6% of women in the entire sample work in services, this represent a 41% increase in the probability of working in services. This supports the theory that mines generate induced employment in retails and services through employees' spending. On contrary, men are found to significantly increase labor participation in skilled and unskilled manual labor (8.2% and 3.4% respectively). Men working in skilled manual labor represent 15.5% of the full sample, so this represents a substantial 53% increase.

Table 1.2: Mine openings and sectoral labor allocation of women and their partners

VARIABLES	(1) working	(2) services	(3) profess	(4) sales	(5) agri_self	(6) agri_emp	(7) domestic	(8) clerical	(9) skilled	(10) unskilled
					a) Women					
close_mine	0.0291**	0.0174***	0.000115	0.0133*	-0.0138	-0.00963	-0.00147	-0.000557	0.0135***	0.0129**
	(0.0121)	(0.00446)	(0.00230)	(0.00803)	(0.0139)	(0.00714)	(0.00223)	(0.00149)	(0.00435)	(0.00556)
Inactive mine	0.0655**	-0.00563	-0.00544*	0.00634	0.0475	-0.0113	-0.00165	-0.00453*	-0.00124	0.0139
	(0.0299)	(0.00377)	(0.00312)	(0.0272)	(0.0342)	(0.00891)	(0.00152)	(0.00242)	(0.0235)	(0.0129)
β1-β2	-3.6%	2.3%***	0.6%	0.7%	-6.1%*	0.2%	0.0%	0.4%	1.5%	-0.1%
Observations	453,183	464,229	464,229	464,229	464,229	464,229	464,229	464,229	464,229	464,229
R-squared	0.130	0.058	0.043	0.102	0.265	0.207	0.023	0.027	0.035	0.084
					b) Partners					
close_mine	0.0282***	-0.0199***	0.00430	0.00163	0.00293	-0.0231*	0.00313	-0.00973***	0.0606***	0.00827
	(0.00868)	(0.00557)	(0.00614)	(0.00755)	(0.0175)	(0.0128)	(0.00216)	(0.00285)	(0.0102)	(0.00593)
Inactive mine	-0.00949	0.0142	-0.0144*	-0.00623	0.0553	-0.00890	-0.00172	-0.000514	-0.0216**	-0.0256**
	(0.0132)	(0.0175)	(0.00763)	(0.0165)	(0.0379)	(0.00602)	(0.00734)	(0.0105)	(0.00860)	(0.0108)
β1-β2	3.8%**	-3.4%*	1.9%*	0.8%	-5.2%	-1.4%	0.5%	-0.9%	8.2%***	3.4%***
Observations	258,196	258,196	258,196	258,196	258,196	258,196	258,196	258,196	258,196	258,196
R-squared	0.334	0.056	0.063	0.061	0.323	0.289	0.019	0.027	0.061	0.040

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

This, in addition to the decrease in agricultural employment for both women and men (by 6.1% and 5.2% respectively), could indicate that mine openings drive native men to leave their occupation in agriculture or to migrate to the mining area to work directly in mines as miners or to work in related employment (mechanics, machines operators) indicated by the increase in skilled and unskilled manual labor which are the two categories used to register miners in most DHS surveys. Additionally, results indicate that women exit the agricultural sector to find work in services, either because they can find more lucrative opportunities in the latter sector or because mining pollution and displacement cause them to lose their plot. However, the simultaneous increase in services employment for women and decrease for men following a mine opening indicate a gender-specific labor allocation where men find work in mines or supporting technical assistance, while some women leaving the agricultural sector find work in supporting services.

1.4.2 *Mine openings effects on women's earnings*

Using the same methodology as the baseline regressions from Table 2, I estimate the effects of a mine opening on nearby women's log of daily earnings, for the full sample as well as according to different characteristics (if the woman is working, if she has a partner, if that partner is working, etc.). I decompose the sample for these various characteristics and run regressions separately in order to allow for heterogeneous impacts on earnings of the covariates. Results are presented in Table 3 below. It is first important to note that I only observe earnings for 18,055 women in the entire sample. The number of observations is thus severely reduced in these regressions. Column (1) presents results for the 18,055 observations sample, while column (2) presents results for working women only. Mine openings seem to significantly reduce women's earnings by 68% (after taking exponentiated values of the coefficients), a result that is driven entirely by working women (as their earnings decrease by 67%). This can be explained by women's loss in employment after a mine opens, observed in Table 2. In fact, we saw that mine openings decreased women's probability of being self-employed in agriculture by 6.1%, and increased their probability of working in services by 2.3%. However, given the fact that a much larger proportion of women are working in agriculture, the increase in services employment is not enough to offset the negative impact on agricultural employment. Women who lose their job might have to resort to menial activities in the mines to keep some income flows. Additionally, as the mine attract workers from farther areas, the labor market might become tighter and more competitive for workers, which will decrease wages.

After decomposing the sample by partner's characteristics, it appears that a women's marital situation and her husband's employment status will have a great impact on her earnings after the mine opens. In fact, while women who don't have a partner are not impacted by the mine opening, having a working partner decreases a woman's earnings by 76% after a mine opens, and an unemployed partner only decreases earnings by 48%. As we saw in Table 2, men's probability of working significantly increases after a mine opens as they appear to leave the agricultural sector to find work in skilled or unskilled manual labor. Attractive salaries at the mine could explain both men's change in sectoral employment, as well as women's decrease in earnings resulting from a wealth effect. As men gain access to more lucrative job opportunities, the incentives for a woman to work outside the household declines (Anderson and Eswaran (2009)). This is supported by the results in column (6) where I restrict the sample to women whose partner works in skilled or unskilled manual labor. Their earnings decrease by 173% after a mine opens.

Table 1.3: Mines openings and women's log earnings

VARIABLES	(1) full sample	(2) working women	(3) no partner	(4) partner working	(5) partner not working	(6) partner skilled or unskilled work	(7) uneducated	(8) educated	(9) native	(10) migrant
close_mine	0.0099	0.0537	0.455	0.0288	-0.0647	-0.677***	0.125	-0.159	0.251	-0.0724
	(0.242)	(0.239)	(0.398)	(0.261)	(0.739)	(0.201)	(0.276)	(0.279)	(0.329)	(0.285)
inactive_mine	0.524***	0.5478***	0.400**	0.584***	0.352	0.805***	0.860***	-0.315**	0.628***	0.277**
	(0.148)	(0.149)	(0.172)	(0.169)	(0.382)	(0.285)	(0.110)	(0.157)	(0.210)	(0.115)
β1-β2	-51%*	-49%*	6%	-56%*	-42%	-148%***	-74%**	16%	-38%	-35%
Observations	18,055	17,479	4,005	15,316	199	3,215	10,471	6,221	7,418	10,637
R-squared	0.548	0.550	0.690	0.522	0.396	0.540	0.328	0.570	0.620	0.493
region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
regional time trend	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

In columns (7)-(10), I restrict the sample according to women's skills and migration status. The only significant result is given in column (7) in which I restrict the sample to uneducated women (women who have never been to school). Unsurprisingly, uneducated women appear to be the most vulnerable to job losses when a mine opens as their earnings decrease by 123%, compared to an increase of 12% for women who are educated and completed secondary education (albeit this result is not significant). In areas close to inactive mines, 17% of uneducated women are unemployed and those who work are mostly in sales (24%) or in agriculture (45%). However, in areas close to active mines, the unemployment rate for uneducated women increases to 22%, and employment in sales and agriculture decreases to 23% and 36% respectively. In conclusion, women whose husbands have the adequate skills to work in the mines and uneducated women who rely on agricultural employment and might have non-transferable skillsets are the most vulnerable to mine openings and experience severe and significant earnings drops.

1.4.3 Decomposing mine openings effects on employment: migration

1.4.3 a) Spatial diffusion of the effects of mine openings

Besides acting as a labor demand shock, mine openings may disturb local labor markets in two other ways: they also act as a pull factor attracting workers from farther areas, and they pollute soil and water sources, impacting agriculture, fishing, or herding activities. In this section, I estimate how the migration generated from the mine impacts native women's employment and welfare. In the baseline regressions, the variables close_mine and inactive_mine are equal to 1 only for households located within 20kms of a producing (and soon-to-be-producing mine) or an inactive mine respectively. However, there is evidence that mine openings attract workers from afar: skilled workers come to find employment as mechanics, administration, etc., while unskilled workers might also migrate towards the mine, hoping to take advantage of either direct employment or informal mining activities. In table 4, I analyze the effects of a past price surge on employment within 20km of the mine, between 20 to 100km, and between 100 to 200km. I compute annual percentage price changes for the main ore produced at the mine and interact the price change from the year before the household was interviewed with whether or not the household is living within 20km, within 20 to 100km, or within 100 to 200km of a producing mine. This allows me to estimate the diffusion of mines attractiveness over space using the following:

$$Y_{i,c,t} = \sum_{i=1}^{3} \beta_i closest\ active\ mine_i + \beta_4 price\ change\ in\ closest\ mine + \sum_{i=1}^{3} \theta_i closest\ active\ mine_i * price\ change\ in\ closest\ mine + \gamma_r + \gamma_t + \gamma_{r,t} + \varepsilon_{i,c,t} \quad (2)$$

where "closest active mine$_{1,2,3}$" is a dummy variable equal to 1 if the closest active mine is located within 20km, 100km and 200km respectively of the household. After a price surge in the main mineral produced by the mine, women living within 20km of the mine have a higher probability of working, while women living up to 100km and up to 200km have a lower probability of working. This could be explained by the fact that women and their partners living farther away might be attracted by recent mineral high prices and migrate closer to the mine to try to find work or to participate in informal mining activity. Results from the last column could support this theory as after a price surge, employment in unskilled manual labor decreases farther away from the mine, while the coefficient stays positive (but not significant) within 20km from the mine. Thus, it could be that women and men who were previously working in unskilled manual labor between 20 and 200km away migrate closer to the mine after a price surge to mine the mineral themselves. This could explain the decrease in probability observed in column (10).

Table 1.4: Spatial diffusion of mine openings' effects

VARIABLES	(1) working	(2) services	(3) profess	(4) sales	(5) agri_self	(6) agri_emp	(7) domestic	(8) clerical	(9) skilled	(10) unskilled
					a) Women					
change_price_closest_mine20	1.251***	0.00813	0.335**	0.365	1.068**	-0.311**	-0.0319	0.0743	0.0245	0.0724
	(0.344)	(0.123)	(0.141)	(0.303)	(0.466)	(0.140)	(0.0370)	(0.0821)	(0.167)	(0.151)
change_price_closest_mine100	-0.384***	-0.0253	0.102***	-0.0362	1.365***	-0.461***	-0.0241	-0.0623***	0.179***	-0.273***
	(0.129)	(0.0354)	(0.0325)	(0.0680)	(0.147)	(0.0744)	(0.0290)	(0.0195)	(0.0482)	(0.0488)
change_price_closest_mine200	0.0358	0.0652**	0.0468*	-0.00818	0.371***	-0.0663	0.00737	-0.0140	0.0356	-0.121***
	(0.0955)	(0.0286)	(0.0247)	(0.0632)	(0.119)	(0.0636)	(0.0112)	(0.0137)	(0.0285)	(0.0299)
Observations	383,338	392,360	392,360	392,360	392,360	392,360	392,360	392,360	392,360	392,360
R-squared	0.064	0.055	0.016	0.068	0.180	0.158	0.018	0.012	0.032	0.088
					b) Partners					
change_price_closest_mine20	0.886	-0.606***	0.909***	-0.350	-0.821	0.0496	-0.0429	0.0474	1.144**	0.556**
	(0.604)	(0.143)	(0.171)	(0.225)	(0.553)	(0.288)	(0.0263)	(0.0883)	(0.562)	(0.225)
change_price_closest_mine100	-2.387***	-0.570***	-0.152***	-0.463***	-0.637***	-0.220**	-0.0217**	0.0203	0.0611	-0.404***
	(0.197)	(0.0562)	(0.0533)	(0.0564)	(0.201)	(0.110)	(0.00974)	(0.0373)	(0.119)	(0.0591)
change_price_closest_mine200	-0.817***	-0.0874*	-0.00826	-0.207***	-0.380***	-0.0710	0.0238**	0.108***	-0.00289	-0.192***
	(0.103)	(0.0517)	(0.0452)	(0.0657)	(0.141)	(0.0950)	(0.00951)	(0.0351)	(0.0779)	(0.0349)
Observations	258,500	258,500	258,500	258,500	258,500	258,500	258,500	258,500	258,500	258,500
R-squared	0.453	0.041	0.032	0.045	0.232	0.253	0.018	0.012	0.049	0.034

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

Employment in agriculture from columns (5) (for men) and (6) also seems to be negatively impacted by a mine opening. Multiple mechanisms could explain this mechanism: first, it could be that skills are easily transferable between employment in agriculture and skilled or unskilled manual labor. The increase in marginal productivity in these two sectors could entice people to reallocate their labor supply. Additionally, as the mine requires land to extract the mineral and potentially pollutes, large plot owners could find it more profitable to sell their land to mining companies and open a new farm elsewhere in the country, thus reducing labor demand for agricultural employment. Another potential explanation might come from the Dutch Disease theory: as the price of the main mineral increases, and if the latter makes a large part of national exports, the national currency could appreciate. This will hurt traditional exports (such as agricultural commodities) and decrease employment in some exporting sectors. In fact, employment in services (non-tradables) increases, no matter the distance to the mine, after a price surge, while employment in agriculture decreases.

In addition to the evidence presented above that an active mine increases labor participation close to the mine and decreases it farther away up to 200km, I analyze spatial decay of a mine opening's effects on employment using the baseline model enhanced with distance to the closest active or inactive mine:

$$Y_{i,c,t} = \beta_1 closest\ mine\ active + \beta_2 closest\ mine\ inactive + \beta_3 \log(smallest\ distance\ to\ active\ or\ inactive\ mine) + \beta_4 closest\ mine\ active * \log(smallest\ distance) + \beta_5 closest\ mine\ inactive * \log(smallest\ distance) + \gamma_r + \gamma_t + \gamma_{r,t} + \varepsilon_{i,c,t} \quad (3)$$

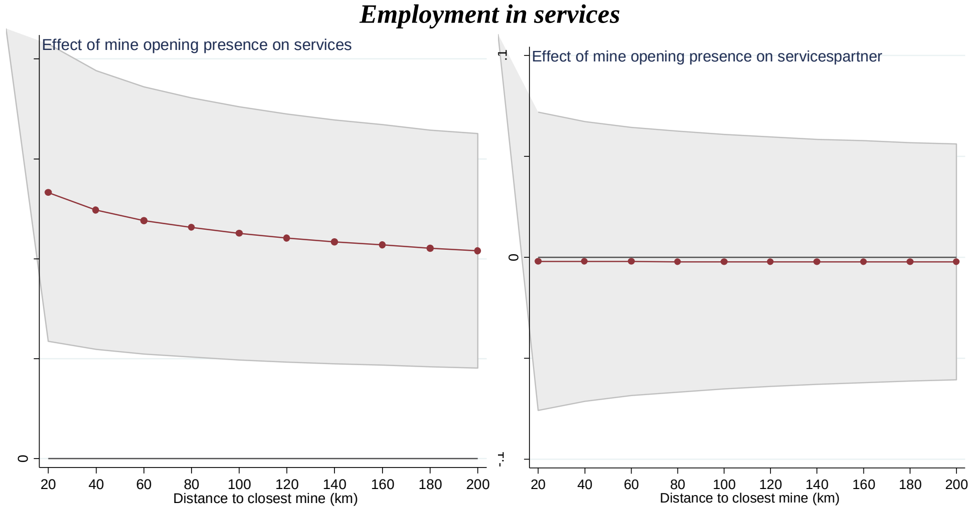
Results are available in Table A.1 in Appendix A and figure 3 below presents estimated effects of mine openings for every 20km, up to 200km of the mine. The latter are computed as the difference between the effect of being closest to an active mine active (closest mine active + closest mine active*distance) and the effect of being closest to an inactive mine active (closest mine inactive + closest mine inactive*distance). For example, households located within 100km of the closest active mine are compared to households located within 100km of the closest inactive mine.

Interestingly, while the effects on husbands' employment quickly decay over space and becomes null around 180km away from the mine, women's employment remains negative up to 200km and does not seem to go back to 0. The same is true for services and skilled manual labor: the probability of working in these two sectors appears to increase everywhere. Inversely, the probability of working in agriculture decreases for both men and women up to 200km from the mine. The fact that employment increases in services and decreases in agriculture even for households located far away from the mine could indicate a national trend: if a country is a major ore producer, as it produces and exports more minerals, a Dutch Disease phenomenon can occur, increasing non-tradable production and decreasing traditional exported commodities. The labor market diversifies and generates employment outside of agriculture.

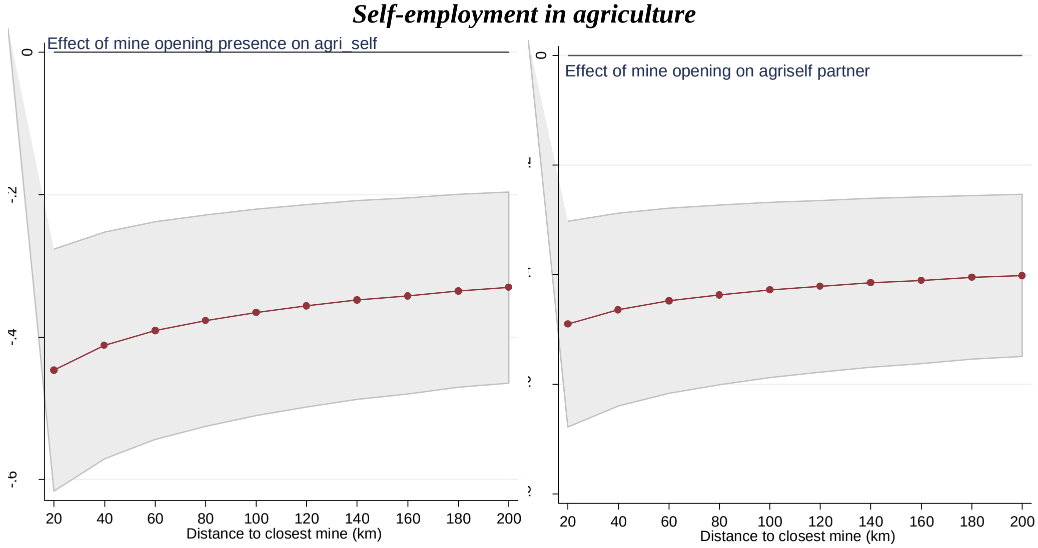
Figure 1.3: Effects of a mine opening over distance to household

Working Probability

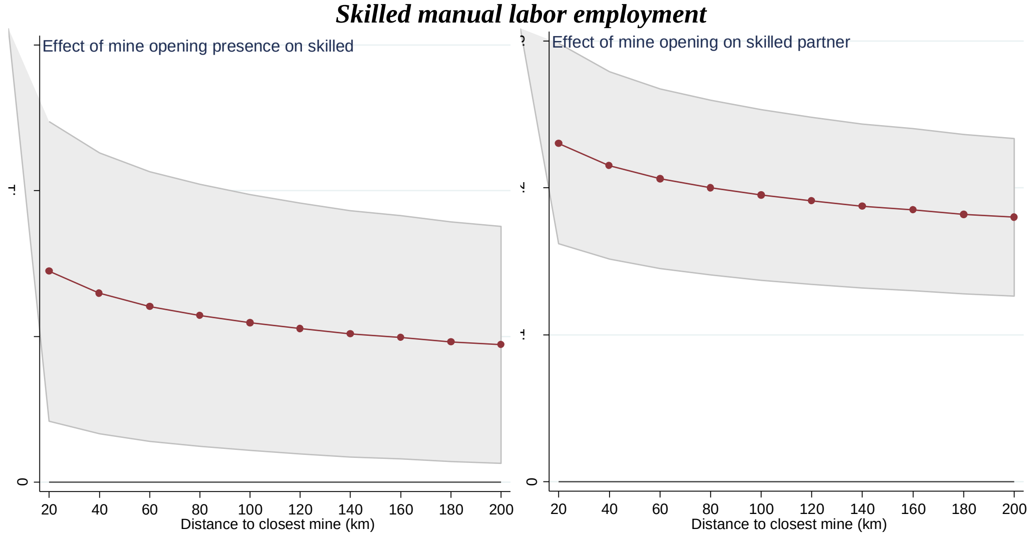
Employment in services



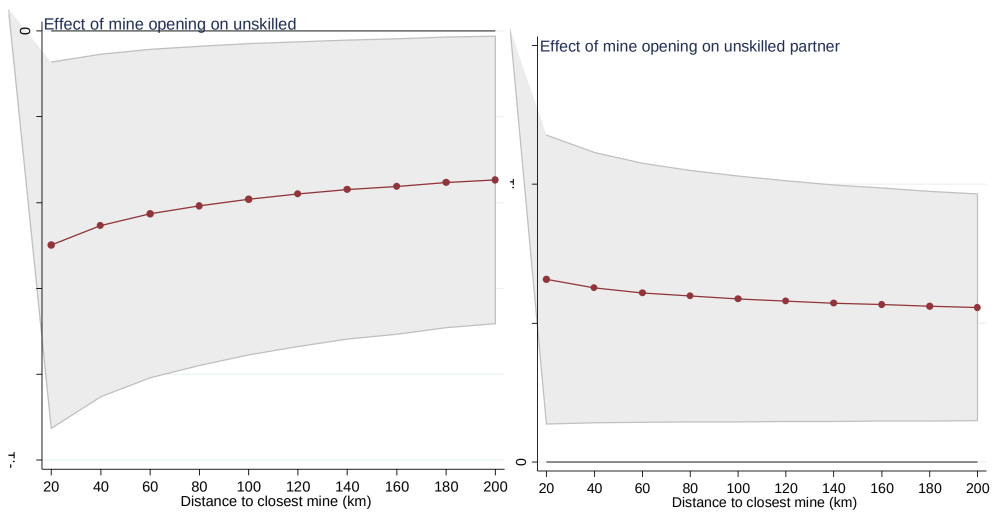
Self-employment in agriculture



Skilled manual labor employment



Unskilled manual labor employment



1.4.3 b) Effects of migrants on native's employment

The previous section showed that a price surge in the main mineral produced by a mine and mine openings have a significant effect on employment (positive or negative depending on the sector) up to 200km of the mine's location. Here, I assess the effect of a mine opening on native women's employment and household wealth following potential migration discussed in section 4-3) a. In order to estimate the effect of migration, I adapt a strategy from Morales (2017) in which he regresses the outcome of interest of a person i living in a municipality m at time t on the inflow of persons who arrived in municipality m at time t-1 ,while controlling for population size. Here, I estimate the effect on native women's employment and wealth of the number of women who moved within 20km of the mine after it began production (I also include people who moved up to five years before production began to take into account the construction period of the mine which might also attract migrants). However, this estimation could suffer from omitted variable bias as both native's welfare and inflow of migrants are influenced by the mine opening which disrupts the local labor market attractiveness, but also by infrastructure and other local institutional variables (such as corruption for example). Morales (2017) used an enclave IV strategy in which he exploited past migration patterns as the instrumental variable for current migration inflows. Since DHS surveys are cross-sectional, I am unable to establish migration patterns between regions. Instead, I use the pool of potential migrants as well as national estimates of percentage of rural population working in artisanal and small-scale mining. The former is made up by the amount of men working in sales and skilled manual labor between 20 and 200km of an inactive mine, as section 4-3)a presented evidence that mine openings had effects up to 200km, and since migrant men located next to a mine work primarily in sales or skilled manual labor. Finally, estimates of artisanal and small-scale mining are taken from Seccatore et al. (2014). I use the same individual controls and fixed effects as in the baseline model, and control for the amount of people living within 20km of the mine.

The pool of potential migrants interacted with the percentage of rural population working in artisanal and small-scale mining seem to be a good predictor of the number of women migrating nearby the mine after it started production. Migration appears to hurt native's women probability of working but increases native households' wealth. As migrant women maybe have experience in non-traded services, sales, or unskilled manual labor, and moved for the sole purpose of taking advantage of the labor opportunities generated by the mine, they might compete for jobs with native women. Artisanal miners also compete with native households for land they might use either for agriculture or for informal mining, thus decreasing native women's labor supply.

Table 1.5: Effects of migration on native women's employment and household wealth

VARIABLES	(1) working	(2) household wealth index	(3) first-stage
nb_women_migrant_after_mine opens	-0.000551**	0.00571***	
	(0.000232)	(0.00155)	
pool_migrant_partners inactive mine			-1.376**
			(0.689)
ASM_pct_ruralpop			16.41***
			(3.408)
pool_migrant_partner_asm			1.412***
			(0.511)
Observations	2,656	1,539	2,681
R-squared	0.157	0.437	0.999
region FE	YES	YES	YES
year FE	YES	YES	YES
regional time trend	YES	YES	YES

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

1.5 LOCAL DEVELOPMENT FUND POLICIES

Starting the 2000s, several mining countries, seeking to better harness minerals extraction benefits, implemented a number of reforms concerning the mining sector. A number of laws were adopted following domestic pressures and to avoid any violence at mining sites that could potentially occur from disrupted and aggrieved locals (Dupuy (2014)). They encompassed multiple policy areas to provide a stronger legal framework for mining companies' activities and ranged from stronger environmental guidelines (water purification, toxic waste management, etc.), tighter exploration permits and production licences procedures, higher tax royalties, and in some cases, the mandatory establishment of Local Development Funds. The latter ensures that mining communities gain greater access to their soil's wealth and helps counter any other potential negative consequences from mining activities (mainly pollution, land scarcity and displacement). These Local Development Funds also helps ensure mineral production translates into lasting and effective development for local communities instead of mere depletion of ore deposits.

The range of specific requirements and characteristics for these funds is rather broad across countries but often entails that a certain percentage of mining companies' gross revenues or royalties must be sent back to mining affected communities (between 0.1% in Sierra Leone to 15% in Niger). There is however great variability across countries, and sometimes even little information in the law, regarding how these funds should be implemented and managed, which gives great discretion to local managing authorities. It could be hard to see any impact from these laws in local communities if the funds are managed by a corrupt elite. On the other, if the specified amount of revenues or royalties is indeed sent back to mining areas, the latter can be invested in projects benefitting the whole communities such as: infrastructure development, assistance in education and for small businesses, agricultural product marketing, etc. (Dupuy, 2014).

To analyze the impacts of these Local Development Funds, I first create a dummy variable (Dev Fund) equal to one if the person interviewed is living within 20kms of an active or soon-to-be-active mine, in a country having already passed a Local Development Fund law in a year prior the time the household is interviewed. I then interact this Dev Fund dummy variable with close mine and inactive mine dummies to identify households living nearby a producing or inactive mine in a year where the mining company is subject to the Local Development tax. The difference between the coefficients on close mine and inactive mine thus gives the effect of mine opening at a time where no such law has been passed. In addition, the difference between the coefficient on close mine*Dev fund and inactive mine*Dev fund gives the effect of a mine opening when the law is in effect. The difference between those two differences will tell us how the law impacted mining activity's effects on sectoral employment. Those results are presented in Table 6 below and regressions still include region and year fixed effects, regional trends and standard errors clustered at the survey cluster level. After a Development Fund Initiative has been created, the total effect of a mine opening on women's employment is now positive. This result is driven by an increase in sales and skilled manual labor employment. The increase in services employment is also much smaller. Interestingly, these laws decreased the positive change in labor participation for men, driven by a lower increase in skilled and a negative change in unskilled manual labor. This result gives rise to interesting questions. Could the Fund's revenues be invested in labor generating opportunities outside of the mine which would explain the decline in skilled and unskilled manual labor? Or on contrary, are mines decreasing their labor demand to compensate for the loss in revenues coming from the Funds which could be another potential explanation for the decrease in manual labor? Are these Funds benefitting women and men's agricultural production thanks to agricultural product marketing and the creation of sustainable income earning opportunities[6]?

Table 1.6: Local Development Funds and sectoral labor allocation of women and men

VARIABLES	(1) working	(2) services	(3) profess	(4) sales	(5) agri_self	(6) agri_emp	(7) domestic	(8) clerical	(9) skilled	(10) unskilled
					a) Women					
Close mine	0.00378	0.0197***	0.00430	0.00122	-0.0456**	-0.00672	0.000492	0.000636	0.00997	0.0230**
	(0.27)	(3.48)	(1.58)	(0.13)	(-3.18)	(-0.71)	(0.21)	(0.33)	(1.91)	(3.06)
Inactive mine	0.0723	-0.00879*	-0.00530	0.0240	0.00936	-0.0114	-0.000836	-0.00484**	0.00570	0.0217
	(1.63)	(-1.98)	(-1.39)	(0.69)	(0.27)	(-0.86)	(-0.70)	(-3.00)	(0.17)	(1.14)
Close mine*Dev Fund	0.0899***	-0.00807	-0.0151**	0.0434*	0.114***	-0.0105	-0.00707	-0.00430	0.0127	-0.0362***
	(3.52)	(-0.96)	(-3.00)	(2.42)	(3.30)	(-0.89)	(-1.25)	(-1.63)	(1.36)	(-4.43)
Inactive mine*Dev Fund	-0.0173	0.00917	-0.000496	-0.0513	0.112	0.000141	-0.00242	0.000889	-0.0202	-0.0228
	(-0.32)	(1.13)	(-0.08)	(1.96)	(1.46)	(0.01)	(-1.61)	(0.14)	(-0.48)	(-1.16)
Total effect of a mine opening after Dev Fund	3.9%*	1.1%***	-0.5%**	7.2%	-5.3%*	-0.6%	-0.3%	0.0%	3.7%	-1.2%
Mine opening after-before fund	18%*	-5%***	-2%**	12%	6%	-2%	-1%	-1%	3%	-1%
Observations	453,183	464,229	464,229	464,229	464,229	464,229	464,229	464,229	464,229	464,229
R-squared	0.130	0.058	0.044	0.102	0.265	0.207	0.023	0.027	0.035	0.084
					b) Partners					
Close mine	0.0378***	-0.0225***	0.0108	0.00230	-0.0187	-0.0283	0.00341	-0.0113***	0.0724***	0.0297***
	(0.0119)	(0.00738)	(0.00757)	(0.00941)	(0.0215)	(0.0177)	(0.00259)	(0.00365)	(0.0128)	(0.00769)
Inactive mine	-0.0337	0.0241	-0.0220	-0.0275	0.0358	-0.00486	-0.00572**	0.0265	-0.0311	-0.0289**
	(0.0422)	(0.0383)	(0.0148)	(0.0304)	(0.0538)	(0.0189)	(0.00258)	(0.0227)	(0.0256)	(0.0119)
Close mine*Dev Fund	-0.0331**	0.00902	-0.0224*	-0.00229	0.0744**	0.0178	-0.000965	0.00541	-0.0404**	-0.0737***
	(0.0137)	(0.00996)	(0.0127)	(0.0153)	(0.0356)	(0.0191)	(0.00467)	(0.00549)	(0.0201)	(0.00991)
Inactive mine*Dev Fund	0.0318	-0.0131	0.00991	0.0282	0.0263	-0.00521	0.00528	-0.0357	0.0122	0.00392
	(0.0433)	(0.0430)	(0.0173)	(0.0360)	(0.0711)	(0.0195)	(0.0100)	(0.0251)	(0.0268)	(0.0184)
Total effect of a mine opening after Dev Fund	0.7%	-2.4%	0.0%	-0.1%	-0.6%	0.0%	0.3%	0.3%	5.1%***	-1.9%***
Mine opening after-before fund	-14%	7%	-7%*	-6%	10%	5%	-2%	8%*	-16%***	-14%***
Observations	258,196	258,196	258,196	258,196	258,196	258,196	258,196	258,196	258,196	258,196
R-squared	0.334	0.056	0.063	0.061	0.323	0.289	0.019	0.027	0.061	0.040

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

[6] http://businessfordevelopment.org/nexus-between-mining-agriculture/

1.6 CASE STUDY: GHANA

The second largest gold producer in Africa, Ghana exported $9.69 billion worth of gold in 2016 which represented approximately 52% of total exports. The Ministry of Lands and Natural Resources is responsible for negotiating and granting mineral rights licenses to large or small-scale mining companies. After the mineral right has been granted, the company is required to pay an annual ground rent, annual mineral right fees, royalties fixed to 5% of revenues (in 2011), as well as corporate taxes (35% in 2012). The mining company must also grant a 10% equity interest to the government.

According to the Minerals and Mining Act of 2006, any mineral found in Ghana is the property of the Ghanaian Republic. The occupier of a land where mineral is found can retain the right to graze livestock or cultivate the land, as long as it doesn't interfere with mining activity. If it does, the owner of the mining lease will determine a financial compensation to the land occupier based on a survey of the crops as compensation depends on lost property value, loss of earnings and expected income. If the occupier prefers to be resettled, the Minister will propose a suitable and similar alternate land. As described in Goldstein and Udry (2008), Ghana's land tenure system is based on chieftaincies. Most of the land cultivated by farmers is owned by the paramount chief (also called a Stool) and is allocated according to farmers' political influence and needs. Land is controlled by a matrilineage leadership (the Abusua) as long as the Abusua members abide by the Stool's rules. Members of a particular Abusua negotiate among themselves to determine which plot to farm. This complex system of land tenure and allocation might then make even more difficult the compensation process. Is the compensation given to the Stool, the Abusua, or each individual farmer? Farmers with low bargaining power such as women or young people can have difficulty proving they were the rightful land occupiers to mining companies.

In 2013, the Ghanaian government set up the Minerals Development Fund Act (MDF) to provide additional financial resources to mining communities as well as to entice mining companies to enhance their involvement in local communities' development. The MDF allocates 20% of all mining royalties received by the Ghana Revenue Authority from holders of mining leases towards the five following goals: mitigating any negative impact of mining on local communities, funding local development and alternative livelihood projects, promoting minerals research and training mines' human capital workforce, promoting mining projects, and supporting the ministry's monitoring of mining activities. The Fund is to be managed by a committee of eleven persons, including a representative director of three different ministries (Local Government and Rural Development; Environment, Science, Technology and Innovation; Finance), the Administrator of Stool Lands, a representative of Ghana Chamber of Mines and a traditional ruler from a mining community nominated by the national House of Chiefs. Additionally, each mining community will appoint a committee in charge of managing revenue received from the Fund. This local committee is composed among others of the community's traditional rulers, a representative of each mining company operating in the district, and two representatives of a local women's and youth group. Each mining community must also establish a Mining Community Development Scheme which will be financed by 20% of the mining royalties allocated to the national Minerals Development Fund. The rest of the national Fund is to be allocated as follows: 50% to the Office of the Administrator of Stool Lands, 13% to the Minerals Commission, 8% to the Geological Survey Department, 5% to the promotion of sustainable development projects, and 4% to the Ministry of Land and Natural Resources. In section 6-1), I assess how the employment effects of an active mine changed after the MDF Act was passed.

Concerning mining's impact of the environment and livelihood, companies have to obtain necessary permits from the Forestry Commission and the Environmental Protection Agency. However, given that the Minerals and Mining Act specifies that "*a holder of a mineral right may, for purposes of or ancillary to the mineral operations, obtain, divert, impound, convey and use water from a river, stream, underground reservoir or watercourse within the land the subject of the mineral right*", the risk of contamination of the water source from the mines waste is quite high. Illegal gold mines heavily depend on mercury and are a big polluting source. In fact, thanks to its properties, mercury facilitates the separation of gold from other materials and amalgams with the precious metal to form little nuggets. These nuggets are then heated to evaporate mercury, only leaving the gold. With this technique, pollution might happen at any stage of artisanal gold production as mercury is either released in the air when being evaporated or in the water as toxic waste get illegally dumped in nearby water sources. According to the United States Environmental Protection Agency, artisanal and small-scale gold mining releases approximately 400 metric tons of airborne elemental mercury each year[7]. At high doses, mercury is not only extremely dangerous for the environment (land contamination, water and fishes improper to consumption for example), it also a neurotoxin. Symptoms of mercury poisoning can include loss of vision and hearing, impairment of speech and walking, and disruption of infants' cognitive and motor skills development[8]. I analyze the impact of mining pollution of gender employment in section 6-2).

1.6.1 Effect of the Minerals Development Fund Act on mine production's impact on employment

From section 4), mine openings are found to decrease women's employment on average for women located within 20km of a mine, compared to women located within 20km of an inactive mine

[7] https://www.epa.gov/international-cooperation/reducing-mercury-pollution-artisanal-and-small-scale-gold-mining
[8] https://www.epa.gov/mercury/health-effects-exposures-mercury

(which will open in more than five years). Women strongly decrease labor supply to agriculture and move to supporting services. Men were found to increase labor supply, mostly to skilled and unskilled manual labor. These results might be evidence of a gender-specific labor allocation where men work as informal or formal miners while women work in services. In this section, I use a simple difference-in-difference method, in which I exploit being close to a productive mine as well as time variation, to estimate the effects on employment of living close to an active mine, before and after the creation of the Minerals Development Fund Act. Table 7 below presents the results of the following model:

$$Y_{i,c,t} = \beta_1 close\ mine + \beta_2\ post\ 2013 + \beta_3 close\ mine * post\ 2013 + \gamma_r + \delta X_i + \varepsilon_{i,c,t} \quad (4)$$

where $Y_{i,c,t}$ is the sectoral labor occupation of individual i living in cluster c in year t. Close mine is a dummy variable equal to 1 if individual i lives within 20kms of an active mine or within 20kms of an inactive mine opening within one to five years (and which is thus considered to be under construction and to have a large impact on employment). β_1 gives the effect on labor occupation of living next to an actively producing mine, compared to households in the rest of the sample located farther than 20kms from an active mine. Post 2013 is a dummy variable equal to 1 if the household was interviewed after 2013. β_3 gives the marginal effect on employment of living close to a producing mine after 2013, or after the Minerals Development Act has been created. I only make use of one survey wave after 2013 in which households were interviewed in 2014, thus results presented here are the short-term effects of the MDF act. The model also includes region fixed effects to control for regional characteristics that might influence the labor market. X_i is the same vector of individual controls as the baseline regression (1) (urban area, age, education, male household head, Muslim). Finally, standard errors are clustered at the survey cluster level.

As in baseline results from Table 2, women living close to productive mines in Ghana have a higher probability of working in services, but appear to decrease labor supply to agriculture. However, once we take into account the new Development Fund from 2013, the change in employment before and after 2013 is not significant for women. This result could come from the fact that post 2013, I only observe households in 2014 but not after. It could be that the Development Fund has not been implemented everywhere yet or that funds are still scarce or not allocated. However, the total effect of being close to a producing mine after 2013 shows a surprising decrease in the likelihood of being employed in unskilled manual labor. When we look at men, the most interesting result comes from the significant decrease in employment in sales and skilled manual labor after 2013, while the baseline coefficient is positive for these two sectors. By funding local development and alternative livelihood projects, the Minerals Development Fund could encourage employment diversification from mining to other types of jobs (as artisans for example, indicated by the positive total effect for men on unskilled manual labor). However, it does not seem to immediately impact agricultural employment or women's outcomes. This could indicate that the Fund's management favors men's outcomes compared to women. However, this estimation would benefit from additional years of observation to assess the long-term impacts of the Minerals Development Fund, as well as panel data to analyze the intensive change in hours worked for in sector.

Table 1.7: Employment effects of the Minerals Development Fund Act

VARIABLES	(1) working	(2) services	(3) profess	(4) sales	(5) agri_self	(6) agri_emp	(7) domestic	(8) clerical	(9) skilled	(10) unskilled
a) Women										
1.close_mine	0.00454	0.0184*	0.00191	0.0277	-0.0386*	-0.00590	0.000555	-0.00224	-0.00600	-0.000942
	(0.0144)	(0.00974)	(0.00644)	(0.0183)	(0.0207)	(0.00512)	(0.000746)	(0.00281)	(0.0102)	(0.00186)
1.post_2013#1.close_mine	0.0271	-0.0165	-0.00479	0.0609	-0.00999	-0.00798	-0.000129	0.00139	0.00885	-0.00649
	(0.0250)	(0.0126)	(0.0113)	(0.0415)	(0.0395)	(0.00563)	(0.000772)	(0.00470)	(0.0174)	(0.00403)
$\beta_1+\beta_2$	0.0316	0.0018	-0.0029	0.0887**	-0.0486	-0.0138***	0.0004**	-0.0008	0.0029	-0.0074*
Observations	25,727	25,727	25,727	25,727	25,727	25,727	25,727	25,727	25,727	25,727
R-squared	0.196	0.025	0.032	0.095	0.254	0.013	0.002	0.034	0.009	0.008
b) Partners										
1.close_mine	-0.00170	0.0109	-0.00894	0.0146	-0.0570**	-0.0124**	0.00110	-0.000503	0.0409**	0.00959
	(0.00639)	(0.0123)	(0.0126)	(0.0124)	(0.0246)	(0.00563)	(0.00121)	(0.00957)	(0.0205)	(0.0110)
1.post_2013#1.close_mine	0.00729	0.00774	0.0112	-0.0420**	0.0522	0.00792	-0.000919	0.00959	-0.0941***	0.0557
	(0.00720)	(0.0174)	(0.0244)	(0.0179)	(0.0512)	(0.00723)	(0.00119)	(0.0135)	(0.0299)	(0.0360)
$\beta_1+\beta_2$	0.0056	0.0186	0.0022	-0.0273**	-0.0048	-0.0044	0.0002	0.0091	-0.0531**	0.0653**
Observations	16,227	16,227	16,227	16,227	16,227	16,227	16,227	16,227	16,227	16,227
R-squared	0.011	0.022	0.055	0.047	0.348	0.006	0.001	0.028	0.071	0.082
region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
regional time trend	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

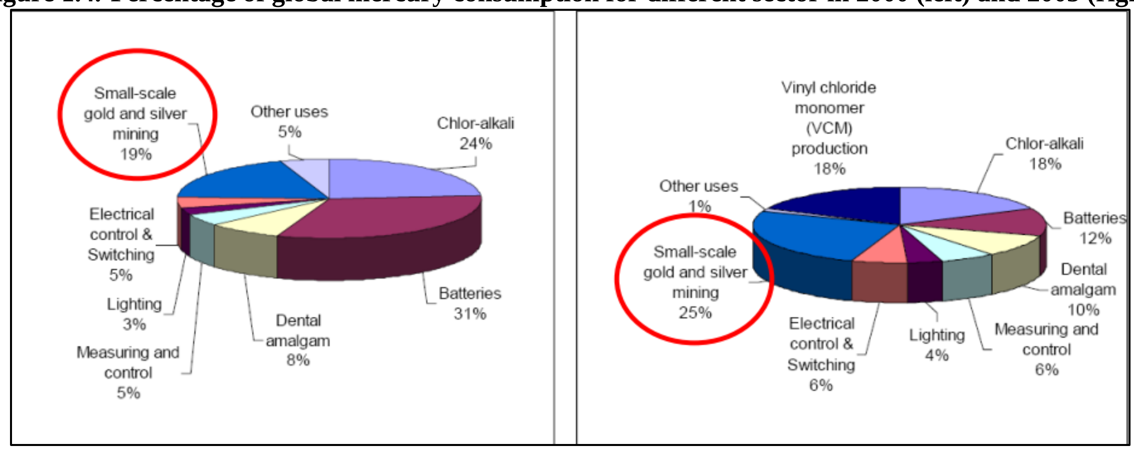
1.6.2 Effect of mining pollution on employment

20% of global gold production is estimated to come from small-scale and informal mining[9]. As discussed above, mercury amalgamation is the most widespread method to mine gold and informal gold mining has the largest mercury consumption worldwide (figure 3)[10]. However, this method can be highly polluting and harmful to the environment as, during the amalgamation process, mercury gets evaporated in the air or toxic waste is discarded in water sources. From figure 4, it appears that gold mining (small and large-scale) is one of the most important emission sources of mercury worldwide, after fossil fuel. Near gold mines, mercury pollution can have two main effects on human activity: first by polluting the land and water sources, mercury decreases soil fertility, forces farmers to find alternative irrigation sources, and makes fish improper for

[9] https://www.epa.gov/international-cooperation/reducing-mercury-pollution-artisanal-and-small-scale-gold-mining
[10] UNEP, Global extent of mercury use in Artisanal and Small-Scale Gold Mining and why is it a problem?

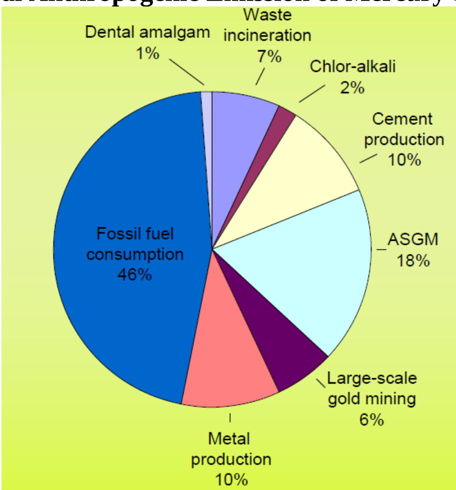
consumption. Additionally, because mercury is a neuro toxin which can become fatal at very high doses, miners who are constantly exposed to mercury vapor or waste might develop troubles such as speech, vision or hearing impairments, neuromuscular problems, kidney and respiratory failures. This could lead to expensive health treatments, premature death or the incapacity to pursue a livelihood. Also, children and infants growing up in mining areas are also in danger of slow cognitive development or motor and spatial skills problems. These children are exposed to lifelong serious health problems compared to children living elsewhere in the country.

Figure 1.4*: Percentage of global mercury consumption for different sector in 2000 (left) and 2005 (right)*



Source: Maxon (2003) and UNEP (2006b)

Figure 1.5: Global Anthropogenic Emission of Mercury by sector in 2005

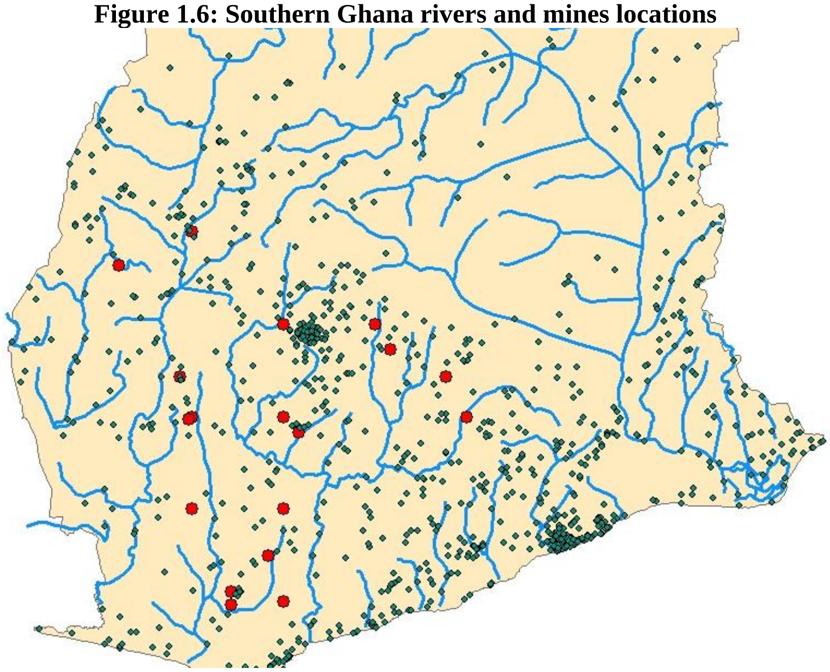


Source: UNEP, Global extent of mercury use in Artisanal and Small-Scale Gold Mining and why is it a problem?

Finally, after a mine opens, mercury pollution might be so severe that it could be an important cause of the labor reallocation studied in section 4-1). In fact, land and water pollution might make any farming or herding activity less attractive given the lower soil fertility or scarce unpolluted irrigation sources, thus explaining the large significant decrease in agricultural employment for both men and women, observed in Table 2.

In this section, I try to isolate the portion of the change in employment coming from water pollution after a mine opens. First, I reduce the sample to households and mines located near a river. I then separate households close to a productive or inactive mine in two groups: households located upstream and households located downstream of the mine. If a gold mine is located near a river and uses mercury, some toxic waste could be emitted into the nearby river and pollute it. Water downstream from the mine is likely to be more polluted than water upstream. Thus, while households within 20km upstream of a mine will be solely impacted by the labor demand shock, households within 20km downstream of the same mine may be impacted by both the labor demand shock and pollution.

Figure 1.6: Southern Ghana rivers and mines locations



I extend model (1) to include this decomposition:

$$Y_{i,c,t} = \beta_1 close\ mine + \beta_2 inactive + \beta_3 close\ mine\ north + \beta_4 inactive\ north + \beta_5 close\ mine\ south + \beta_6 inactive\ south + \gamma_r + \gamma_t + \gamma_{r,t} + \delta X_i + \varepsilon_{i,c,t} \quad (5)$$

Close mine (or inactive) north is equal to 1 if the person interviewed lives north (upstream) of a producing (or inactive) mine. ($\beta_1 + \beta_3$)-($\beta_2 + \beta_4$) gives the total effect on sectoral employment of a mine opening if the village is located upstream. This upstream total effect is assumed to come only from a labor demand shock. Similarly, close mine (or inactive) south is equal to 1 if the person interviewed lives south (upstream) of a producing (inactive) mine. ($\beta_1 + \beta_5$)- ($\beta_2 + \beta_6$) gives the total effect on sectoral employment of a mine opening if the village is located downstream. The downstream total effect is assumed to come from both a labor demand shock and pollution. Thus, the effect of mining pollution on sectoral employment will be given by the difference between total downstream and total upstream effects. For clarity, Table 8 below only presents the effect of pollution on sectoral labor allocation after a mine opening.

Table 1.8: Impact of mining pollution on sectoral labor reallocation

VARIABLES	(1) working	(2) services	(3) profess	(4) sales	(5) agri_self	(6) agri_emp	(7) domestic	(8) clerical	(9) skilled	(10) unskilled
					a) Women					
mine opening south - north	13%	8%***	4%	22%**	-38%***	-1%	0%	1%	13%*	1%
Observations	25,727	25,727	25,727	25,727	25,727	25,727	25,727	25,727	25,727	25,727
R-squared	0.010	0.032	0.012	0.051	0.100	0.048	0.011	0.010	0.016	0.012
					b) Partners					
mine opening south - north	-4%	7%	-4%	14%***	-23%	2%	2%	-2%	4%	-6%
Observations	16,227	16,227	16,227	16,227	16,227	16,227	16,227	16,227	16,227	16,227
R-squared	0.010	0.029	0.016	0.032	0.172	0.040	0.010	0.045	0.049	0.100
region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
regional time trend	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

In clusters located downstream of a nearby mine, employment in agriculture decreases by 38% more than households located upstream of a mine, after the mine opens. A potential consequence from mines toxic waste pollution, this additional loss in agricultural employment is only significant for women. In fact, even though men are also found to decrease agricultural employment by an additional 23% south of a mine, the result is not significant. Additionally, the increase in women's labor supply in services and skilled employment is respectively 8% and 13% higher in downstream clusters than upstream. Finally, the only labor sector significantly impacted for both men and women is sales, as employment in sales is respectively 14% and 22% higher in downstream villages than upstream. In conclusion, mining pollution may have a significant impact on women's labor reallocation after a mine opens as their labor supply to self-employment in agriculture decreases by a significant 38% against 23% for men. Heavily documented in the environmental literature (Daniel et al. (2014); Saunders and Sprague (1967); Gozzard et al. (2011); Cabrera et al. (1984); Liu et al. (2013); Malm et al. (1990); Bhuiyan et al. (2010)), water sources used for fishing or irrigation get polluted from mines toxic waste. As agricultural productivity declines on plots affected by the pollution, women are potentially forced to abandon their most productive plots of land to their husband if they have low bargaining power within the household. Whether the reallocation of productive land plots within the household is indeed a consequence of mining pollution is left for further research. Finally, as women appear to be the most vulnerable to mine openings and pollution shocks, governmental policies aiming a reducing pollution and enforcing stricter environmental mining guidelines could help these women maintain their livelihood and original sources of earnings.

1.7 ROBUSTNESS TESTS

1.7.1 Other mines dataset

I perform two robustness tests to support the findings in section 4. First, I use another dataset on mines location. In section 3, I used a dataset composed of 233 industrial-scale mines, from RMD (Raw Material Data), compiled by IntierraRMG (now part of S&P Global). This dataset offers information on the annual production status and quantity of each mine since 1980. In the first robustness test, I use a dataset compiled by Arroyo (2017)[11] for 274 various large-scale mines in Africa with information on ore deposits size, years of project inception and completion, latitude and longitude coordinates. This new dataset is composed at 33% of gold mines, at 10% of coal, 9% of copper and 8% of platinum and iron. As such, the main difference with RMD is the relative lack of diamond mines (they made up 17% of the mines in the RMD dataset) which are relatively less capital intensive than other mines. In fact, with this new dataset, diamond mines' energy needs are 2.433 MW on average, while the mean of the rest of the mines sample reach 55.98 MW. I estimate Table 2 on the effects of mine openings on women and men employment using Arroyo's data. Results are presented in Table B.1 in Appendix B.

Results are similar to table 2: women are likely to decrease their labor supply by 2.7% after a mine opens. This result is driven by a decrease of 5.2% in self-employment in agriculture. The probability of working on a plot for somebody else increases significantly for both men and women, which could be explained by the fact that some households living nearby the deposits have to be displaced when a mine opens. These households might increase the labor supply in nearby farms. Additionally, men's working probability increases significantly by 3.6% (3.8% in Table 2),

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[11] Arroyo, I. P. (2017), Africa - PowerMining Projects Database (2014), The World Bank.

a result driven by the increase in agricultural employment and in unskilled manual labor (a category which includes the "miner" occupation in a lot of countries).

1.7.2 Spatial HAC correction

In a given country, local labor markets could be correlated with each other, given the widespread consequences of any national labor policy, such as minimum wage, foreign direct investment regulations, hours of work rules, etc. Following Berman et al. (2017), I correct for labor markets correlation by using a spatial HAC correction (heteroscedasticity and autocorrelation consistent). This method, developed by Conley (1999) and Hsiang, Meng, and Cane (2011), allows for cross-sectional spatial correlation and location specific serial correlation. I assume an infinite time horizon for the serial correlation, and a spatial correlation limit of 500km. Table B.2 in Appendix B provides the baseline results for women using this correction. As in table 2, the decrease in general employment is significant and, at -5.9%, is slightly higher than the baseline results. Also, the increase in services employment is strongly significant at 3.6%.

1.7.3 Reducing the control group to 200km away

In all the regressions presented above, the predicted labor force participation of households located near a productive or inactive mine is compared to the average labor force participation of all the other households in the sample. However, it could be that these other households are located too far away from mining communities and present significantly different characteristics in gender and cultural norms, industrial structure and labor market sectoral composition. To take into account this potential difference in trends, I reduce the sample to households located up to 200km from an inactive or producing mine. Results in Table B.3 in Appendix B for both women's and men's employment remain consistent with Table 2: even though it is not significant, female labor force participation decreases, driven by a decrease in agriculture, partly compensated by an increase in services. Men increase labor supply to skilled and unskilled manual labor, indicating an increase in mine related activity.

1.8 CONCLUSION

Ores and metals are an important source of income for several Sub-Saharan countries and form the majority of merchandise exports in Zambia, Sierra Leone or Guinea for example. In order to take the full measure of the mining sector's impact on national economies, it seems important to understand the impact on local labor markets. Also given recent worldwide policies promoting gender equality and greater access to resources for women, studying the impact on labor markets with a gender perspective can provide more relevant information to policymakers. In this paper, I analyze the effects of mine openings on sectoral employment for men and women using household survey data from DHS for 29 countries from Sub-Saharan Africa. After a mine opens within 20km, women's employment decreases while men's employment increases. While both gender groups leave employment in agriculture, some women are able to find work in supporting services, while men find work in skilled or unskilled manual labor (miners, mechanics…). The negative effects on employment appear to be strongest for women whose husbands find work as miners. A hypothesis to explain this result is that as men leave agriculture to go work in mines, their income increases, which decreases the incentive for women to work outside the household. Additionally, some countries have tried to increase mining companies' involvement in local communities by implementing Minerals Development Funds. A fixed percentage of mining companies' revenues or royalties are assigned to these Funds and are used to finance development schemes for local communities. Specific examples concerning the use of these funds vary a lot across countries and include infrastructure and school construction, supporting farmers, providing school furniture, providing training to mining communities, etc. I find that these Mineral Development Funds mitigate the employment loss in agriculture for women by almost 6% and increase labor supply to sales by 11%. The funds also decrease agricultural employment loss for men by 10% as they decrease labor supply to mining-related activities by 16% and 14% for skilled and unskilled manual labor respectively. These results indicate that the funds encourage local workers to find a livelihood outside of the mine, perhaps due to easier access to financing or training.

Finally, using the case study of Ghana, I find that pollution is responsible for 38% of the decrease in agricultural employment for women. This impressive result, even though signaling that women are extremely vulnerable to negative impacts to the environment, is also surprisingly encouraging. In fact, there have been many initiatives in the past few years to decrease mining pollution, enforce environmentally friendly guidelines and find alternatives to mercury gold mining. It would be interesting in the future to study whether these initiatives had any effect in mitigating women's loss in employment in polluted environments. In further research, it would be interesting to analyze how bargaining power and plot allocation within the household respond to a mine opening nearby. As the results described in this paper suggest, women who are farmers and whose partners find work in the mine are the most at risk of leaving the labor market, due to pollution and deteriorated outside options. Finally, children living next to mines are also subject to the heavy pollution which can have lifelong impact on cognitive skills. A full assessment of mining activity should include the long-term impact on these children's outcomes.

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APPENDIX A - SPATIAL DECAY OF MINE OPENINGS' EFFECTS ON EMPLOYMENT

A.1 SPATIAL DECAY

Table A.1: Spatial decay of mine openings' effects on sectoral labor allocation of women and men

VARIABLES	(1) working	(2) services	(3) profess	(4) sales	(5) agri_self	(6) agri_emp	(7) domestic	(8) clerical	(9) skilled	(10) unskilled
					a) Women					
closest_mine_active	0.615***	0.00840	0.0735***	-0.0702	-0.111	-0.0641	0.0184**	0.0610***	0.189***	0.293***
	(0.0772)	(0.0194)	(0.0168)	(0.0606)	(0.111)	(0.0557)	(0.00804)	(0.00852)	(0.0334)	(0.0279)
closest_mine_inactive	0.799***	-0.0600***	0.0523***	-0.289***	0.486***	-0.144**	0.00772	0.0420***	0.0836	0.363***
	(0.0917)	(0.0198)	(0.0175)	(0.0713)	(0.128)	(0.0574)	(0.00788)	(0.00897)	(0.0510)	(0.0318)
closest_mine_active*dist	-0.106***	-0.00163	-0.0106***	0.00895	0.0239	0.00572	-0.00225	-0.00956***	-0.0311***	-0.0516***
	(0.0128)	(0.00325)	(0.00282)	(0.00996)	(0.0185)	(0.00919)	(0.00138)	(0.00144)	(0.00553)	(0.00471)
closest_mine_inactive*dist	-0.133***	0.0100***	-0.00769**	0.0611***	-0.0920***	0.0156	-8.46e-05	-0.00657***	-0.00592	-0.0668***
	(0.0164)	(0.00335)	(0.00302)	(0.0130)	(0.0230)	(0.0100)	(0.00135)	(0.00154)	(0.00974)	(0.00575)
log_min_dist_mine	0.0958***	-0.00714**	0.0114***	-0.0286***	0.0174	0.00187	1.78e-05	0.00804***	0.0236***	0.0523***
	(0.0120)	(0.00299)	(0.00271)	(0.00943)	(0.0175)	(0.00922)	(0.00119)	(0.00134)	(0.00536)	(0.00442)
Observations	420,746	429,803	429,803	429,803	429,803	429,803	429,803	429,803	429,803	429,803
R-squared	0.067	0.053	0.018	0.080	0.190	0.217	0.020	0.009	0.030	0.081
					b) Partners					
closest_mine_active	0.213***	0.0504	0.120***	-0.185***	-0.174	-0.133**	0.0192**	0.0366*	0.134***	0.344***
	(0.0584)	(0.0479)	(0.0329)	(0.0460)	(0.122)	(0.0636)	(0.00833)	(0.0191)	(0.0446)	(0.0340)
closest_mine_inactive	0.188***	0.0519	0.0153	-0.203***	0.432***	-0.222***	0.0175**	-0.00783	-0.161***	0.266***
	(0.0593)	(0.0494)	(0.0349)	(0.0517)	(0.137)	(0.0643)	(0.00860)	(0.0211)	(0.0483)	(0.0360)
closest_mine_active*dist	-0.0371***	-0.00986	-0.0187***	0.0334***	0.0266	0.0178*	-0.00325**	-0.00594*	-0.0182**	-0.0590***
	(0.00969)	(0.00790)	(0.00552)	(0.00765)	(0.0205)	(0.0106)	(0.00139)	(0.00319)	(0.00754)	(0.00573)
closest_mine_inactive*dist	-0.0257***	-0.00953	-0.000186	0.0343***	-0.0622**	0.0298***	-0.00243*	0.00153	0.0320***	-0.0490***
	(0.00997)	(0.00843)	(0.00616)	(0.00911)	(0.0247)	(0.0110)	(0.00146)	(0.00375)	(0.00863)	(0.00627)
log_min_dist_mine	0.0133	0.0103	0.0145***	-0.0288***	-0.0156	-0.00716	0.00106	0.00380	-0.0216***	0.0569***
	(0.00909)	(0.00766)	(0.00523)	(0.00724)	(0.0195)	(0.0101)	(0.00126)	(0.00301)	(0.00704)	(0.00541)
Observations	287,063	287,063	287,063	287,063	287,063	287,063	287,063	287,063	287,063	287,063
R-squared	0.441	0.048	0.039	0.044	0.254	0.326	0.017	0.019	0.052	0.038

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

APPENDIX B – ROBUSTNESS TESTS

B.1 ROBUSTNESS TEST 1: OTHER MINING DATASET

Table B.1: Arroyo's dataset, mine openings and sectoral labor allocation of women and men

VARIABLES	(1) working	(2) services	(3) profess	(4) sales	(5) agri_self	(6) agri_emp	(7) domestic	(8) clerical	(9) skilled	(10) unskilled
					a) Women					
close_mine	0.0278*	0.00568	-0.00182	0.0270***	-0.0258	0.00503	0.000226	0.00107	0.0100*	0.00399
	(0.0146)	(0.00361)	(0.00269)	(0.0103)	(0.0174)	(0.00620)	(0.00271)	(0.00164)	(0.00512)	(0.00654)
Inactive mine	0.0546***	0.00857**	-0.000236	0.0175*	0.0257*	-0.0300***	-0.00101	-0.00185	0.0107*	0.0167**
	(0.0127)	(0.00433)	(0.00179)	(0.0105)	(0.0153)	(0.00964)	(0.00164)	(0.00136)	(0.00639)	(0.00652)
β1-β2	-2.7%	-0.3%	-0.2%	1.0%	-5.2%**	3.5%***	0.1%	0.3%	-0.1%	-1.3%***
Observations	453,183	464,229	464,229	464,229	464,229	464,229	464,229	464,229	464,229	464,229
R-squared	0.131	0.057	0.043	0.102	0.265	0.208	0.023	0.027	0.035	0.084
					b) Partners					
close_mine	0.0363***	-0.0125***	0.00168	0.00174	0.0124	0.00277	0.00650***	0.00243	0.0322***	-0.0109*
	(0.0108)	(0.00434)	(0.00630)	(0.00719)	(0.0183)	(0.00938)	(0.00251)	(0.00296)	(0.00963)	(0.00596)
Inactive mine	0.000563	-0.0142**	0.00713	0.00181	-0.00868	-0.0309**	0.00101	-0.00552	0.0352***	0.0147**
	(0.00780)	(0.00705)	(0.00683)	(0.00855)	(0.0192)	(0.0155)	(0.00302)	(0.00405)	(0.0112)	(0.00695)
β1-β2	3.6%***	0.2%	-0.5%	0.0%	2.1%	3.4%*	0.5%	0.8%	-0.3%	-2.6%***
Observations	258,196	258,196	258,196	258,196	258,196	258,196	258,196	258,196	258,196	258,196
R-squared	0.334	0.056	0.063	0.061	0.323	0.289	0.019	0.027	0.061	0.040

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

B.2 ROBUSTNESS TEST 2: CORRECTING FOR SPACIAL HETEROSKEDASTICITY AND AUTOCORRELATION

Table B.2: Spatial HAC correction

VARIABLES	(1) working	(2) services	(3) profess	(4) sales	(5) agri_self	(6) agri_emp	(7) domestic	(8) clerical	(9) skilled	(10) unskilled
close_mine	0.0324	0.0227***	-0.000818	0.0179	-0.00884	-0.00774	-0.00339	-0.000441	0.00801	0.00853
	(0.02150)	(0.00794)	(0.00227)	(0.0167)	(0.0246)	(0.00908)	(0.00342)	(0.00245)	(0.00634)	(0.00963)
close_long_inactive_mine	0.0910**	-0.0131	-0.00422	0.0146	0.0695	-0.0214*	-0.00145	-0.00262	-0.00870	0.0174
	(0.03831)	(0.00804)	(0.00351)	(0.0336)	(0.0548)	(0.0118)	(0.00199)	(0.00268)	(0.0286)	(0.0156)
β1-β2	-5.9%**	3.6%***	0.3%	0.3%	-7.8%	1.4%	-0.2%	0.2%	1.7%	-0.9%
Observations	464,229	464,229	464,229	464,229	464,229	464,229	464,229	464,229	464,229	464,229
R-squared	0.050	0.012	0.030	0.034	0.122	0.015	0.006	0.018	0.003	0.005
region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
regional time trend	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

B.3 ROBUSTNESS TEST 3: REDUCING CONTROL GROUP TO A 200KM NEIGHBORHOUD

Table B.3: Reducing sample to households living up to 200km of a mine

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	working	services	profess	sales	agri_self	agri_emp	domestic	clerical	skilled	unskilled
					a) Women					
close_mine	0.0317***	0.0138***	0.00244	0.00468	-0.00768	-0.00461	-0.00166	-0.00104	0.0153***	0.0189***
	(0.0120)	(0.00454)	(0.00225)	(0.00781)	(0.0139)	(0.00712)	(0.00213)	(0.00147)	(0.00428)	(0.00529)
close_long_inactive_mine	0.0731**	-0.00610*	-0.00560*	0.0198	0.0366	-0.0112	-0.00156	-0.00492**	0.00359	0.0163
	(0.0302)	(0.00358)	(0.00308)	(0.0252)	(0.0350)	(0.00894)	(0.00157)	(0.00243)	(0.0217)	(0.0126)
$\beta 1$-$\beta 2$	-4%	2%***	1%**	-2%	-4%	1%	0%	0%	1%	0%
Observations	238,080	247,260	247,260	247,260	247,260	247,260	247,260	247,260	247,260	247,260
R-squared	0.150	0.047	0.043	0.098	0.294	0.301	0.027	0.034	0.040	0.053
					b) Partners					
close_mine	0.0187***	-0.0191***	0.00383	-0.00117	0.00224	-0.0193	0.00182	-0.0120***	0.0474***	0.0150***
	(0.00651)	(0.00573)	(0.00618)	(0.00753)	(0.0166)	(0.0122)	(0.00217)	(0.00297)	(0.00956)	(0.00568)
close_long_inactive_mine	-0.0112	0.00815	-0.0130*	-0.0106	0.0539	-0.00752	-0.00275	-0.00314	-0.0190**	-0.0173**
	(0.0127)	(0.0180)	(0.00778)	(0.0173)	(0.0367)	(0.00492)	(0.00749)	(0.0101)	(0.00810)	(0.00859)
$\beta 1$-$\beta 2$	3%**	-3%	2%*	1%	-5%	-1%	0%	-1%	7%***	3%***
Observations	137,094	137,094	137,094	137,094	137,094	137,094	137,094	137,094	137,094	137,094
R-squared	0.358	0.055	0.065	0.067	0.350	0.274	0.025	0.028	0.091	0.038
region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
regional time trend	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

Chapter 2. Mines, Migration and Households' Welfare in Ghana: A Structural Gravity Model Approach

2.1 INTRODUCTION

Extractive industries have long played an important role in the economic development of emerging countries. In 2016, mineral rents represented almost 1.95% of GDP in Sub-Saharan Africa, following a peak at 4.3% in 1980[12]. In some countries, mineral production amounts to a large share of the government's revenue through direct ownership, taxation or royalties (for example, gold mining rents represented 33% of government's revenue in Mali in 2008, 27.4% in Peru or 16.3% in Tanzania[13]). However, overly relying on economic rents (difference between value and cost of production) from extractive industries can endanger national financial stability because of volatile world commodity prices (UNCTAD, 2012[14]), the risk of sharp currency appreciation (commonly referred to as the Dutch Disease) and low direct employment impact (enclave industry).

In the first chapter of this dissertation, I studied the gender-specific labor effects of large-scale mining in Sub-Sahara Africa. I leveraged spatial and temporal variation in minerals production using Demographic and Health Surveys and mines location from Berman et al. (2017)[15] for 29 Sub-Saharan countries. Decomposing survey clusters into two treated groups (located near an active or a soon-to-be-active mine) and one control group (located far away from any mine) allowed me to implement a difference-in-difference strategy which revealed that women appeared to be more vulnerable than men to labor market disruptions from mine openings. After a mine opens, labor force participation significantly decreases for female workers but increases for men.

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[12] The World Bank data.
[13] "Excessive Commodity Price Volatility: Macroeconomic Effects on Growth and Policy Options", UNCTAD, 2012.
[14] "Excessive Commodity Price Volatility: Macroeconomic Effects on Growth and Policy Options", UNCTAD, 2012.
[15] Berman et al. (2017) obtained large-scale mines data from the Raw Material Data (RMD) from S&P Global.

However, while overall employment in agriculture significantly decreases, some women are able to transfer to the services sector while some men transfer to manual labor (skilled and unskilled). Additionally, I provided evidence that mine openings disrupt local labor markets up to 200kms away as male labor force participation decreases farther away from the mine but increases closer to the extraction site. The percentage of migrants was also significantly higher in active mining areas (70%) than in soon-to-be-active mining areas (56%). These results are evidence of migration flows which can be explained by several factors: first, there is evidence in the literature that mines improve local roads infrastructure to facilitate transport of merchandises (Söderholm & Svahn (2015)[16], Cust & Poelhekke (2015)[17]), which indirectly facilitates migration journeys. Second, mine openings create a male labor demand shock which acts as pull factor, attracting workers from other regions. But these observations only give a partial understanding of how mining impacts regional migration. Does mining significantly alter migration patterns? What is the change in local household welfare or in land value due to these migration inflows? To my knowledge, no paper has formally studied how mineral extraction attracts workers from afar and the impacts of the subsequent labor supply change on households' welfare and land markets.

This paper contributes to the literature in several ways and estimates the effects of a mine opening on local household indirect utility and land price per acre using a theoretical model accompanied by an empirical strategy. First, I draw on Morten & Oliveira (2017), Donaldson & Hornbeck (2016) and Monte et al. (2018) to elaborate a spatial general equilibrium model and study subnational migration and trade flows following a mine opening. In this model, the cost of trade and migration flows between districts increases with the distance between origin and destination. Flows also

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[16] Söderholm, P. and N. Svahn (2015), "Mining, regional development and benefit-sharing in developed countries", Resources Policy, vol. 45, p. 78-91.
[17] Cust, J. and S. Poelhekke (2015), "The Local Economic Impacts of Natural Resource Extraction", Annu. Rev. Resour. Econ., vol. 7, p. 251-268.

depend on each district's "market access". Following Morten & Oliveira (2017), I distinguish two different types of market access expressed as reduced-form expressions: trade market access (TMA), which represents a district's pool of available tradable goods coming from other districts; and labor market access (LMA), which represents the pool of available workers in and around a district. As the road network becomes relatively denser in mining districts and the male labor wage increases, migration and trade costs to these mining districts are expected to fall and both their trade and labor market access should increase as it becomes cheaper to trade goods and workers. As a result, land price and indirect utility will change in opposite directions: as migration costs decrease in mining districts, labor supply increases and land prices are pushed up due to increased competition between farmers, workers and mines for plots. Additionally, the increase in labor supply will push down wages and depress indirect utility. Inversely, as trade costs decrease in mining districts, consumers have access to a wider variety of goods which increases indirect utility. Formally, a mining shock is three-fold: 1) a 5% increase in the mining district's productivity, 2) an increase of land's weight in the parameters of the mining district's production function, and 3) a decrease in the distance traveled on roads to the mining district. To estimate the decrease in migration costs in point 3), I use Ghana's relatively large gold mining sector and improvement in road network between 1960 and 2016 (using digitized road maps from Jedwab & Moradi (2016)[18] and ESRI) to establish whether mine openings have a significant effect on local transport infrastructure (using roads density as a proxy). Then I analyze whether the cost of distance on gross migration flows between districts (taken from the 2000 Population and Housing Census) is smaller for active mining destination districts. This could not only indicate that mining locations have access to more nearby roads but also that their specific characteristics (average consumption,

[18] Jedwab, R. and A. Moradi, (2016), "The Permanent Effects of Transportation Revolutions in Poor Countries: Evidence from Africa", The Review of Economics and Statistics, vol. 98, no. 2, pp. 268–284.

price level, comparative advantage and amenities) increase the indirect utility that households derive from migrating to that mining location.

Finally, I calibrate and estimate the change in land price and household indirect utility following a mining shock with data from Population and Housing Census (2000), Living Standard Surveys (1987 to 2013), Enterprise Surveys from the World Bank (2007 and 2013), and Demographic and Health Surveys (1998-2003). Welfare increases by 1.3% on average in treated districts thanks to an increase in wages, which mitigates the large spike of 11.5% in land rental rates. Results indicate a significant change in indirect utility and land rental rates up to 200kms from the treated district and shed new light on the mechanisms through which a mining boom can spread to nearby regions as most untreated districts are impacted not by the mine itself, but by the decrease in trade and migration costs.

Ghana's relatively developed gold mining sector and data availability made it a good candidate for this case study. The country is the second largest gold producer in Sub-Saharan Africa and the mineral represented 52% of its exports (a bit less than $10 billion) in 2016[19]. Furthermore, the artisanal and small-scale gold mining directly employs an estimated one million people in the country and supports approximately 4.5 million more[20]. In 2013, the Ghanaian government set up the Minerals Development Fund Act (MDF) to provide additional financial resources to mining communities as well as to entice mining companies to enhance their involvement in local communities' development. The MDF allocates 20% of all mining royalties received by the Ghana Revenue Authority from holders of mining leases towards the five following goals: mitigating any negative impact of mining on local communities, funding local development and alternative

[19] The World Bank data.

[20] McQuilken, J. and G. Hilson (2016), "Artisanal and Small-Scale Gold Mining in Ghana – Evidence to Inform "Action Dialogue"", IIED, Sustainable Markets Group, Country Report.

livelihood projects, promoting minerals research and training mines' human capital workforce, promoting mining projects, and supporting the ministry's monitoring of mining activities.

This paper contributes to the literature on the mining industry as well as the literature on gravity equations and migration patterns. Positive microeconomic effects of extractive industries include increased household assets wealth and consumption that is mitigated by increased inequality, lower availability of agricultural lands and migration. Mines have also been shown to improve public infrastructure such as roads, bridges and ports (Bonfatti & Poelhekke (2017), Bunte et al. (2018)), which decrease migration and trade costs (Aggarwal (2018), Morten & Oliveira (2017)).

This paper is organized as follows: section 2 reviews the literature on the socioeconomic impacts of mines, the impact of mining activity on migration. This section also reviews the use of structural gravity models to study these impacts. I describe the Ghanaian mining industry in section 3, and then lay out the theoretical foundation for the structural gravity model in section 4. The calibration strategy is explained in section 5. Section 6 presents the change in household welfare and agricultural land prices in mining districts following a shock in mining activity. In section 7 I empirically estimate the effects of mining activity and migration inflows on household income. Finally, section 8 concludes.

2.2 LITERATURE REVIEW

2.2.1 Socioeconomic outcomes of mining

Long confined to macroeconomic studies, natural resource extraction, such as mining or oil production, has recently gathered attention from micro-economists. The variety of topics, combined with the great diversity of resource-rich countries, has led to many interesting studies, bringing mixed results on the effects of natural resources production on local economies and households. Von der Goltz & Barnwal (2018) conducted a cross-country study with DHS survey data on health and wealth from 44 countries on 800 mining communities. They first assessed the impact of mining activity on asset wealth with a difference-in-difference strategy using spatial and temporal variation in nearby mining activity. Medium and long-run asset wealth were found to increase respectively by 0.3 and 0.1 standard deviations. However, wealth inequality appeared to increase as the wealthiest households saw the highest increase in asset wealth over the long run.

Loayza & Rigolini (2016) used the mining boom in Peru during the 1990s and 2000s to explore the effects of fiscal revenue from mining on local communities. Compared to nonmining areas, mining districts had larger consumption per capita, lower poverty rates and higher consumption inequality (both across and within districts). Zabsonré, Agbo & Somé (2018) also linked mining activity to increased inequality using a difference-in-difference strategy, even though results were not highly significant. They analyzed mining socioeconomic impacts in the context of the gold mining boom in Burkina Faso during the 2000s. Mining areas were found to have higher living standards (higher headcount ratios, lower poverty gaps, and higher household expenditures). Bozigar, Gray & Bilsborrow (2016) exploited a novel dataset spanning 11 years on 484 indigenous households exposed or not to oil extraction in the Ecuadorian Amazon. Fixed and random effects regressions revealed that oil extraction increases off-farm employment and asset wealth. However, the observed decrease in fish harvests could hint to the environmental issues reported in other studies.

For example, Von der Goltz & Barnwal (2018) found evidence of heavy metal toxicity in mining communities. They used general knowledge over metal types and respective lead contamination to show that in areas located near mines strongly associated with lead pollution, women were 10% more likely to be anemic, children were 5% more likely to have stunted growth and women who suffered from blood loss during pregnancy and delivery were slower to recover. Hausermann et al. (2018) documented the mining boom in Ghana following the financial crisis of 2008 which revamped gold mining activity along the Offin River's banks. Negative environmental impacts included rerouting and polluting streams and converting agricultural lands into mining pits.

2.2.2 Dutch Disease and local economic impacts

Natural resources production has been linked to a join phenomenon of rapid foreign exchange accumulation and currency appreciation, coined as "Dutch Disease" (Corden & Neary (1982)). A small number of studies have analyzed the macro effects of Dutch Disease using computable general equilibrium models (CGE). The CGE framework allows taking into account complex interactions across time, inputs and sectors of the economy. The CGE model can be calibrated and estimated from a SAM (social accounting matrix). For example, Benjamin, Devarajan & Weiner (1989) found that in Cameroon, agriculture (the traditional tradable sector) contracted the most but manufacturing sectors with low substitution elasticities to imports expanded thanks to increased internal demand. Khan & Gottschalk (2017) also used a CGE model to analyze the impact of an expansion of the mining sector between 2013 and 2016 in Mongolia. A doubling in mining production led to an appreciation of the real exchange rate by 15% and to a contraction of the tradable sector output by approximately 20%. As explained in Cherif (2013), the extent of crowding-out in the tradable sector depends positively on the interaction between revenues from natural resource exports and the productivity gap vis-à-vis the trade partners. However even in less technologically advanced economies, there is still potential for positive spillovers occurring from backward linkages in extractive industries. Aragon & Rud (2011) came to this conclusion by studying gold mining in Peru and finding that the mines' demand for local inputs led to an increase in the local price of non-tradable goods but also to an increase in real income. On the other hand, Allcott & Keniston (2014), studying the Dutch Disease phenomena in modern-day America, found relatively small local manufacturing productivity spillovers. Additionally, Allcott & Keniston (2014) were among the few authors to tackle the migration issue following the mining boom and bust of the 1970s. They found that migration did not fully offset labor demand growth in the United States, so local wages rose. On a more local scale, Caselli & Michaels (2013) concluded that oil-rich municipalities in Brazil experienced an increase in revenue, which materialized into increased public spending. These preliminary results on migration and increase in public infrastructure are part of a relatively small body of literature.

2.2.3 Mines and migration

Few studies have specifically analyzed the impact of mining activity on migration flows and the subsequent effects on native and migrant household welfare. First, Bonfatti & Poelhekke (2017) acknowledged the potential effects of mines on public infrastructure as most resource-rich countries export their production overseas. They hypothesized that mine-related infrastructure is more likely to be connected to the coast than to neighboring countries, which would decrease trade costs with overseas countries more than with neighbors (and inversely with landlocked countries which depend on their neighbors' access to the coast). Bunte et al. (2018) used quasi-experimental evidence from Liberia to analyze the effects of extractive industries on local growth. The country requires foreign investors to invest in nearby communities' public goods (for example, they are required to build and maintain roads near mining extraction sites) in order to crowd in additional investments, create clusters of interconnected firms and foster economic agglomeration. Mining investment projects appeared to positively impact local economic growth. Improved transport infrastructure and new employment opportunities act as pull factors that increase migration to mining areas and create employment in skilled or unskilled manual labor and services (Loayza & Rigolini (2016), Bryceson & Jønsson (2010), Fisher et al. (2009)). Finally, roads themselves have been shown to foster migration and regional trade by decreasing both migration and trade costs. Aggarwal (2018) and Aggarwal et al. (2018) studied the effect of a change in market access in Tanzania on agricultural productivity. They found that an additional standard deviation in travel time is associated with almost 25% lower agricultural input adoption and output sales. After quantifying a spatial model of input adoption, they estimated that reducing travel costs by 50% will double input adoption.

2.2.4 Structural gravity models

Introduced by Tinbergen (1962), gravity models have been extensively used for the past fifty years to analyze bilateral interactions in trade or migration. As explained in Anderson (2016), the original gravity model, derived from Newton's physical law of gravity, was built on the hypothesis that economic flows are positively related to the economic masses at the origin o and destination d areas and inversely related to the distance between them. Thus, trade flows between o and d were predicted by the product of a gravitational constant and the relevant economic activity mass (such as output) in o and d divided by the squared distance between them. However, this model could not fit data well, implying the exponents of the economic mass indicators and of the distance variable should be allowed to vary according to the data. Gradually, structural gravity embedded in models of resource allocation across economic sectors became widely used.

For example, Morten and Oliveira (2017) leverage a spatial general trade model to estimate the effect of the road network expansion in Brazil following the construction of Brasilia. They use spatial data to leverage temporal variation in roads location and modelled the change in welfare with a general equilibrium trade model incorporating trade costs τ_{odt} from Eaton & Kortum (2002) and migration costs κ_{odt} from Monte et al. (2016). In their model, agents optimally chose their location each period and locations specialize in production based on their comparative advantage and the cost of importing goods from other locations. The exogenous shock in road network decreased trade and migration costs and increased welfare by 16%, 88% of which is due to decreased trade costs and 12% to lower migration costs. The model is designed in terms of Trade Market Access (TMA) and Labor Market Access (LMA) as originally described in Donaldson & Hornbeck (2016).

The latter paper assessed the effects of railroad expansion in the late 1800s in the United States on the agricultural sector. A new railroad route meant new trade and migration opportunities for nearby districts but other districts located farther away from the network were also indirectly impacted by the network change and the reallocation of trade and migration flows. To take into account these various effects, the total impact on each county is captured by their trade market access, which depends on the county's lowest-cost county-to-county freight routes. The cheaper it is to trade with other counties (made possible by the improvement of the railroads network), the larger the trade market access. Donaldson & Hornbeck (2016) found that as railroads expanded, it became easier for counties located close to these new railroads to trade with other counties. This increased their trade market access and drove up their agricultural land values.

Finally, Monte et al. (2018) estimate the effects of a reduction in commuting costs on workers' welfare, using American data from the Commodity Flow Survey, the American Community Survey and the US Census from 1960 to 2000. The authors employ a quantitative general equilibrium model expressed in terms of Labor and Trade Market Access, in which trade and commuting are costly. Following a shock in productivity, they find that local employment elasticities range from 0.5 to 2.5. This variation in employment can be explained by the heterogeneity in local labor markets' openness to commuting (measured by the share of a county's residents who work in that same county).

2.3 THE GHANAIAN MINING INDUSTRY

2.3.1 Background

The second largest gold producer in Africa, Ghana exported $9.69 billion worth of gold in 2016 which represented approximately 52% of total exports. The Ministry of Lands and Natural Resources is responsible for negotiating and granting mineral rights licenses to large or small-scale mining companies. After the license has been granted, companies are required to pay an annual ground rent, annual mineral right fees, royalties fixed to 5% of revenues, corporate taxes (35% in 2012), as well as 10% equity interest to the government.

According to the Minerals and Mining Act of 2006, minerals found in Ghana are the property of the Ghanaian Republic. The occupier of a land where mineral is found can retain the right to graze livestock or cultivate the land, as long as it does not interfere with mining activity. If it does, the owner of the mining lease will determine a financial compensation to the land occupier based on a survey of the crops as compensation depends on lost property value, loss of earnings and expected income. If the occupier prefers to be resettled, the Minister will propose a suitable and similar alternate land. As described in Goldstein and Udry (2008), Ghana's land tenure system is based on chieftaincies. Most of agricultural land plots are owned by local paramount chiefs (also called Stools) and are allocated according to farmers' political influence and needs. Additionally, land is controlled by a matrilineage leadership (the Abusua) and members of a particular Abusua negotiate among themselves to determine which plot to farm. This complex system of land tenure and allocation may complicate the compensation process. Is the compensation given to the Stool, the Abusua, or each individual farmer? Farmers with low bargaining power such as women or young people can have difficulty proving they were the rightful land occupiers to mining companies.

To mitigate these negative consequences, the Ghanaian government set up the Minerals Development Fund Act (MDF) in 2013 to provide additional financial resources to mining communities as well as to encourage greater involvement from mining companies in local community development. The MDF allocates 20% of all mining royalties received to the five following goals: mitigating any negative impact of mining on local communities, funding local development and alternative livelihood projects, promoting minerals research and training the mining sector workforce, promoting mining projects, and supporting the ministry's monitoring of mining activities. The Fund is managed by a committee of eleven persons, including a representative director of three different ministries (Local Government and Rural Development; Environment, Science, Technology and Innovation; Finance), the Administrator of Stool Lands, a representative of Ghana Chamber of Mines and a traditional ruler from a mining community nominated by the national House of Chiefs. Additionally, each mining community appoints a committee in charge of managing revenue received from the Fund. This local committee is composed among others of the community's traditional rulers, a representative of each mining companies operating in the district, and two representatives of a local women and youth group. Each mining community must also establish of a Mining Community Development Scheme which will be financed by 20% of the mining royalties allocated to the national Minerals Development Fund. The rest of the national Fund is to be allocated as follows: 50% to the Office of the Administrator of Stool Lands, 13% to the Minerals Commission, 8% to the Geological Survey Department, 5% to the promotion of sustainable development projects, and 4% to the Ministry of Land and Natural Resources.

2.3.2 Employment and Migration

Artisanal and Small-Scale Mining (ASM) refers to subsistence miners who are not officially employed by a mining company and use manually-intensive methods to extract minerals. This sector is quite developed in resource rich countries and accounts for 20% of global gold production (The World Bank, 2013)[21]. Participation in ASM is usually seen as a temporary, seasonal occupation as well as an income diversification strategy for rural households, particularly for farmers during the pre-harvest season.

In Ghana, despite the fiscal importance of the large-scale mining sector (17.5% of total corporate tax earnings), artisanal and small-scale mining (ASM) offers the most job opportunities in the gold mining industry. In 2014, 34% of Ghana's gold production came from the ASM which employs an estimated 1.1 million workers (compared to 16,000 for the large-scale mining sector (ICMM, 2015)). An additional 4.4 million is thought to depend on the sector (McQuilken and Hilson, 2016)[22]. In fact, ASM provides an attractive alternative livelihood to rural households thanks to regular income flows and low barriers to entry as miners can hold various positions, from general labouring to skilled machine work or haulers. Following the rapid growth of the small-scale mining sector in the 1980s, national authorities tried to regulate the sector thanks to the Small-Scale Gold Mining Law (PNDC Law 218)[23] passed in 1989. The goal was to streamline artisanal activities by opening official marketing channels for informally produced gold and controlling the number of miners by allocating renewable five-year mining licences.

[21] http://www.worldbank.org/en/topic/extractiveindustries/brief/artisanal-and-small-scale-mining

[22] McQuilken J., and G. Hilson (2016), "Artisanal and Small-Scale Gold Mining in Ghana". IIED, Country Report, August 2016.

[23] Ministry of Finance, Government of Ghana, Minerals Commission, Artisanal and Small-Scale Mining (ASM) Framework.

This new structural framework, coupled with high unemployment and the decline of investments in enterprises, motivated many semi- and non-skilled workers to try their luck in gold mining[24]. Exploration and development in the mining industry led to an increase in infrastructure investment (road and railroad networks) and the expansion of the service sector in resource-rich areas. The improvement in transportation and communication infrastructure encouraged migrants to move to the Gold Coast in search of work (Nyame et al., 2009). Migration patterns to mining areas also depend on the stages of mining: migration inflows are relatively low during the exploration phase; increase strongly during the development phase; and become net outflows during the closure stage. Nyame et al. (2009) also note that the farther migrants come from, the longer they will stay near the mining area to find work. When they can't find jobs as miners, migrants have been found to work on farms or services.

However, working informally (which is the case for an estimated 60 to 80% of miners) restricts access to credit, discourages long-term investments, prevents mechanization, and decreases tax revenue. Additionally, the competing use of land plots between mining and agriculture, added to land degradation and water pollution from mining activities, has created tensions between land owners and miners. A study in Northeastern Ghana by Awumbila and Tsikata[25] documented high net migration outflows to the mining areas of the South (a migration that can be explained by low land productivity and the relatively high poverty rates compared to the rest of the country) but also high environmental impact from land degradation. I will explore the long-run impacts of these North-to-South migration flows in chapter three.

[24] Nyame, F. K., Grant J. A. and N. Yakovleva (2009), "Perspectives on migration patterns in Ghana's mining industry", Resources Policy, no. 34, p. 6-11.

[25] Awumbila, M. and D. Tsikata, « Migration Dynamics and Small-Scale Gold Mining in North-Eastern Ghana: Implications for Sustainable Rural Livelihoods ».

2.4 THEORETICAL FRAMEWORK

2.4.1 Foundation

Following Morten & Oliveira (2017), Donaldson & Hornbeck (2016), and Monte et al. (2018), I develop a general equilibrium model with spatial linkages in trade and migration to estimate the effects of a mining shock on welfare and land prices. In this model, trade flows between two districts depend on the cost of production in the origin district but also on the destination's district trade market access (TMA). Defined by Donaldson & Hornbeck (2016), trade market access measures the size of a destination district's pool of potential origin supplier districts. A destination district's TMA increases with the productivity of origin districts (as goods become cheaper to produce) but decreases with distance to origin districts (as it becomes more expensive to trade). In other terms, a destination district's trade market access increases if it becomes cheaper to receive goods from origin districts, either because of a decrease in trade costs or smaller costs of production. Trade flows between two districts are defined as the share of total revenue in d spent on goods from o.

Similarly, migration flows between two districts depend on the cost of living in the destination district but also on the origin's district labor market access (LMA). As presented in Morten & Oliveira (2017), labor market access measures the size of an origin district's pool of potential destination districts. An origin district's LMA increases with the wage in destination districts (as it becomes more profitable to live in other districts) but decreases with distance to destination districts and their cost of living (as it becomes more expensive to migrate and live in these destination districts). In other terms, the labor market access of an origin district increases as it becomes cheaper to live in and travel to other destination districts. Migration flows between two districts are defined as the share of origin district's population that is migrating to destination district d.

By construction, both TMA and LMA capture the effects of a change in migration and trade costs not only in areas located next to new mines and roads, but also in areas located farther away that are indirectly impacted by the new infrastructure. For example, as the new mining district has now access to a wider variety of cheaper goods, its previous trade partners will suffer from this increase in competition. I am then able to evaluate the aggregate effects of mine openings and roads network expansion and to estimate how they might have encouraged migration to mining districts.

2.4.2 Spatial General Equilibrium Model

2.4.2 a) Preferences and labor migration

Agents are assumed to be mobile and can choose the location where they work. They are subject to heterogeneous and stochastic location preference shocks. Each agent i from district o chooses a destination district d to maximize her Cobb Douglas utility function:

$$U_{od(i)} = \frac{b_{d(i)}}{\kappa_{od}} \left[\frac{C_d}{\alpha}\right]^{\alpha} \left[\frac{H_d^H}{1-\alpha}\right]^{1-\alpha} \quad \text{subject to} \quad w_d = P_d C_d + q_d H_d^H \qquad (1)$$

where $\kappa_{od} \geq 1$ is an iceberg migration cost between origin o and destination d (I assume $\kappa_{od} = \kappa_{do}$ and $\kappa_{oo} = 1$), and H_d^H is the land surface (in acres) held by the worker in d. Additionally, $b_{d(i)}$ is an idiosyncratic amenities shock and represents worker i's heterogeneous preferences over destination districts with similar characteristics. For each worker i originating from o and living in d, idiosyncratic amenities shocks $b_{d(i)}$ are drawn from an independent Fréchet distribution: $G_{d(b)} = e^{-B_d b^{-\varepsilon}}$, where $B_d > 0$ determines the average amenities when living in location d and $\varepsilon > 1$ represents the dispersion of amenities. Additionally, the consumption goods index C_d in location d is a constant elasticity of substitution function of a continuum of tradable varieties over [1; N] sourced from each location o:

$$C_d = \left[\sum_{o=1}^{N} c_{od}^{\rho}\right]^{\frac{1}{\rho}} \text{ and } \sigma = \frac{1}{1-\rho} > 1 \tag{2}$$

For tractability, labor supply is assumed to be inelastic and of size 1, so workers receive labor income w and the total labor supply in a district will be measured by its population size. Additionally, 1-α fraction of workers' income is spent on land which is assumed to belong to immobile landowners. As documented in Ghana Housing Profile (UN Habitat, 2011)[26] and Goldstein & Udry (2008)[27], land in Ghana is under the control of villages' chieftaincy (also called a stool) and is allocated to farmers depending on their political influence and perceived need. However, land rights are more secure for cultivated plots than for fallow ones. So, land rental rate q_d may represent the rent given to the stool, as well as any investment made to expand one's political clout or to improve crops' growth.

Following utility maximization, demand c_{od} for a good produced in o and consumed in d is given by the expression below where Y_d is the aggregate expenditure in d, P_d is the consumption price index in d, and p_{od} is the cost of buying one unit of c_{od} in district d:

$$c_{od} = \alpha Y_d P_d^{\sigma-1} p_{od}^{-\sigma} \quad \text{and} \quad P_d = \left[\sum_{o=1}^{N} p_{od}^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{3}$$

The indirect utility of a worker living in destination d is given by:

$$V_d = B_d w_d^{\varepsilon} \kappa_{od}^{-\varepsilon} \left[P_d^{\alpha} q_d^{1-\alpha}\right]^{-\varepsilon} \tag{4}$$

Each worker selects the destination district that maximizes her utility. Additionally, migration flows M_{od} from origin o to destination d are represented by a gravity equation equal to the share

[26] Ghana Housing Profile, UN-Habitat, United Nations Human Settlements Programme, 2011.
[27] Goldstein, M. and C. Udry (2008), « The Profits of Power: Land Rights and Agricultural Investments in Ghana », Journal of Political Economy, vol. 116, no. 6, p. 981-1022.

λ_{od} of the population L_o in origin district o that is migrating from o to d. M_{od} is then a function of the labor supply in origin o and of the probability of moving from o to d compared to all the other potential destination districts:

$$M_{od} = \left(\frac{B_d w_d^{\varepsilon}[P_d^{\alpha} q_d^{1-\alpha}]^{-\varepsilon} \kappa_{od}^{-\varepsilon}}{\sum_d B_d w_d^{\varepsilon}[P_d^{\alpha} q_d^{1-\alpha}]^{-\varepsilon} \kappa_{od}^{-\varepsilon}}\right) L_o \quad (5)$$

$$M_{od} = \lambda_{od} L_o \text{ and } LMA_o = \sum_d B_d w_d^{\varepsilon}[P_d^{\alpha} q_d^{1-\alpha}]^{-\varepsilon} \kappa_{od}^{-\varepsilon} \quad (6)$$

Migration flows from o to d increase with the equilibrium wage and amenities in destination d, and decrease with the cost of living (given by the consumption price index and land rental rate) and migration costs (proxied with the distance between o and d). The gravity equation above also implies an elasticity $-\varepsilon$ of migration flows with respect to migration costs and of ε with respect to wage. Finally, according to the labor market clearing condition, the endogenous population size in destination d L_d is given by the sum of migrants coming from all origin districts o:

$$L_d = \sum_{o \epsilon N} \lambda_{od} L_o \quad (7)$$

2.4.2 b) Production and trade

Assuming perfect competition between producers, each location o produces a variety of goods according to its comparative advantage A_o and uses a Cobb-Douglas production function with labor L_o and land H_o^F:

$$Y_o = A_o L_o^{\gamma} H_o^{F^{1-\gamma}} \quad (8)$$

From profit-maximization, the equilibrium price p_{od} (which is the cost of buying in destination d a unit of the good produced in origin o) is given by:

$$p_{od} = \left(\frac{\sigma}{\sigma-1}\right) \frac{\tau_{od} w_o^{\gamma} q_o^{1-\gamma}}{A_o} \quad (9)$$

where w_o and q_o are the rental rate of labor and land respectively, and $\tau_{od} \geq 1$ is an iceberg trade cost between origin o and destination d (I assume $\tau_{od} = \tau_{do}$ and $\tau_{oo} = 1$). Similarly to migration, trade flows from origin o to destination d depend on the cost of production of the goods in o and the geographic distance between o and d, compared to the cost of production of the goods in other districts and the geographic distance between the destination d and all of the other origin districts. So, trade flows X_{od} between o and d are given by the share π_{od} of total expenditures in d spent on goods produced in o:

$$X_{od} = \left(\frac{{A_o}^{\sigma-1}\left[w_o^{\gamma} q_o^{1-\gamma}\right]^{1-\sigma} \tau_{od}^{1-\sigma}}{\sum_o {A_o}^{\sigma-1}\left[w_o^{\gamma} q_o^{1-\gamma}\right]^{1-\sigma} \tau_{od}^{1-\sigma}}\right) Y_d \quad (10)$$

$$X_{od} = \pi_{od} Y_d \text{ and } TMA_d = \sum_o {A_o}^{\sigma-1}\left[w_o^{\gamma} q_o^{1-\gamma}\right]^{1-\sigma} \tau_{od}^{1-\sigma} \quad (11)$$

Trade flows between o and d are inversely related with the cost of production in origin o (that depend on wage and land price in o) and with the trade costs between o and d (proxied with geographic distance). Inversely, trade flows increase with productivity in o. It is possible to use a reduced-form expression of equations (14)-(15) to retrieve the underlying consumption elasticity of substitution σ. However, internal trade flows X_{od} are rarely available. To overcome this absence of data, Donaldson & Hornbeck (2016) used the population size around a county as a proxy for that county's availability of traded goods. Given the lack of data on internal trade flows between districts in Ghana, I will use the same strategy in section 5 to compute an initial guess for consumption elasticity of substitution σ.

Following Donaldson & Hornbeck (2016) and Monte et al. (2018), the equilibrium pricing rule and the trade flows equation brings the following consumption price index:

$$P_d = \left[\sum_{o=1}^{N} p_{od}^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \quad (12)$$

$$P_d = \left[\sum_{o=1}^{N} \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \left(\frac{\tau_{od} w_o^{\gamma} q_o^{1-\gamma}}{A_o}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \quad (13)$$

$$P_d = \left(\frac{\sigma}{\sigma-1}\right)\left(\frac{\tau_{od} w_o^{\gamma} {q_o}^{1-\gamma}}{A_o}\right)\left(\frac{1}{\pi_{dd}}\right)^{\frac{1}{1-\sigma}} \tag{14}$$

Finally, assuming an inelastic land supply $\overline{H_o}$, the equilibrium land rental rate is given by the land market clearing equation:

$$\overline{H_o} = H_o^H + H_o^F \quad \text{or} \quad \overline{H_o} = \frac{(1-\alpha)}{q_o} Y_o + \frac{(1-\gamma)}{q_o} w_o L_o \tag{15}$$

2.4.2 c) General equilibrium

Given the model's parameters $\{\alpha, \gamma, \varepsilon, \sigma\}$ and exogenous variables $\{A_o, B_o, \tau_{od}, \kappa_{od}, \overline{H_o}\}$, the equilibrium vector of six endogenous variables $\{w_o, q_o, L_o, P_o, \lambda_{od}, \pi_{od}\}$ will solve the following set of six equations written below: (1) labor income in district o equals labor expenditure in o (which is a fraction ϒ of total production in o, or the sum of goods flows sent from o to all possible destinations d), (2) land market clearing, (3) migration flows probabilities, (4) trade flows probabilities, (5) price index, and (6) labor market clearing.

$$w_o L_o = \gamma Y_o = \gamma \sum_{d \epsilon N} \pi_{od} Y_d \tag{16}$$

$$q_o = \frac{w_o L_o}{\overline{H_o}} \left[\frac{1-\gamma}{\gamma} + 1 - \alpha\right] \tag{17}$$

$$\lambda_{od} = \left(\frac{B_d w_d^{\varepsilon} \left[P_d^{\alpha} q_d^{1-\alpha}\right]^{-\varepsilon} \kappa_{od}^{-\varepsilon}}{\sum_d B_d w_d^{\varepsilon} \left[P_d^{\alpha} q_d^{1-\alpha}\right]^{-\varepsilon} \kappa_{od}^{-\varepsilon}}\right) \tag{18}$$

$$\pi_{od} = \left(\frac{{A_o}^{\sigma-1} \left[w_o^{\gamma} q_o^{1-\gamma}\right]^{1-\sigma} \tau_{od}^{1-\sigma}}{\sum_o {A_o}^{\sigma-1} \left[w_o^{\gamma} q_o^{1-\gamma}\right]^{1-\sigma} \tau_{od}^{1-\sigma}}\right) \tag{19}$$

$$P_d = \left(\frac{\sigma}{\sigma-1}\right)\left(\frac{\tau_{od} w_o^{\gamma} q_o^{1-\gamma}}{A_o}\right)\left(\frac{1}{\pi_{dd}}\right)^{\frac{1}{1-\sigma}} \tag{20}$$

$$L_d = \sum_{o \epsilon N} \lambda_{od} L_o \tag{21}$$

The goal of this paper is to compute the change in welfare and land rental rates following a mine opening. The latter is represented using a shock in the district's productivity of 5%, along with a simultaneous change in the production function's parameter ϒ (the share of labor) from .92 to 0.32

(computed in section 5.3 below) and a change in trade and migration costs of -14% (computed in section 5.1 below). Like Monte et al. (2018), I will compute equilibrium changes in the main variables of interest by using initial guesses for changes in w_d and λ_d at time t: $\widehat{w}_d^{(t)}$=1 and $\hat{\lambda}_d^{(t)}$=1 in the following iterative algorithm (in which $\hat{x} = \frac{x'}{x}$) and update conjectures to $\widehat{w}_d^{(t+1)}$ and $\hat{\lambda}_d^{(t+1)}$ until convergence:

$$\hat{L}_d^{(t)} = \frac{\bar{L}}{L_d} \sum_{o \epsilon N} \lambda_{od} \widehat{\lambda_{od}}^{(t)} \quad (22)$$

$$\hat{q}_d^{(t)} = \widehat{w}_d^{(t)} \hat{L}_d^{(t)} \quad (23)$$

$$\hat{\pi}_{od}{}^{(t)} = \left(\frac{\hat{A}_o{}^{\sigma-1} \left[\widehat{w}_o^{\gamma(t)} \hat{q}_o^{1-\gamma(t)} \right]^{1-\sigma} \hat{\tau}_{od}^{1-\sigma}}{\sum_{o \epsilon N} \pi_{od} \hat{A}_o{}^{\sigma-1} \left[\widehat{w}_o^{\gamma(t)} \hat{q}_o^{1-\gamma(t)} \right]^{1-\sigma} \hat{\tau}_{od}^{1-\sigma}} \right) \quad (24)$$

$$\hat{P}_d{}^{(t)} = \left(\frac{\sigma}{\sigma-1} \right) \left(\frac{\hat{\tau}_{dd} \widehat{w}_d^{\gamma(t)} \hat{q}_d^{1-\gamma(t)}}{\hat{A}_d} \right) \left(\frac{1}{\hat{\pi}_{dd}{}^{(t)}} \right)^{\frac{1}{1-\sigma}} \quad (25)$$

$$\hat{\lambda}_{od}{}^{(t+1)} = \left(\frac{\hat{B}_d \widehat{w}_d^{\varepsilon(t)} \left[\hat{P}_d^{\alpha(t)} \hat{q}_d^{1-\alpha(t)} \right]^{-\varepsilon} \hat{\kappa}_{od}^{-\varepsilon}}{\sum_d \lambda_{od} \hat{B}_d \widehat{w}_d^{\varepsilon(t)} \left[\hat{P}_d^{\alpha(t)} \hat{q}_d^{1-\alpha(t)} \right]^{-\varepsilon} \hat{\kappa}_{od}^{-\varepsilon}} \right) \quad (26)$$

$$\widehat{w}_o{}^{(t+1)} = \frac{\gamma}{\hat{L}_o{}^{(t)}} \sum_{d \epsilon N} \hat{\pi}_{od}{}^{(t)} \hat{Y}_d{}^{(t)} \pi_{od} Y_d \quad (27)$$

2.5 DATA AND CALIBRATION STRATEGY

In order to compute equilibrium changes in welfare and land prices following a shock in mining activity, I have to estimate the model's parameters {α, γ, ε, σ} from the data, as well as the change in migration costs following a mine opening.

2.5.1 Change in migration costs following a mine opening

I approximate migration and trade costs between two districts by the distance travelled on the road network to go from the origin district to the destination district. Using Ghana's districts' administrative boundaries (there are 216 districts distributed across 10 regions in the country), I estimate the distance on the roads network between each pair of districts' centroids using digitized maps for the years 1960, 2000 (source: Jedwab and Moradi (2016)[28]) and 2013 (source: ESRI data). This results in a 216 x 216 matrix of the distance by roads in kilometers between each origin-destination pair. I then estimate the change in migration costs following a mine opening in two steps: first, I compute the change in roads density following a mine opening in a district and second, I compute the change in the effect of distance on migration flows to a new mining district. The total change in migration costs is given by $\Delta migration\ flows\ for\ 1\ additional\ road\ km * \Delta roads\ density\ km$.

2.5.1 a) Mining Activity and Transportation Infrastructure

As documented in the literature, mine openings may increase the number and quality of roads. In fact, mining companies located in more or less populated districts need to transport minerals out of the country to reach international markets. They could rely on pre-existing transportation infrastructure (roads, railroads, bridges, ports, etc.) or obtain the authorization to build their own. In some countries, these companies are even required to pay for the infrastructure necessary for minerals transportation. In Ghana, roads construction inherent to mining activity is usually financed by the Minerals Development Fund (MDF) and mining companies themselves. In this section, I analyze whether mining activity significantly increases transportation infrastructure in the district. To estimate the magnitude of transport infrastructure in a district, I use total roads kilometers (roads density) in a district using Geographic Information System (GIS) data on the Ghanaian road network in 1960, 2000 (from Jedwab & Moradi (2016)) and in 2013 (from ESRI).

[28] Jedwab, R. and A. Moradi (2016), « The Permanent Effects of Transportation Revolutions in Poor Countries: Evidence from Africa », The Review of Economics and Statistics, vol. 98, no. 2, p. 268-284.

Figure 2.1: Large-scale gold mines

Figure 2.2: Road network in 1960

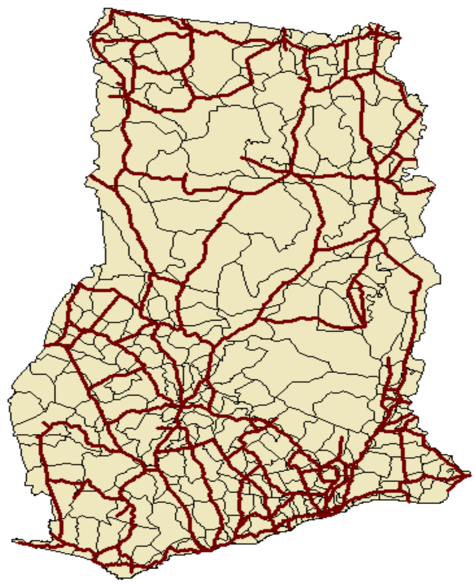


Figure 2.3: Road network in 2000

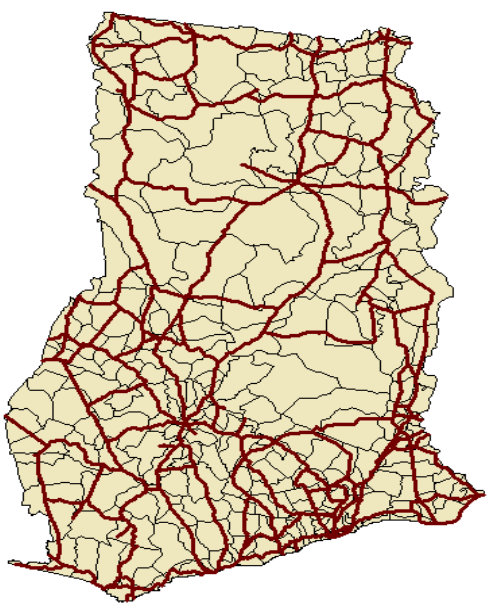
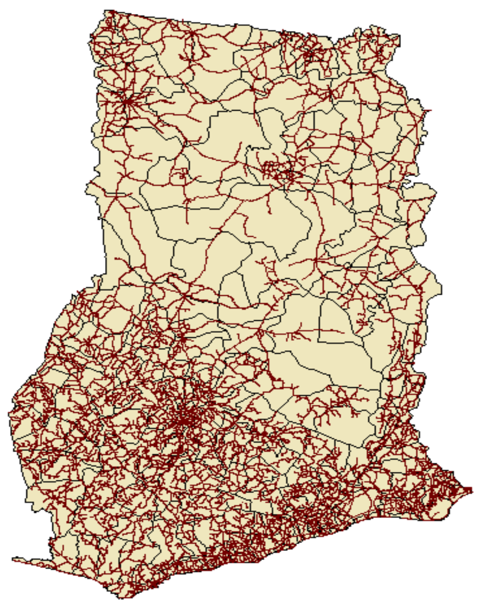


Figure 2.4: Road network in 2013



Given the wide temporal gap in roads network data (I only have three years of observations: 1960, 2000 and 2013), I create year categories (category 1 for years 1960 to 1990, category 2 for years 1991 to 2010, and category 3 for years 2011 to 2015), and compute total roads kilometers in each district for the three year categories. I then estimate the change in roads density after a mine opens using a difference-in-difference strategy and leveraging spatial and temporal variation in mining. I identify districts in which a mine currently operates and districts in which a mine will open at any point in time. The estimating equation would then be:

$$log\ (roads\_density)_{i,t} = \beta_1 active\_mining\_district_{i,t} + \beta_2 mining\_district_i + \alpha_r + \alpha_t + \varepsilon_{r,t} \quad (28)$$

with $roads\_density_{i,t}$ total roads kilometers in district i in year t, $active\_mining\_district_{i,t}$ a dummy variable indicating if there is an active mine in district i at year t, and $mining\_district_{i,t}$ a dummy variable indicating if a mine will open in district i at any point in time and used to control for time-invariant factors differentiating mining and non-mining districts. I also include region and yearly fixed. However, there is some potential endogeneity between mines and roads density: if hesitating between two districts, mining companies might decide to settle in the district with the most pre-existing transportation systems in order to decrease future investments in infrastructure. I instrument mining activity with the location of gold deposits in Ghana obtained from the United States Geological Survey (USGS) and the world price of gold to compute the value of gold deposits. The latter variable is appropriately correlated with mining activity but not with local roads density. Finally, I set the value of gold deposits to 0 in non-mining districts. The resulting estimation equation is the following:

$$\log\ (roads\_density)_{i,t} = \beta_1 \widehat{active\_mine}_{i,t} + \beta_2 mining\_district_i + \rho_r + \rho_t + \varepsilon_{r,t} \quad (29)$$

$$active\_mine_{i,t} = \beta_1\, mineral\_deposit_{i,t} + \delta_i + \delta_t + u_{i,t} \quad (30)$$

From table 1 below, the effect of mining activity on roads density is strongly significant and rather large. In fact, the geometric mean of roads density increases by 112% in districts with an active mine. Given that the unconditional geometric mean of roads density is approximately 70km, mining districts have on average 78.4km of additional roads compared to other districts.

Table 2.1: Roads density in mining districts

VARIABLES	(2) log(roads density)
Active mine at time t	11.969***
	(4.308)
Mining district	9.735**
	(3.858)
Observations	648
Number of district id	216
Region FE	YES
Year FE	YES

*Clustered standard errors at the regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

2.5.1 b) Mining Activity and Migration Costs

As explained above, mining activity acts as a pull factor toward mining districts. Mine openings represent a shock in male workforce which increases male equilibrium wage. Informal miners may also migrate to the area to access the same gold deposits as the large-scale mines. Additionally, as shown in the first chapter of this dissertation, even though female labor force participation decreases in total after a mine opening, some women find work in supporting services. These new labor opportunities attract workers to the mining areas. Furthermore, the increase in roads density documented in the previous section might help decrease the trip length from migrants' origin district to the mining district, which would make it more affordable.

In this section, I use a migration gravity equation following Morten & Oliveira (2017) to estimate the effect of mining activity on the cost of distance on migration flows between two districts. A smaller migration flows elasticity with respect to distance in mining districts would indicate that these districts have access to more nearby roads but also that their specific characteristics (average consumption, price level, comparative advantage and amenities) increase the indirect utility households derive from migrating to that mining location. I estimate the following migration gravity equation with Poisson Pseudo-Maximum Likelihood to assess if mining destination districts have lower migration costs:

$$\log(M_{od}) = \delta_o + \delta_{rd} + \beta_1 \log(d_{od}) + \beta_2 Mining_d \log(d_{od}) + \beta_3 ActiveMining_d \log(d_{od}) + \epsilon_{od} \quad (31)$$

with M_{od} the migration flows from origin district o to destination district d in 2000, d_{od} the travel distance on the road network between the two districts' centroids, $Mining_d$ a dummy variable indicating if a district d had an identified gold deposit in 2000, $ActiveMining_d$ a dummy variable indicating if a district d had an active gold mine in 2000, δ_o an origin district fixed effect, and δ_{rd} a destination region fixed effect.

To estimate this gravity equation, I build subnational migration flows between districts using the Population and Housing Census from 2000, and use a Poisson-Pseudo Maximum Likelihood (PPML) estimation which has become the standard estimation method for gravity models[29,30]. In fact, one of the common challenges in migration or trade studies is the prevalence of zero flows. The origin-destination flows matrix can thus be very sparse and a simple ordinary least squares estimation will drop flows with zero value once they are log-transformed. However, zero flows contain important information as two districts might not exchange migrants due to high migration costs, preferences, or destination and origin characteristics. In comparison, the PPML technique has several advantages for count outcome variables, the first being that it keeps zero flows in the sample. It also equates total actual and predicted flows. Results are presented in Table 2 below.

[29] Head, K. and T. Mayer, (2013), "Gravity Equations: Workhorse, Toolkit, and Cookbook", CEPII working paper no. 2013-27.
[30] Larch M. et al., (2016), "An Advanced Guide to Trade Policy Analysis: the Structural Gravity Model", WTO publications.

Table 2.2: Migration flows and distance on the road network between origin and destination

VARIABLES	log(migration flows)
$\log(distance_{od})$	-0.841***
	(0.0187)
$\log(distance_{od})$*Mining destination district	-0.047
	(0.058)
$\log(distance_{od})$*Active mining destination district	0.131*
	(0.0793)
constant	5.304***
	(0.820)
Observations	10,186
R-squared	0.811
Origin district FE	YES
Destination region FE	YES

*Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

As distance between origin and destination districts increases by 1%, migration flows are expected to decrease by 0.8%. However, if there is an active mine in the destination district, migration flows are expected to fall by only 0.7%. This represents a decrease in migration costs to mining districts of 12.5% and could indicate that their specific characteristics (such as average consumption basket and amenities) increase the indirect utility households derive from living in that mining location or that mining districts have access to better transport infrastructures for the same distance travelled compared to other districts.

In conclusion, mine openings were found in section a-1 to increase roads density in mining districts by 10 kilometers or 112%, while a decrease of 1% in distance travelled lowered migration costs by 12.5%. Thus, after a mine opening, migration costs decrease by a total of 12.5%*112%=14%.

2.5.2 Share of land in workers' utility (1-α)

The workers' Cobb-Douglas utility function depends on consumption index C_d with weight α and land surface H_d^H with weight 1-α. From the first order conditions, 1-α also represents the share of land in households' expenditure. Using the Ghana Living Standard Survey waves from 1988 to 2013, I retrieve households' annual income, daily and annual average expenditure on a variety of goods (durable and non-durable), daily and annual average food expenditure, as well as land rental rate per acre. The share of land in households' total expenditure ranges from 2% in 1988 to 11.3% in 2013. These estimates are in line with the literature as the UN-Habitat found that housing rents accounted for 1.5% to 11.5% of households' monthly expenditure in large cities in 2005 and the Global Consumption Database of the World Bank indicates that housing rental costs represented 4.97% of the average consumption expenditures in 2010. Given that the migration flows from district to district are estimated using the 2000 Population and Housing Census (the only year available), I use $1-\alpha = 3\%$ which corresponds to the estimate from the closest wave of Living Standard Survey (1998-1999). I will use $1-\alpha = 11\%$ in robustness checks.

2.5.3 Share of land in firms' production function (1-ϒ)

Firms use a Cobb-Douglas production function to produce goods from labor (with weight ϒ) and land (with weight 1-ϒ). To compute ϒ for mining and non-mining firms, I use the only two waves of Microenterprise Surveys available from 2007 and 2013. I am able to retrieve the annual value of output and of expenditure on labor and land rentals. One advantage of these surveys is that the firm's industry is listed. This allows me to estimate a constrained linear regression of the production function where the log of annual output value is regressed on the log of annual labor expenditure, log of annual land rentals value, as well as year and industry fixed effects. From table 3 below and as predicted, firms listed in the mining industry seem to use a larger share of land compared to other types of firms combined (68.3% compared to 8.3%).

Table 2.3: Weight of labor and land in firms' production function

VARIABLES	(1) non-mining firms	(2) mining firms
log_labor	0.917***	0.317
	(0.0524)	(0.206)
log_land	0.0828	0.683***
	(0.0524)	(0.206)
Constant	8.625***	5.165**
	(0.442)	(1.999)
Observations	388	18
year FE	YES	YES
industry FE	YES	NO

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

2.5.4 Consumption elasticity of substitution: σ

From equations (14) and (15) of the general equilibrium model, I derive the following reduced form expression for land rental rate q_d:

$$\log(q_d) = \frac{\log\left((1-\gamma)\bar{H}_d^{-1}A_d\right)}{1+\sigma(1-\gamma)} - \frac{\gamma\sigma}{1+\sigma(1-\gamma)}\log(w_d) + \frac{1}{1+\sigma(1-\gamma)}\log\left(TMA_d\right) \qquad (32)$$

$$\text{with } TMA_d = \sum_o {A_o}^{\sigma-1}\left[w_o^{\gamma} q_o^{1-\gamma}\right]^{1-\sigma} {\tau_{od}^{1-\sigma}}.$$

Land rental rate in district d is a nonlinear function of total factor productivity A_d and consumption elasticity of substitution σ, both of which are unknown. Hence there are only 216 equations for 432 unknowns. To solve for σ, I follow the strategy of Donaldson & Hornbeck (2016) and approximate the trade market access using the population in other districts weighted by the distance in kilometers to district d:

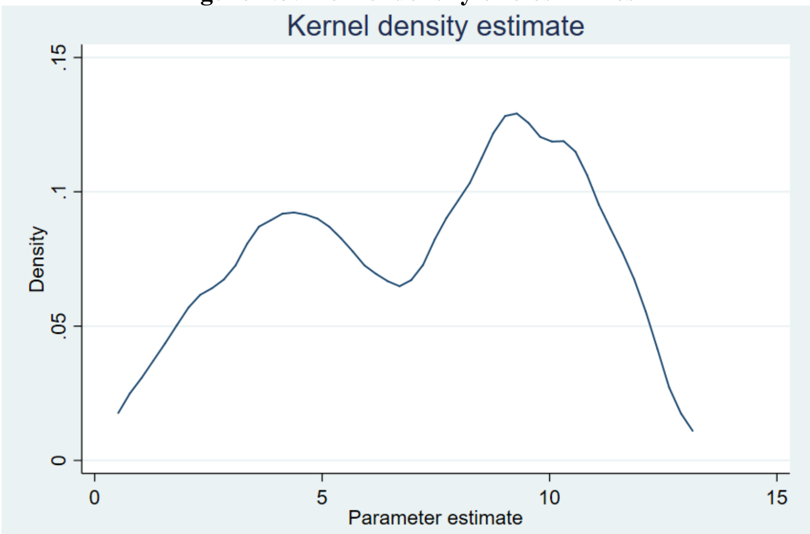
$$\widetilde{TMA}_d = \sum_{o\neq d} {\tau_{od}^{1-\sigma}} pop_o \qquad (33)$$

The equation for $\log(q_d)$ can then be written as:

$$\log(q_d) = f(\sigma)_d + \varsigma_{od} = -\frac{\gamma\sigma}{1+\sigma(1-\gamma)}\log(w_d) + \frac{1}{1+\sigma(1-\gamma)}\log\left(\widetilde{TMA}_d\right) + \varsigma_{od} \qquad (34)$$

where ς_{od} is orthogonal to $f(\sigma)_d$, conditional on district and region fixed effects. I solve for σ using a grid search on an evenly spaced grid with 2,000 points and get an average value of 7.21 with a 95% confidence interval between 4.68 and 9.73.

Figure 2.5: Kernel density of σ estimates



Intuitively, the lower the trade costs, the larger the variety of goods available to consumers and the larger the consumption elasticity of substitution. This estimate of 7.21 is consistent with the literature: Donaldson & Hornbeck (2016) found a consumption elasticity of substitution of 8.22 in the 1870-1890 United States, Caliendo & Parro (2015)[31] got an estimate of 8.11 for agricultural products in 1993 for the NAFTA countries, and Head & Mayer (2014)'s literature survey found a mean value of 6.74[32]. Morten & Oliveira (2017) and Monte et al. (2018) assumed an elasticity of substitution σ of 4, which I will also use in robustness tests.

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[31] Caliendo, L. and F. Parro (2015), "Estimates of the Trade and Welfare Effects of NAFTA", Review of Economic Studies, vol. 82, 1-44.

[32] Head, K. and T. Mayer (2014), "Gravity Equations: Workhorse, Toolkit, Cookbook", Handbook of International Economics, vol. 4, Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, eds. (New York: Elsevier, 2014)

2.5.5 *Migration flows elasticity to destination district's wage: ε*

In the theoretical model, workers are assumed to select a destination district d in order to maximize their utility. Additionally, migration flows between origin district o and destination district d were defined as follow:

$$M_{od} = \left(\frac{B_d w_d^{\varepsilon} [P_d^{\alpha} q_d^{1-\alpha}]^{-\varepsilon} \kappa_{od}^{-\varepsilon}}{\sum_d B_d w_d^{\varepsilon} [P_d^{\alpha} q_d^{1-\alpha}]^{-\varepsilon} \kappa_{od}^{-\varepsilon}} \right) L_o$$

Even though I observe migration flows M_{od}, wage w_d, land rental rate q_d, population L_o and migration costs κ_{od}, the districts' amenities B_d are unobservable. Thus, in order to compute ε, I follow the strategy by Morten & Oliveira (2017) and Monte et al. (2018) which consists in first proxying destination districts' unobserved amenities by districts' fixed effects obtained from a migration gravity equation, then evaluating the impact of a change in wage on the indirect utility. First, the gravity equation for migration is estimated using the following equation:

$$\log(M_{od}) = \delta_o + \delta_d + \beta_1 \log(d_{od}) + \beta_2 X_{od} + \epsilon_{od} \tag{35}$$

where M_{od} is the flow of people migrating from origin district o to destination district d in 2000, d_{od} is the distance in kilometers one has to travel on the road network in 2000 to go from o to d, δ_o is an origin fixed effect, δ_d is a destination fixed effect and X_{od} is a set of variables to control for unobserved heterogeneity of migration (a dummy equal to 1 if the districts are in the same region, a dummy equal to 1 if the main ethnic group in origin district is the same as in the destination district, and a dummy equal to 1 if the same religious group represents the majority of the population in both districts).

Because missing migration flows represent the fact that no one is migrating between o and d, it is important to take them into account in the estimation. The gravity equation for migration is then estimated using a Poisson-Pseudo Maximum Likelihood and a negative Binomial method as a robustness test in order to take into account pairs of districts with 0 observed migration flows. Results are presented in the table 4 below. All estimations give a strong negative and significant coefficient for the effect of distance on migration flows. Since PPML give expected signs for all variables, I retrieve destination districts fixed effects from this estimation method.

Figure 2.6: Migration flows between o and d and distance traveled on the road network

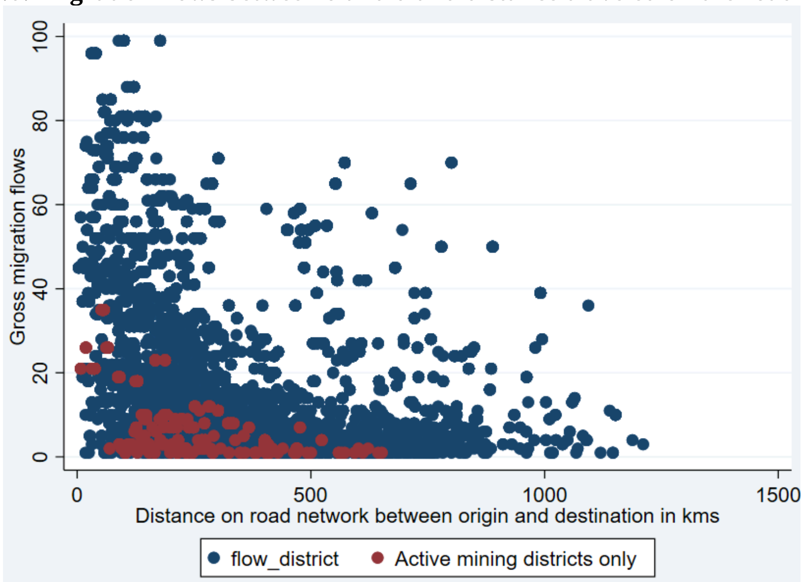


Table 2.4: Gravity equation for migration

VARIABLES	(1) OLS	(2) PPML	(3) PPML-FE	(4) negative binomial
Log of distance in km between districts	-0.897***	-0.572***	-0.572***	-1.130***
	(0.00772)	(0.0215)	(0.0215)	(0.0454)
Same ethnicity	0.234***	0.251***	0.251***	0.235**
	(0.0194)	(0.0493)	(0.0493)	(0.0959)
Same religion	-0.186***	0.119***	0.119***	-0.0409
	(0.0113)	(0.0362)	(0.0362)	(0.0534)
Same region	-0.159***	0.372***	0.372***	0.186
	(0.0169)	(0.0334)	(0.0334)	(0.139)
Constant	5.592***	0.880	2.776***	-0.978***
	(0.0470)	(0.547)	(0.130)	(0.130)
Observations	45,373	45,374	45,373	45,374
R-squared	0.459	0.366		
origin_district FE	YES	YES	YES	YES
destination_district FE	YES	YES	YES	YES

*Clustered standard errors at the origin-destination district pair level in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

2.5.5 a) Computation of ε

From the Poisson-Pseudo Maximum Likelihood estimation results obtained in column (2) of table 4, I retrieve the destination district fixed effects. As explained in Morten & Oliveira (2017), these estimated fixed effects $\hat{\delta}_d$ represent the destination-specific component of indirect utility which was given by: $V_d = B_d w_d^{\varepsilon} \kappa_{od}^{-\varepsilon} [P_d^{\alpha} q_d^{1-\alpha}]^{-\varepsilon}$.

So, $\hat{\delta}_d = B_d + \varepsilon \log(w_d) - \varepsilon\alpha \log(P_d) - \varepsilon(1-\alpha)\log(q_d)$. Additionally, the unobserved common amenity value B_d is approximated with a region fixed effect δ_r: $B_d = \delta_r + \xi_d$. $\hat{\delta}_d$ can be written as: $\hat{\delta}_d = \delta_r + \varepsilon \log(w_d) - \varepsilon\alpha \log(P_d) - \varepsilon(1-\alpha)\log(q_d) + \xi_d$ (37).

Furthermore, an equilibrium condition of the model is that rents in district d q_d can be expressed as a function of wages in d, trade market access and some parameters as already mentioned in section 4:

$$\log(q_d) = \frac{\log\left((1-\gamma)\bar{H}_d^{-1} A_d\right)}{1+\sigma(1-\gamma)} - \frac{\gamma\sigma}{1+\sigma(1-\gamma)}\log(w_d) + \frac{1}{1+\sigma(1-\gamma)}\log(TMA_d)$$

A reduced-form estimate of $\log(q_d)$ can be written as: $\log(q_d) = \rho_r + \beta\log(w_d) + \omega_d$. However, wages, prices and land rental rates might be endogenous. In fact, the higher the destination-specific component, the more migrants will be attracted to this district, resulting in an increase in population. Consequently, wages, consumption and land prices might increase. Morten & Oliveira used Bartik shocks to instrument for wages and prices. Due to data restriction, I use instead the variation in other districts' rainfall (obtained from the Global Precipitation monthly grids of University of Delaware's Climate Database[33]) weighted by their respective population and their distance to district d as an instrument for wages and prices. In fact, the rainfall in other districts will only impact district d's amenities through changes in local wages and prices. Following Monte

[33] http://research.jisao.washington.edu/data/ud/

et al. (2018) and assuming the two are unrelated, I also use the total factor productivity of the destination district estimated in the section below as an additional instrument. The equations for wages and rents are estimated simultaneously using a constrained three-staged least squares method. Results are presented in table 5 below and the estimate of ε=3.236 is in line with previous results in the literature (Morten & Oliveira (2017) found a migration elasticity to wage of 2.24 while Monte et al. (2018) found an elasticity of 3.30). From table 5 below, after a mine opens, as wages in destination district increase by 1%, migration flows to that district are expected to increase by 3.2%. I use the minimum and maximum values (1 and 6 respectively) from ε confidence interval as alternative values in robustness checks.

Table 2.5: Estimation of ε

VARIABLES	(1) Destination district fe	(2) Log rents
log_wage	3.236*	1.450*
	(1.677)	(0.840)
log_price	-1.945	
	(1.358)	
log_rents	-1.276	
	(1.645)	
Observations	80	80
R-squared	0.224	0.983
region FE	YES	YES

*Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

2.6 EFFECTS OF A MINING SHOCK ON HOUSEHOLDS' WELFARE AND LAND RENTAL RATES

Now that I have estimated the main parameters (summarized below in table 6) of the theoretical model, I calibrate the model to solve for the equilibrium changes in welfare and land price following a shock in mining activity. This mining shock is three-fold: 1) a shock in the district's productivity of 5%, 2) a simultaneous change in the production function's parameter ϒ (the share of labor) from 0.92 to 0.32 (computed in section 5.3 earlier), 3) a change in trade and migration costs of -14% (computed in section 5.1 above).

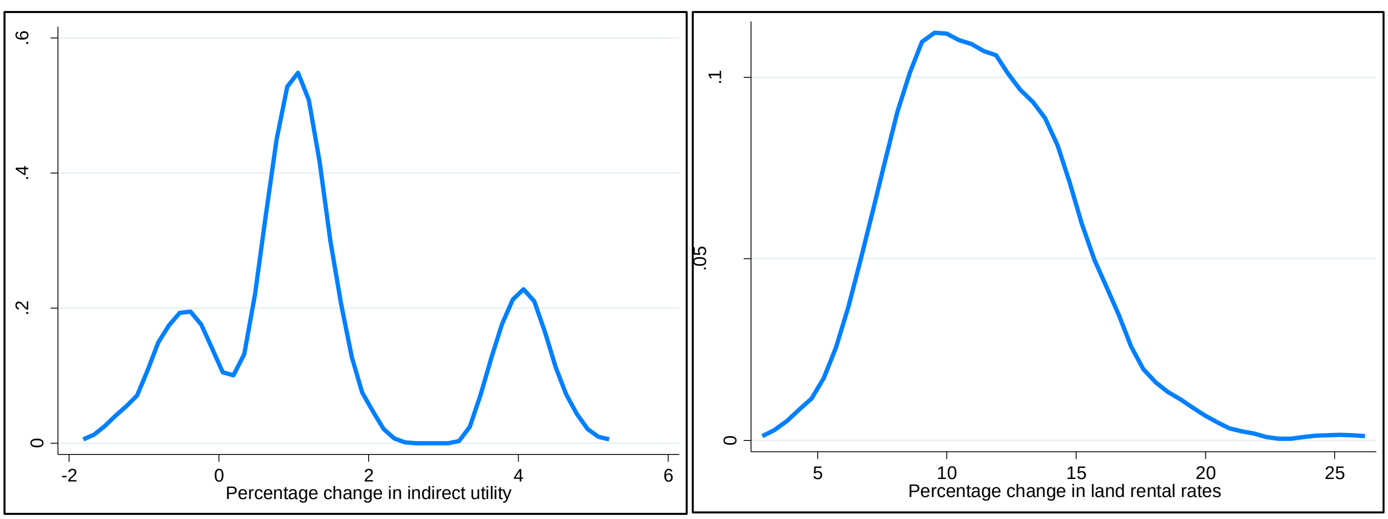
Table 2.6: Parameters

Parameter	Signification	Value
α	Share of consumption in households' expenditure	0.97
γ	Share of labor in production function	0.92 (non-mining firms) 0.32 (mining firms)
ε	Migration flows elasticity to destination district's wage	3.236
σ	Consumption elasticity of substitution	7.21

Kernel densities of welfare and land price (rents) elasticities in mining districts following a mining shock are presented below in figure g. To simplify interpretation, I take the log of the change in welfare (and rents) $\hat{x}$ (which is equal to $\frac{x'}{x}$). These results can then be interpreted as the percentage change in welfare and rents.

Figure 2.7: Kernel densities of welfare and land rental rates elasticities in treated districts

Figure 2.7.1: Welfare elasticities *Figure 2.7.2: Land rental prices elasticities*



Again in this exercise, I implement a mining shock in each of the 216 districts consisting in an increase in total factor productivity by 5% in each district separately (shock 1), an increase in TFP and land weight in the production function from 0.08 to 0.68 (shock 2), and a simultaneous increase in TFP, land weight and decrease in bilateral migration and trade costs to/from treated districts by 14% (shock 3). I then computed the equilibrium change in land rental price and welfare for these treated districts. Indirect utility increases by 1.4% for shock 3 (with a 95% confidence interval between 1.2% and 1.6%). As mining districts become more productive, factors of production use increases, thus putting upward pressure on equilibrium wages and land rents. As firms increase labor demand, wages go up as well as workers' welfare.

The shock also creates more competition in the land market, increasing land rental rates. In fact, firms rely more on land after a mining shock. Land rents increase on average by 11.5%. Additionally, the 14% decline in trade and migration costs enables the geographical propagation of the shock since non-mining districts exhibit a rather large increase in welfare and rents (1.04% and 5.9% respectively). Even though land weight in the production function increases only in the treated district, thus increasing land rental rates, the decline in migration and trade costs make it easier for households to migrate in and out of the mining district and settle in nearby areas. As labor supply decreases in the treated district (and increases in nearby districts), equilibrium wage goes up.

2.7 EMPIRICAL ESTIMATION

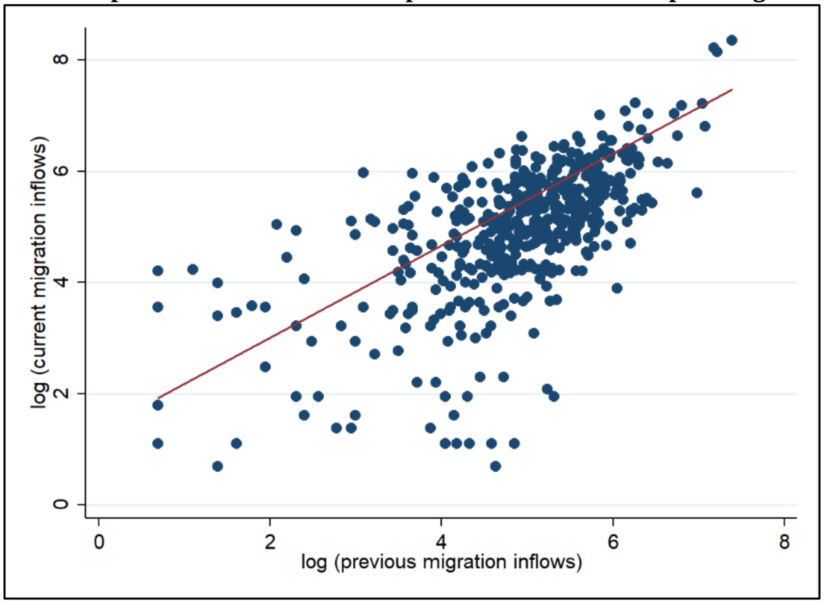
In this section, I will provide empirical evidence to back the findings from the theoretical model in section 6 above. Households' welfare increases following a mining shock due to a positive change in wages thanks to increased labor demand and migration inflows which support the expansion of other employment sectors. From section 6 above, it appears that this rise in wages is strong enough to mitigate the increase in land rental rates and to increase welfare. In this section, I use data from Ghana Living Standard Surveys (waves 2, 4, 5 and 6) to estimate both the direct effects of mining on households' income and the indirect effects of mining through migration inflows on income. From the descriptive statistics table below, farm revenues appear to be significantly higher in mining districts, specifically among migrant households. In fact, migrants in mining districts are much older than natives but also better educated.

Below, I estimate the indirect effects of mine openings on households' income. In a district d observed at time t, migration inflows $M_{d,t}$ will impact wage of household i at time t $w_{i,d,t}$. However, the relationship between income and migration suffers from reversed causality as higher revenue attract migrants and thus lead to larger migration inflows. I instrument for $M_{d,t}$ with both past migration flows to district d, $M_{d,t-1}$. This instrument is strongly correlated with and a good predictor of current inflows (as shown in figure h below).

Table 2.7 : Descriptive Statistics

For all districts :	***Non-mining districts***	***Mining districts***	***Difference***
Log(revenue from farm – 12mo)	13.82	14.01	0.188***
Work in agriculture	0.56	0.52	-0.034***
Work in retail or trade	0.14	0.16	0.023***
Age	32.35	33.33	0.98***
Received post-primary education	0.46	0.39	-0.071***
N=732,257			
Only for mining districts :	***Non-migrants***	***Migrants***	***Difference***
Log(revenue from farm – 12mo)	13.90	14.18	0.278***
Work in agriculture	0.54	0.51	-0.023***
Work in retail or trade	0.16	0.16	0.005
Age	30.9	36.7	5.81***
Received post-primary education	0.34	0.46	0.119***
N=32,873			

Figure 2.8: Scatterplot and linear relationship between current and past migration inflows



I estimate the following estimation equation:

$$\log(income)_{i,d,t} =$$

$$\log\,(migration\ inflows)_{d,t} + active\_mine_{d,t} + mining\ district_d + X_i + \delta_r + \delta_t + \varepsilon_{i,d,t} \qquad (38)$$

with

$$\log(migration\ inflows)_{d,t} =$$

$$\log\,(migration\ inflows)_{d,t-1} + active\_mine_{d,t} + mining\ district_d + \gamma_r + \gamma_t + u_{i,d,t} \qquad (39)$$

where $\log\,(income)_{i,d,t}$ is the log of income of household i living in district d at time t, $\log\,(migration\ inflows)_{d,t}$ and $\log\,(migration\ inflows)_{d,t-1}$ are logs of migration inflows to district d at time t and t-1 respectively, $active\_mine_{d,t}$ is an indicator for the presence of an active mine or a mine that will open in less than five years in district d at time t, $mining\ district_d$ indicates a district in which a mine will open at any time, X_i are household-level controls (head of household's gender, age, marital situation and education level). Finally, I also include regional and yearly fixed effects to control for unobserved heterogeneity across regions and GLSS waves. Results are presented in table 8 below.

An active mine at time t increases current migration inflows at time t by 37.9%. Mines, by generating jobs and new economic opportunities in supporting sectors, act as a pull factor that attracts migrants. Migration inflows are also found to have a significant positive effect on households' income as a 1% increase in migration inflows will increase income by 0.291%. As migrants arrive in the district, they can take advantage of new employment opportunities in manual labor and services, thus increasing the local level of income. The development of new sales outlets for farming produce may also benefit local farming households. In conclusion, the proportional change in migration inflows due to mining activity will increase households' income in the district by 11%.

Table 2.8: Effects of mining activity and migration flows on households' income

VARIABLES	First stage Migration flows in t	Second stage income
Log(migration flows in t)		0.291**
		(0.139)
Log(migration flows in t-1)	0.426***	
	(0.131)	
Presence of an active mine at t	0.379***	0.360**
	(0.128)	(0.167)
Mining district	-0.401**	-0.816***
	(0.183)	(0.192)
Male household head		0.0254
		(0.0312)
Married household head		0.134***
		(0.0463)
Age of household head		-0.102***
		(0.0336)
Primary school diploma		0.00720
		(0.0370)
Observations	326,061	326,061
Region FE	YES	YES
Year FE	YES	YES
Effect of mine opening on migration flows	0.379***	
Direct effect of mining opening on income	0.360**	
Indirect effect of mine opening on income through migration flows	0.379x0.291=0.11**	
Portion of total mine opening effect on income coming from migration flows	23.4%	

Clustered standard errors at the regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

2.8 CONCLUSION

In this paper, I have contributed to the extractive industries literature by providing evidence that mining is not just an enclave industry and does not only impact areas next to the mines. I have demonstrated that a mining boom disrupts local economic markets through two main channels, the first of which is a change in the production function. In fact, mines will heavily rely on land compared to traditional firms and this implies a decrease in the weight of labor and an increase in the weight of land in a Cobb-Douglas production function. This was shown in section 5.3 where I used a constrained linear estimation and micro-enterprise surveys from the World Bank and computed that land's weight is only 0.08 in non-mining firms, but increases to 0.68 for mining firms. One caveat to keep in mind is that these are conservative estimates since the micro-enterprise surveys only present data for formal private firms with no minimum on the number of employees, while it is heavily documented that (1) informal mining is widely present in Ghana, and (2) large-scale mines are likely to have an even greater share of land.

The second channel through which mining affects local areas is the construction of roads and other transport infrastructures as mining companies often participate in the financing and construction of transport infrastructures necessary to the export of minerals. Thanks to road maps data from Esri and Jedwab and Moradi (2016), I was able to compute the road densities for each district in Ghana in 1960, 2000 and 2013 and estimated that road densities increased by 112% in mining districts using an instrumental variable strategy in which I instrumented mining activity in a district with the value of gold deposits in that district. Additionally, I built gross migration flows between districts using Ghana Living Standard Surveys from 2000 and estimated a migration gravity equation to find that mining activity decrease migration costs by 14% to and from mining districts compared to non-mining districts.

Finally, I used a general equilibrium model with spatial linkages in trade and migration to compute equilibrium changes in welfare and land price following a mine opening in a district. I supported this analysis with an instrumental variable strategy to estimate the change in households' income following a change in migration inflows due to a mine opening. The percentage increase in rents is rather large (approximately 11.5%) since the land demand shock from firms increases land's equilibrium price. This is mitigated by an increase in income which allows the increase in welfare to reach 1.3%. Additionally, the decrease in migration costs from and to the mining district allows for the spatial propagation of the shock as my results indicate a strong effect on indirect utility and rents up to 200kms from the treated district. This sheds new light on the mechanisms through which a mining boom can spread to nearby regions. An interesting expansion to the model would be to allow for intermediate inputs as well as elastic labor supply to the private and farming sector to model the change in sectoral employment composition as documented in Kotsadam and Tolonen (2016) and in Fafchamps et al. (2017).

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APPENDIX A - WELFARE AND RENTS ELASTICITIES IN TREATED DISTRICTS WHEN σ =4

Figure A.1: Kernel densities of welfare and land rental rates elasticities in treated districts

Figure A.1.1: Welfare elasticities

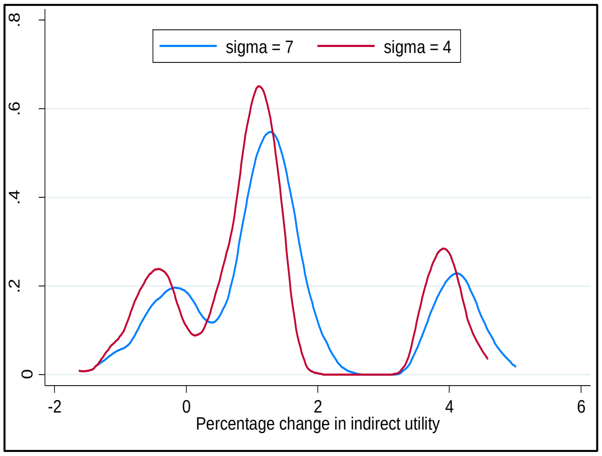
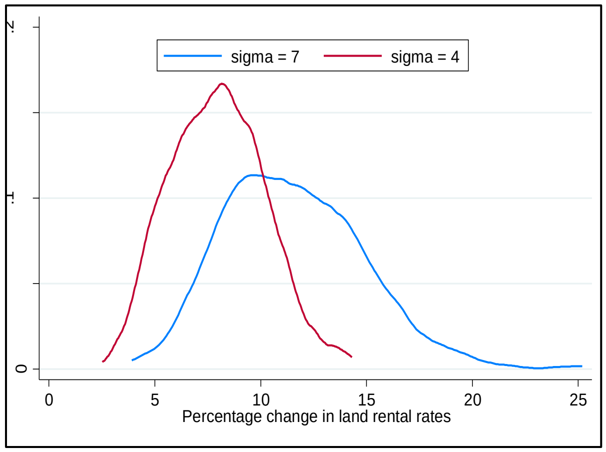


Figure A.1.2: Land rental rates elasticities



As the consumption elasticity of substitution σ decreases from 7 to 4 (value commonly used in the literature, in particular by Morten & Oliveira (2017) and Monte et al. (2018)), goods become less substitutable and harder to replace. Goods that were produced in the mining district before the mining boom will still be produced. As migration inflows increase due to new employment opportunities from the mine and a decrease in migration costs, the equilibrium wage in the mining sector will increase. However, since consumers still demand goods that were produced before the mining boom, more factors of production are allocated to non-mining sectors than in the baseline model. Hence changes in land rental rates and indirect utility will be smaller than when consumption elasticity of substitution σ equals 7.

APPENDIX B - ELASTICITIES IN RELATION TO DISTANCE TO THE SHOCK WHEN σ =4

Figure B.1: Lowess smoothing of elasticities in relation to distance to the shock

Figure B.1.1: Lowess welfare elasticities

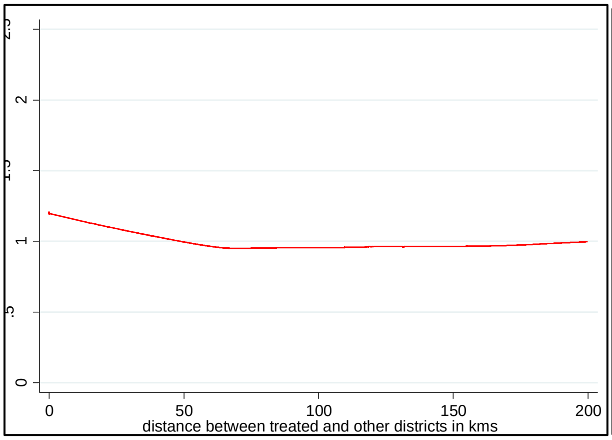
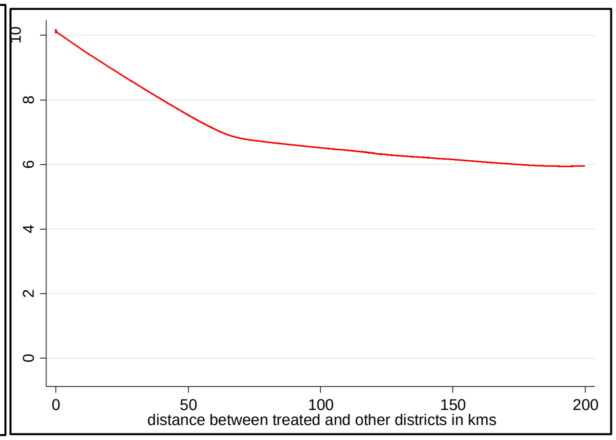


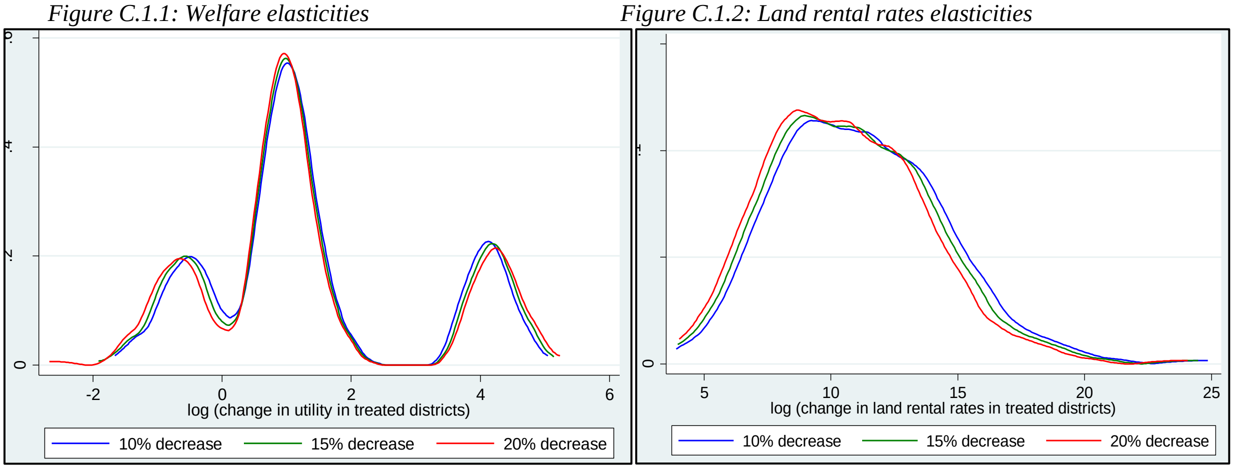
Figure B.1.2: Lowess rents elasticities



APPENDIX C - WELFARE AND RENTS ELASTICITIES IN TREATED DISTRICTS WHEN MIGRATION AND TRADE COSTS DECREASE BY 10%, 15%, AND 20%

Figure C.1: Kernel densities of welfare and land rental rates elasticities in treated districts

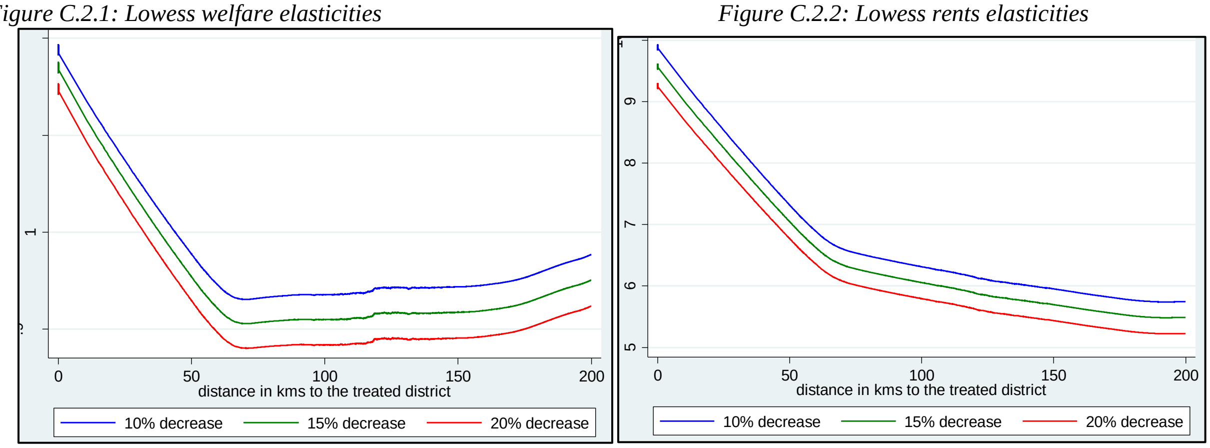
Figure C.1.1: Welfare elasticities *Figure C.1.2: Land rental rates elasticities*



As the migration and trade costs decline even further by 10%, 15% or 20%, it becomes much cheaper to migrate in and out of the mining district. The expected increase in migration inflows will put additional pressure on the mining district's labor market and land rental rates but this will be compensated by newly unemployed farmers who can easily migrate out of the district. Thus, the cheaper it is to migrate, the smaller the impact on land rates. Additionally, it becomes cheaper for the district to trade goods with other districts. Households have now access to a greater variety of goods at a cheaper price and indirect utility increases.

Figure C.2: Lowess smoothing of elasticities in relation to distance to the shock

Figure C.2.1: Lowess welfare elasticities *Figure C.2.2: Lowess rents elasticities*



APPENDIX D: WELFARE AND RENTS ELASTICITIES IN TREATED DISTRICTS WHEN $\alpha = 0.89$

Figure D.1: Kernel densities of welfare and land rental rates elasticities in treated districts

Figure D.1.1: Welfare elasticities

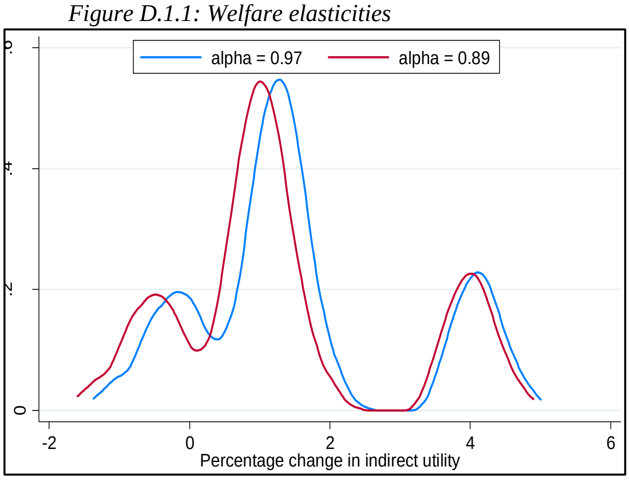
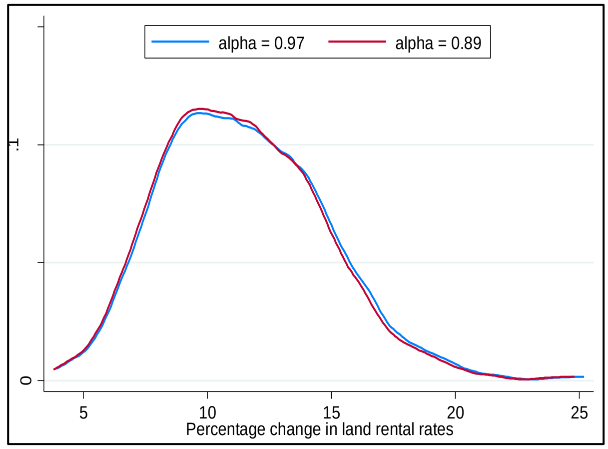


Figure D.1.2: Land rental rates elasticities

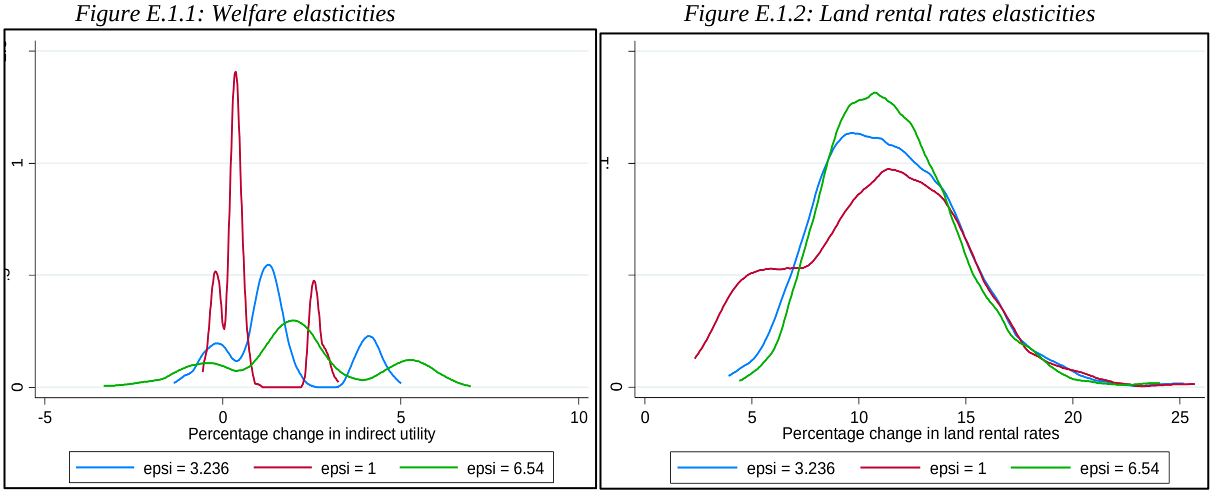


The share of consumption in households' expenditures α was calibrated from the data and set at 97% in section 5.2. Here, I set it to 89% which is the minimum value found across the Ghanaian Living Standard Surveys and from UN-Habitat reports on Ghana. When the share of consumption in households' expenditures decreases from 97% to 89%, households spend a greater portion of their budget on land. However, as migration inflows increase and both new migrants and mines add pressure on the land market, households' expenditures on land will increase, and the change in indirect utility will be smaller compared to the baseline model.

APPENDIX E: WELFARE AND RENTS ELASTICITIES IN TREATED DISTRICTS WHEN $\varepsilon = 1$ AND $\varepsilon = 6.54$

Figure E.1: Kernel densities of welfare and land rental rates elasticities in treated districts

Figure E.1.1: Welfare elasticities *Figure E.1.2: Land rental rates elasticities*



In the baseline model, the migration flows elasticity to wages ε is 3.236 obtained in section 5.5 a). After a mine opens, as wages in destination district increase by 1%, migration flows to that district are expected to increase by 3.2%. Here, I set ε to the lower and upper bounds of the 95% confidence interval for ε, respectively 1 and 6.54. When migrations flows are less responsive and increase only by 1% ($\varepsilon = 1$) after a 1% change in wages, inflows to the mining district are much smaller, thus there is less disruption in the labor and land markets. Thus, out of the three ε values, indirect utility is less likely to change when ε=1. On the opposite, if migrants are more responsive to changes in wages and inflows increase by 6.54% following a 1% change in wages, the larger inflow of migrants will put increase land rental rates. The equilibrium wage is also more likely to decrease if the increase in labor demand from the mine is not enough to absorb all the newcomers. The change in indirect utility is more spread out when ε=6.54 as some mining districts will benefit the smaller their population before the mining boom, while others will experience a decrease in indirect utility following the decline in wages and large increase in land rental rates.

APPENDIX F: WELFARE AND RENTS ELASTICITIES IN UNTREATED DISTRICTS WHEN $\sigma = 7.21$

Figure F.1: Kernel densities of welfare and land rental rates elasticities in untreated districts

Figure F.1.1: Welfare elasticities

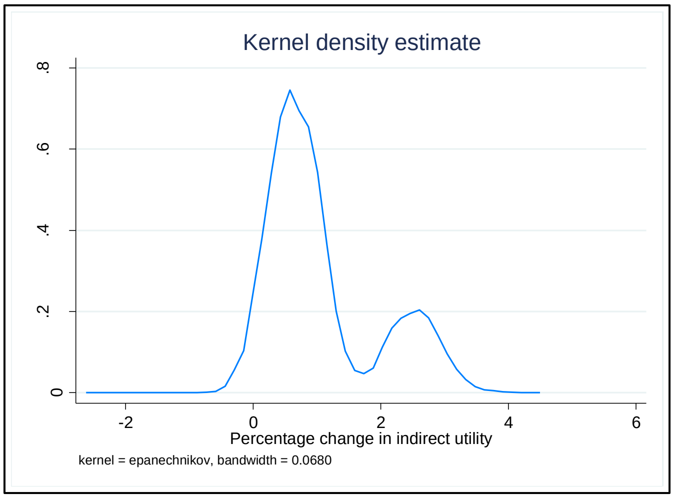
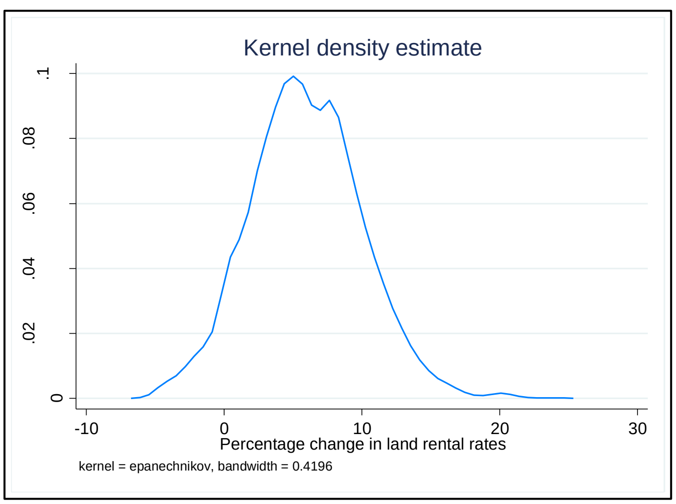


Figure F.1.2: Land rental rates elasticities



Chapter 3. Effects of Domestic and International Remittances on Expenditure Patterns in Ghana

3.1 INTRODUCTION

Following the decline in transportation costs over the last few decades, travel (international or domestic) has been decoupled and so has migration. Recent numbers from the United Nations suggest that 3.5% of global population in 2019 was comprised of international migrants, compared to only 2.8% in 2000[34]. However internal (within countries or specific geographic areas) migration flows have also increased in recent years and make up the majority of migration flows worldwide but data vary widely across areas. Within West Africa for example, while international migrants represented 1.8% of total population in the region[35], almost 72% of migrants from the area leave their country for another country also located in West Africa[36]. Domestic migration is a third type of migration that has been given increasing attention, mainly owing to the importance of rural-urban migration for economic development. In Ghana, the country analyzed in this case study, 27.4% of the population was living in an area other than their place of birth[37] in 2010.

Besides the effects on sending and receiving regions' labor markets, an important consequence to international, regional and domestic migration flows is the amount of money sent from migrants back to their home place. Global remittances flows totaled $466 billion in 2017[38], about three times the size of official development assistance that year and surpassed private capital flows as well. Not only is the level of remittances striking, but they have increased at an impressive rate.

[34] United Nations, DESA, 2019, "International Migration 2019", ST/ESA/SER.A/438
[35] UNCTAD, 2018, "Economic Development in Africa Report 2018"
[36] UNCTAD, 2018, "Economic Development in Africa Report 2018"
[37] Ghana Statistical Service, 2014, "2010 Population & Housing Census Report – Migration in Ghana"
[38] International Organization for Migration, 2018, "Global Migration Indicators"

According to the World Bank[39], remittances sent to middle- and low-income countries had increased by an impressive 10% between 2017 and 2018. Remittances sent to Sub-Saharan Africa amounted to $48 billion in 2018 (World Bank, 2019) and have broad reaching consequences as they represent an important source of external financing for receiving households which use them for many different expenses: food, miscellaneous items, education, investments in agricultural inputs, etc., depending on the amount received and region. On aggregate, remittances have the potential to mitigate negative income shocks, help households smooth their lifetime consumption, modify households labor supply through income and substitution effects, decrease poverty rates, and alter domestic consumption patterns as households will reinvest the money received in domestically produced goods, specifically in the food sector, services, or education and health (IMF, 2007). Remittances are also considered to be more stable than other sources of income, and have the advantage of being potentially countercyclical depending on the altruism of migrant workers and whether economic conditions in the receiving regions are not linked to the sending region[40].

It results that international remittances might have different impacts on poverty and consumption than internal and domestic remittances. For example, remittances sent within the same country are less likely to be countercyclical if sender and recipient households are subject to the same macroeconomic conditions. Additionally, the amount of domestic remittances received may be much lower than remittances received from more developed countries since wages are on average higher than in Ghana. Thus, it is important to understand which type of households receive international remittances over domestic remittances and how the characteristics of alternative

[39] World Bank, 2019, "Migration and Development Brief 31"
[40] International Monetary Fund, 2007, "Impact of Remittances on Poverty and Financial Development in Sub-Saharan Africa"

sources of remittances (mainly their level and volatility) impact households differently. One can suspect that richer households are more likely to receive remittances from abroad as they would have more financial resources to pay for the cost of international travel than poorer households (Kóczán & Loyola (2018), Möllers & Meyer (2014)). On another note, additional income may help relieve budget constraints and help decrease food and other commodities expenditure burden in a context of increasing food prices (Riley (2018), Combes et al. (2013)). The higher the remittances, the more households will be able to increase the percentage of income spent on education and modern agricultural inputs, as basic necessities will already be covered. In conclusion, households receiving international remittances could be richer than households receiving domestic remittances, but could also invest more in sectors with strong multiplier effects, for both the economy and the household (such as education and health) (Banzak & Chezum (2009)). Thus, households' relative dependence on international versus domestic remittances might be an overlooked explaining factor of the recent increase in inequality in some parts of the world, notably in Ghana where the GINI coefficient has steadily increased from 0.354 in 1987 to 0.409 in 2013 (UNDP, 2017)[41].

In this paper, I look at the effects of different types of remittances received on households' expenditures patterns in Ghana between 1988 and 2013. Ghana is a middle-income country from West Africa, with strong economic growth (6.7% in 2019) resulting from dynamic services (57.2% of GDP) and industry services (24%)[42]. During the period of study in this paper, employment in agriculture in percentage of total employment fell consistently from 56.8% in 1991 to 45.3% in 2013. However, while the percentage of population living with less than $1.90 per day decreased from 42.3% in 1988 to 12% in 2012, GINI coefficient increased from 0.36 to 0.424 in the same

[41] UNDP, 2017, "Income Inequality Trends in Sub-Saharan Africa. Divergence, Determinants and Consequences"
[42] Central Intelligence Agency, 2019, "The World Factbook".

period. Coincidentally, personal remittances received increased from 0.115% of GDP in 1988 to 5.14% in 2012[43]. In this paper, I estimate how different types of remittances impact households' expenditures patterns, and how these impacts are altered by two different shocks: a shock in gold prices and a currency depreciation. Specifically, I study the effects of international remittances and internal remittances sent from mining regions in Ghana on recipient households' expenditures in different sectors (mainly food, non-food, and education) in percentage of total expenses. I leverage geo-coded data from multiple waves of the Ghana Living Standard Survey (GLSS): wave 2 (1988-1989), wave 4 (1998-1999), wave 5 (2005-2006), and wave 6 (2012-2013). Clusters' GPS information were taken from Aragon & Rud (2015)[44] but wave 3 information is unfortunately not available. The resulting dataset is a repeated cross-section of approximately 12,700 households.

A simple regression of households' expenses on remittances received (international or domestic) during the same year could suffer from omitted variables and reverse causality as an expected increase in expenses could drive households to seek alternative sources of funding and encourage remittances senders to send larger amounts. I alleviate endogeneity concerns by instrumenting for the level of remittances received using variables impacting the supply of remittances. I instrument for domestic remittances sent from mining regions using the distance between the sender's region and recipient household's place of residence as well as the number of workers involved in the mining industry in the sender's region. These two variables influence both the frequency and size of remittances sent from mining regions and they are likely to impact recipient households' expenditure patterns only through remittances received from mining regions.

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[43] World Bank data, 2020.
[44] Aragon, F. M. and J. P. Rud, 2016, "Polluting Industries and Agricultural Productivity: Evidence from Mining in Ghana", The Economic Journal, vol. 126, no. 597, p. 1980-2011.

However, I suspect remittances received from mining regions to be heavily dependent on international gold prices as gold represents 49% of Ghana's export revenue[45] and most workers in mining regions are temporary migrants who are more likely to send back remittances than permanent migrants (Dustmann & Mestres, 2010). Additionally, informal miners' income is directly dependent on the gold they extract as they sell their production to intermediaries who buy it at prices based on market values. Finally, mining regions are entitled to receiving royalties from extractive companies, based off the revenue they make on international markets. Thus, for mining regions, these royalties represent an additional source of financing for mining regions which fluctuates with international gold prices. Hence the whole economic fabric of mining regions might also be influenced by gold prices. To assess how a decline in remittances received might affect recipient households, I use the number of unexpected negative shocks in the price of gold over the last 12 months and interact it with the amount of mining remittances received. Annual standard deviation in gold price is also used in robustness test 2 as another proxy for gold price volatility.

I then study the effects of international remittances on households' expenditures. These regressions might also suffer from a reverse causality problem for the same reason mentioned earlier. A valid instrument for this category of remittances would need to be strongly correlated to the amount of international remittances received and only impact households' expenditures through the remittances. Unfortunately, the dataset doesn't specify the region of origin of international remittances. I can only observe if they come from an ECOWAS country or out of Africa. Consequently, I rely on data from OIM (2009)[46] about the Ghanaian diaspora: the majority (64%) of Ghanaian migrants living abroad in 2000 settled in nearby ECOWAS countries (Nigeria, Côte

[45] The Observatory of Economic Complexity, 2020

[46] International Organization for Migration, 2009, "Migration in Ghana – A Country Profile"

d'Ivoire, Guinea and Burkina Faso). Additionally, migrants who settled outside of ECOWAS countries can be found predominantly in the following OECD countries: United States, United Kingdom, Italy, Germany, Canada and the Netherlands. I then build two different instrumental variables based on these countries' economic conditions. For each country, I compute the number of unexpected negative shocks in the exchange rate against the US dollar (currency appreciation) and compute a weighted average of negative shocks across these countries, using the national stock of Ghanaian migrants as weight. I also use the average GDP per capita, weighted by the diaspora stock. Using these two instruments, I first analyze how international remittances impact recipient households' expenditures. I then study how international remittances help recipient households mitigate the effects of a domestic negative economic shock, proxied by a depreciation in the Ghanaian currency.

Concerning the general effects of remittances on expenditures, mining remittances appear to significantly increase education and non-food items expenditures in percentage of total expenses, an effect that is even stronger for poorer households. Households in the first quartile of income distribution appear to use remittances to relieve their budget constraint and spend larger portions of their expenses on education. These positive effects are however hampered by negative gold price shocks. Additionally, the effects on total expenditure of mining remittances is positive but not significant compared to international remittances which allow recipient households to significantly increase total expenditures without reallocating expenses across categories. Thus, households who receive international remittances appear to use them to increase the overall level of their expenditure, which can be explained if their budget constraint was already non-binding. This could very well be the case, as an interesting feature of the dataset is that households receiving international remittances are different than those receiving mining remittances: they are richer and more educated. This difference in characteristics could help explain for example the observed increase in education expenditures for households receiving mining remittances, but not for households receiving international remittances. Finally, in case of currency depreciation, international remittances appear to protect recipient households and help them mitigate the negative effects of the shock: the food burden in percentage of total expenditures is much smaller for international remittances recipient households than non-recipient households.

This paper contributes to the literature in several ways: first, the literature on the effects of remittances on inequality is still growing and a lot is still left to be understood. Notably, the effects of remittances volatility on recipient households' consumption smoothing is crucial if we really want to understand how and when households reinvest remittances in the economy. Additionally, it is important to analyze whether all types of remittances are equal. International remittances might help already relatively well-off households hedge against unexpected economic downturns, while this will not necessarily be the case for recipients of domestic remittances. This latter feature might help explain increases in inequality following national negative economic shocks.

This paper is organized as follows: section 2 reviews the recent literature on remittances, section 3 describes the data and some stylized facts, section 4 explains the estimation and identification strategies, section 5 presents results on mining and international remittances, section 6 displays some robustness tests, and section 7 concludes.

3.2 LITERATURE REVIEW

3.2.1 Determinants of remittances

There is a rich and extensive literature on both the impacts and determinant factors of remittances. Various explaining factors of the level of remittances sent have been explored, such as the expected duration of the migration as analyzed in Banerjee (1984) or Dustmann & Mestres (2010). In the latter paper, using panel data from the German Socio-Economic Panel from 1984-1995, the authors leverage on available information on amount of remittances sent, the intended use of these remittances and the return plans of immigrants. They are able to distinguish between migrants who think their migration will be temporary and those who think it will be permanent, and thus are able to analyze whether, controlling for other factors, a temporary migrant will send more or less than a permanent migrant. To do so, they build a dynamic panel estimation in which remittances sent are regressed on return intentions in the same period. However past remittances could impact current return intentions. Dustmann & Mestres address this problem using fixed effects and past return intentions of other household members as instrumental variable for current return intentions. After estimating the model with a generalized method of moments, temporary migrants are found to send relatively larger amount of remittances than permanent migrants. As explained by Dustmann & Mestres, temporary migrants are more likely to have family in their origin country and remittances can be sent to fulfill familial and social commitment. Additionally, remittances can be considered a price to be paid to be able to come back home later in the future and be accepted in the family and community. In Ghana, mining activity is usually considered to be temporary or seasonal, so migration to mining region is likely to be temporary which can influence remittances levels.

The level of education of migrants is another suspected determinant of remittances level. Educated migrants' opportunity cost of labor is relatively high and they can be expected to find a higher salary job abroad compared to less educated migrants. They should thus be able to remit larger remittances. However, they can also afford to come back home more often and thus visit their family more frequently than less educated migrants. This could have the opposite effect on remittances and decrease the amount sent between the destination and home country. Faini (2007) tests these hypotheses using attrition patterns in the European Community Household Panel and estimating the probability of remaining in the survey following variation in time-dependent dummies capturing changes in a migrant's home country. Educated non-EU immigrants are found to be less likely to drop out of the survey compared to other migrants, which he interprets as the indication that more educated migrants are less likely to go back home and more likely to remain in their destination country for an extended period of time. Fairi uses additional data sources on international remittances from the International Monetary Fund, on income data from the World Bank, and level and skills composition of migrations from Docquier & Marfouk (2004). Migrants' remittances are assumed to be a function of the migrant' wage and family members' income back home. On a side note, skilled migrants can afford to go back home more often than unskilled migrants. They could still give money to their family back home when they visit, but this information would not be available in the IMF dataset used. On the other hand, the wage of skilled migrants is larger than the wage of unskilled migrants. Thus, the amount of remittances sent will depend on the relative wage versus reunification effects. Faini (2007)'s results suggest that reunification effect is actually stronger for educated migrants thus they would be less likely to remit than less educated households. This could have implications for richer and more educated Ghanaian households receiving remittances from abroad.

3.2.2 Impacts of remittances on home regions' poverty

There is a rich economic literature on the effects of remittances on regional poverty; the consensus seems to point to positive impacts (Acosta et al (2007), Adams & Cuecuecha (2013), Wagle & Devkota (2018), Gupta et al (2009)). Banzak & Chezum (2009) study the effects of international remittances on capital accumulation and educational achievements of Nepalese boys and girls using data from the Nepal Living Standard Surveys. An increase in remittances can alleviate budget constraints which would allow households to increase their investments in children's education. On the other hand, the absence of working household members may entice parents to rely on child labor to counter the loss in income. The likelihood of being enrolled in school is regressed on household remittances, household migration outcomes, and other controls. However, migration and education decisions can be taken simultaneously within a household (for example, an expected new school enrollment might encourage an adult household member to move away to find a better remunerated job). Banzak & Chezum (2009) instrument for the propensity of migration (with past literacy rates) and network effects (with political unrest by district). Young children appear to benefit from remittances received but the positive effects are stronger for male children, in constrast to Askarov & Doucouliagos (2020) who found similar positive effects for both boys and girls in Latin America. These results support previous results from the literature documenting positive effects of remittances on human capital investments and educational achievements (Zhunio et al (2012), Amega (2018), Bucheli et al (2018)).

Researchers have also analyzed whether remittances increase productive investments. Qin & Liao (2016) conducted a meta-analysis of the effects of labor out-migration and remittances on agricultural changes in rural China. Despite the potential consequences on labor markets and labor shortage, migration out of rural areas can help improve rural economic conditions by relieving budget constraints through remittances, diversifying income resources, and providing financial capital for investment in production inputs. Additionally, Qin & Liao (2016) relay evidence that rural areas benefit from new knowledge and skills brought back by migrants. However, a decrease in agricultural production was mainly observed in less developed areas with limited land supply. On the other hand, remittances contributed to, or supplemented, agricultural production in more developed coastal regions of China.

As highlighted in the aforementioned papers, remittances can be used as an additional source of income and enable budget constrained households to smooth their consumption (Clarke & Wallsten (2003), Yang & Choi (2007), Amuedo-Dorantes & Pozo (2011), Anzoategui et al (2014), Combes & Ebeke (2011)). Using data from Mexico, the latter paper found that remittances are often not used to specifically smooth consumption, but mainly to leverage on the difference between investment returns in the home and destination countries, invest in the recipient household's business, and generally strengthen social ties between the migrant and her community back home. However, Amuedo-Dorantes & Pozo (2011) found that in case of economic hardship, remittances stabilize recipient households' income, even more so for households with tighter budget constraints and fewer savings options.   Thus, remittances can be used to mitigate negative shocks, in income or consumption goods, as shown in Riley (2018) and Combes et al. (2013). In the latter, they measure the impacts of unexpected negative and positive food price shocks on households' consumption level and volatility using a sample of developing countries from 1980 to 2009, and the extent to which international remittances helped them cope with negative shocks. They first build a "Food vulnerability index" that measures how sampled countries depend on food imports according to the four following variables: food weight in the consumers' basket, food imports in total household consumption, food imports as a percentage of GDP, and income gap across countries. They construct the food vulnerability index by a principal component analysis on the four variables above. Sub-Saharan African Countries are found to be the most vulnerable to changes in food prices. They also build a food price index for each country-year combination using the price of different food groups weighted by the share of the food group in consumers' basket. They then compute unexpected shocks in food prices using residuals signs from a time series specification. I use the same strategy in this paper to compute the unexpected shocks in gold prices and currencies' exchange rates. Combes et al. (2013) first estimate the effects of the number of shocks in food prices on consumption level and volatility. They then use interaction variables between the number of shocks and level of remittances received to assess if remittances can play a mitigating role in case of negative food price shocks. The more vulnerable the country is to food shocks, the larger the negative impact on households' consumption levels and the larger consumption volatility. However, remittances are found to mitigate these negative effects.

3.2.3 Do remittances improve or worsen inequality?

Following the results from Combes et al. (2013), remittances appear to indeed help diversify their income sources and smooth their consumption in case of unexpected price shocks. However, this also means that remittances-receiving households will be better off in case of shocks compared to households who do not receive remittances. Researchers have increasingly looked at the effects of remittances on inequality in recipient countries with mixed results. GINI coefficients are usually found to increase due to remittances but over time, migration becomes cheaper and access to international migration increases for poorer households. As poorer households gain access to international remittances, the GINI coefficient declines (Taylor et al (2005), Combes & Ebeke (2011)). For example, Kóczán & Loyola (2018) estimate the effects of international remittances on inequality in Mexico following two crises: the 1994 Mexican Peso Crisis (domestic crisis) and the global financial crisis (international crisis). Using data from the National Survey of Income and Expenditure, they start by reviewing remittances determinants by income deciles: earlier waves of remittances were initially received by households in the middle of income distribution, however, the recent decrease in transportation costs have made remittances become gradually pro-poor as poorer households become increasingly able to send migrants abroad. Additionally, remittances received decrease with the number of children in the household, the household head's education, and the number of employed household members are employed. Kóczán & Loyola (2018) then compare the GINI coefficient over income (with and without remittances), but also use propensity matching to build a counterfactual income distribution. This technique relies on the assumption that, in the absence of remittances, the income of remittances-receiving households would be the same as households who do not receive remittances but who exhibit similar characteristics. Results indicate that income inequality would be slightly higher in the absence of remittances.

However, using a similar technique, Möllers & Meyer (2014) find that international remittances had the opposite effects in Kosovo and increased the GINI coefficient. On the other hand, they confirm the poverty-reducing potential of remittances as 40% of remittances-receiving households are found to climb above a poverty-vulnerability threshold over time. Contrary to Kóczán & Loyola (2018) who found that remittances made up a larger share of households' income in the lower deciles of the income distribution, Möllers & Meyer (2014) found the opposite: thanks to remittances, income rises by 13% for wealthier households, compared to only 4% in lower terciles of the distribution. Additionally, propensity matching allows Möllers & Meyer (2014) to determine that between 18% and 41% of households are no longer poor thanks to the remittances received. These positive findings are mitigated by the increase in income inequality as wealthier households receive large amounts of remittances while poorer households have less access to migration and remittances in general. Howell (2017) sheds light on the change in inequality due to remittances: in rural China, remittances are found to lower spatial inequality but increase ethnic inequality.

3.3 DATA AND STYLIZED FACTS

3.3.1 Data

This paper explores the effects of different types of remittances (international and domestic sent from mining regions) on receiving households' expenditures in Ghana, how these effects are altered by unexpected negative shocks in gold prices and in Ghana's currency's exchange rate. To do so, I rely on multiple waves of the Ghana Living Standard Survey 1988-2013 which provide a rich source of information on households' living conditions and welfare. The survey also has a rich section on remittances indicating the value of remittances received by the household in the past 12 months of the interview date. In this study, I include all types of remittances (cash, food, and in-kind) to get a comprehensive view of the effects of all remittances on households' expenditures. Additional information includes whether the remittances are sent from within Ghana and if yes, the region from which they are sent. Otherwise, I can observe whether the remittances are sent from a country belonging to the Economic Community of West African States (ECOWAS, which are main recipients of Ghanaian migrants), or from abroad. Complementary information contains the frequency of remittances, how they were received (through bank accounts, money transfer agencies, or if they were brought by the sender or someone else). The finalized dataset is repeated cross-section of approximately 34,000 remittances transactions received by 12,700 households.

3.3.2 Summary statistics

Table 1 below presents some summary statistics taken from the entire sample, and then broken down by income quartile to better understand the remittances characteristics between poorer and richer households. First, the majority of households have a male head, even more so in richer households which might be explained by the difficulty for women to access financial resources.

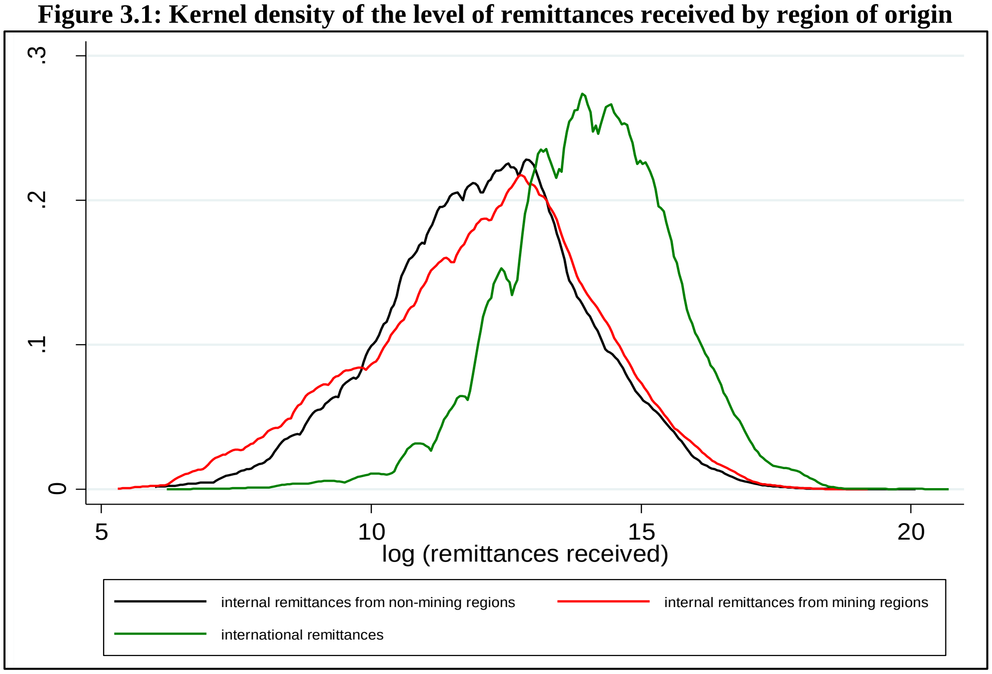
Unsurprisingly, richer households have higher educational achievements as 40% of household heads finished primary school compared to 31% in poorer households. This might be an underlying factor explaining the fact that 70% of household heads in the first quartile of the income distribution are involved in the agricultural sector compared to 48% in the fourth quartile. Richer households are also more likely to have at least one adult household member living away as this is the case for 17% of households in the fourth quartile of the income distribution compared to only 11%. This, added to the fact that 20% of poorer households receive remittances from outside Ghana compared to 32% for richer households, indicate that the cost of migration is still high for the poorest households despite the decrease in transportation costs of these past few decades. These poorer households wouldn't be able to benefit from the positive windfalls of migration documented in the literature review, which could explain the increase in inequality observed in some studies.

Finally, the level of remittances received per transaction varies widely according to the quartile: richer households in the fourth quartile of income distribution receive remittances that are on average 22 times higher than remittances received by households in the first quartile. This is also documented in figure 1 below presenting the Kernel density distribution of remittances received. International remittances appear to be much larger than domestic remittances, owing to the higher level of development of Ghanaian migrants' destination countries, and potentially the skills composition of Ghanaian migrants.

Table 3.1: Summary statistics

Summary statistics	All households	Households in first quartile	Households in fourth quartile
Household head			
Men	66%	62%	71%
Age	50.9	50.2	51.4
Finished primary school	34%	31%	40%
Works in agriculture	66%	70%	48.1%
Average household size	3.9	3.3	4.1
Households with at least 1 adult member living away	14%	11%	17%
Remittances received (out of households receiving positive amounts of remittances)			
Internal remittances from non-mining regions	62%	65%	56%
Internal remittances from mining regions	14%	15%	12%
International remittances	24%	20%	32%
Average remittances (Cedis)	14,000,000	1,788,884	39,900,000
Median remittances (Cedis)	3,500,000	1,300,000	18,000,000

Figure 3.1: Kernel density of the level of remittances received by region of origin



3.3.3 Stylized facts on remittances

Table 2 below provides additional insights on remittances. First, international remittances are received less often than internal remittances, probably caused by the distance that migrants must travel to bring back the money if they bring it themselves to the recipient households, or by the cost of sending money internationally. In fact, according to estimates from the World Bank (2019)[47], costs of sending remittances to Sub-Saharan Africa amounted on average to 10% of the amount of sent. The lower frequency and high cost of international remittances could explain why their levels are so much higher than domestic remittances (international migrants might send money back home less often but when they do, they send larger amounts to compensate for the lost time and high cost). The three types of remittances are primarily spent on daily consumption (food and non-food items), health and education but the larger level of international remittances allows recipient households to invest in more durable and expensive assets such as housing.

A final important remark is that households who receive international remittances are different from households who receive domestic remittances as hinted in section 3.3.2 above. Remittances received from mining regions are on average smaller but do represent a larger share of recipient households' income compared to domestic remittances sent from other regions. In fact, informal mining in Ghana is widespread in mining regions and the sector usually attracts young and less educated men. These migrants will be different from relatively better educated migrants who settle in urban areas in search for better employment prospects. They will be even more different than international migrants who have enough funding to travel abroad. This could be a first indication that all remittances are not equal: high levels of international remittances have the potential to increase recipient households' income but they can also increase inequality as poorer households do not have enough funding to afford the cost of migration (even domestic migration) and will receive much smaller remittances. Additionally, international remittances can protect households

[47] World Bank, 2019, "Migration and Development Brief 31"

from domestic economic shocks, as ECOWAS or OECD countries might not be influenced by a shock in Ghana. The same will not be necessarily true of internal remittances if the domestic remittance sender works in a sector that is either volatile or strongly depends on national economic conditions.

Table 3.2: Summary statistics on remittances

Summary statistics	Internal remittances from mining regions	Internal remittances from other regions	International remittances
Frequency			
Not often	48%	53%	47%
Weekly	8%	4%	3%
Monthly	14%	13%	13%
Quarterly	8%	11%	10%
Annually	18%	15%	14%
Other	5%	4%	14%
Amount and use			
Average remittances (Cedis)	1,091,799	1,916,422	4,718,810
Median remittances (Cedis)	200,000	500,000	1,200,000
1st use (GLSS 5 and 6 only)	daily consumption	daily consumption	daily consumption
2nd use (GLSS 5 and 6 only)	health	health	health
3rd use (GLSS 5 and 6 only)	education	education	education & housing
Households characteristics			
% of remittances over income (average)	34%	26%	17%
% of remittances over expenses (average)	38%	40%	32%
Average education level of household head	primary education (8-10 years)	primary education (8-10 years)	vocational education (10-12 years)

3.4 ESTIMATION STRATEGY AND IDENTIFICATION

In this paper, I explore the effects of remittances on households' expenditures by expenses categories and show how remittances can mitigate or worsen negative macroeconomic shocks depending on their origin. I first focus on remittances sent from mining regions of the country to other Ghanaian households.

3.4.1 Effects of remittances sent from mining regions on households' expenditures in case of shocks in gold price

Because mining regions' economic conditions depend on gold production (numerous workers are migrating to these regions to work in the informal or formal mining sector, but also in supporting services), I expect remittances sent from gold producing regions to depend on the current value of gold on international markets. In fact, one million Ghanaians are assumed to be involved in artisanal and small-scale gold mining in rural areas according to 2013 estimates from IISD[48]. Informal miners often operate their own small-scale gold mining operations and sell their production to intermediaries who buy the gold at a price fixed by international markets. A decrease in gold prices drives down both miners' disposable income and the level of remittances they can afford to send back home. On the other hand, a decline in gold prices is less likely to impact the small number of formal miners and other large-scale mine operatives (9,950 in 2018, Ghana Chamber of Mines)[49] since they are more likely to receive a stable wage, not tied to the price of gold. To estimate the effect of remittances sent from mining regions on recipient households' expenditures in case of gold price shocks, I estimate the following regression:

$$\%\, exp\ on\ good\ _{i,d,t} = mining\ rem_{i,d,t} + neg\ gold\ price\ shocks_{i,d,t} + mining\ rem_{i,d,t} * neg\ gold\ price\ shocks_{i,d,t} + X_{i,d,t} + \delta_t + \delta_d + \delta_r + \varepsilon_{i,d,t} \qquad (1)$$

with:

- $\%\exp\ on\ good_{i,d,t}$ either the log of total expenditures spent by household i living in district d at time t, or expendites on either education, food or non-food items in percentage of total expenditures,

[48] The International Institute for Sustainable Development, 2017, "Global Trends in Artisanal and Small-Scale Mining (ASM): A review of key numbers and issues"
[49] Ghana Chamber of Mines, 2018, "Performance of the Mining Industry in Ghana – 2018"

- $mining\ rem_{i,d,t}$ the log value of remittances received from mining regions by household i and expressed in percentage of the recipient household's total income,
- $neg\ gold\ price\ shocks_{i,d,t}$ the number of unexpected negative shocks in the price of gold that occurred in the past 12 months of the households' survey interview date. In the GLSS, households list the amount of remittances received in the last 12 months. A decline in the price of gold that occurred in the past 12 months could decrease the level of remittances received from mining regions. The larger the number of negative shocks, the more unstable the remittances and the stronger the decline in purchasing power. I compute the gold price shock variable by taking the first difference of the price in log and filtering cyclical components with a Hodrick-Prescott filter, then predict the residuals of an ARMA process (see partial autocorrelation and autocorrelation graphs in appendix A). A negative residual is interpreted as an unexpected negative shock. I then compute the number of negative shocks in the past 12 months for each month-year combination.
- $X_{i,d,t}$ is a vector of household controls including the household head's age, sex, education, as well the number of children below the age of 18 and the number of household members above the age of 18 living away from the household.

I include yearly, district and region fixed effects to account for unobserved heterogeneity across years and geographic areas. I also cluster standard errors at the regional level.

A negative shock in the price of gold, would penalize households receiving remittances from mining regions in two ways: first, the country is still heavily dependent on gold as it represents 27% of foreign exchange sources[50] as well as 50% of exports, and mining companies pay a fraction

[50]https://www.reuters.com/article/us-africa-investment-gold-analysis/analysis-gold-price-drop-jolts-west-africa-from-mining-dreams-idUSBRE99O0S320131025

of their revenue to the government in royalties. Thus, a decline in gold prices would decrease government's revenue and the latter might have to cut public services provision or increase taxes. Additionally, lower commodity exports decrease the demand for the national currency which depreciates, resulting in an increase in imported goods' costs. As a result, we can expect all households to be negatively impacted by a decrease in gold prices. However, households who receive remittances from mining regions might also experience a decline in remittances received since the source of these remittances is tied to gold prices. Because of this, I expect the interaction term to be negative for the level of total expenditures and to be positive for categories of imported goods (food and non-food items).

3.4.1 a) Identification

A caveat to the estimating equation written above is the potential for reverse causality, as expected changes in households' expenditures might entice households to seek additional remittances or change the relative source of remittances senders. To correct for endogeneity, I use two instrumental variables to instrument for remittances received from mining regions: the inverse distance between the household and the sender's region, and the size of mining workforce in the region where the remittance sender lives. First, remittances sent from mining regions are more likely (68% of mining remittances) to be carried directly by the sender or by someone else to the recipient household. The shorter the distance to be travelled between the origin region and the household, the more frequently the sender can come visit the household and give away remittances. Additionally, the size of the mining workforce could indicate the size of the gold deposit in the region. Thus, a larger workforce could have a positive impact on the amount of remittances sent. However, it could also signal a stronger competition amongst gold miners which would then decrease remittances; thus, the final impact of mining workforce would depend on the relative deposit size versus labor competition effect. I proxy regional mining workforce with the number of adults in the survey who self-declare to be working in the mining sector. However, because an expected increase in household expenditures at time t could entice families to send members to mining regions to seek employment, I only count mine workers who have settled in the region at least one year before the recipient household is interviewed.

I expect these two instruments to be strongly correlated with the amount of remittances received and only impact recipient households' expenditures through remittances. Finally, I control for model validity using commonly accepted statistics (Kleibergen-Paap, Wald and Hansen tests). Therefore, I estimate the following set of equations using 2SLS, first with the whole sample, and then decomposing the sample between the first and fourth quartiles of the income distribution:

$$\%\, exp\ on\ good_{\ i,d,t} = \widehat{mining}\ rem_{i,d,t} + neg\ gold\ price\ shocks_{i,d,t} + \widehat{mining}\ rem_{i,d,t} * neg\ gold\ price\ shocks_{i,d,t} + X_{i,d,t} + \delta_t + \delta_d + \delta_r + \varepsilon_{i,d,t} \quad (2)$$

$$\widehat{mining}\ rem_{\ i,d,t} = inv\ dist\ to\ sender_{i,d,t} + mining\ workforce_{i,d,t} + inv\ dist\ to\ sender_{i,d,t} * mining\ workforce_{i,d,t} + X_{i,d,t} + \delta_t + \delta_d + \delta_r + \varepsilon_{i,d,t} \quad (3)$$

In the specification above, a shock in gold prices would impact all households but even more so those for which remittances sent from mining regions represent a large share of their income. The estimation strategy from equations (2) and (3) will give some insights into how remittances receiving households change their expenses allocation in case of a negative shock in remittances supply. Similarly, it would be interesting to understand how international remittances receiving households use these remittances to mitigate macroeconomic shocks. I do so below by using currency depreciation in the Ghanaian Cedi as an example of a domestic macroeconomic shock.

3.4.2 *Effects of remittances sent from abroad on households' expenditures in case of currency depreciation*

An episode of currency depreciation would increase the price of imported goods. As households' consumption basket becomes relatively more expensive, we can expect food to make up a larger share of households' total expenditures as rice and wheat, two staples in Ghanaian cuisine, represent 2.8% and 1.4% of imports respectively. Other non-food imported goods (such as modern agricultural inputs like fertilizers or insecticides) will also become relatively more expensive and will represent a larger share of households' total expenditures. However, households receiving remittances from abroad might be sheltered from these negative consequences in two ways: first, the supply of international remittances are not tied to Ghana's economic conditions (the ability to remit of a Ghanaian migrant living in Côte d'Ivoire doesn't depend on Ghana's economic outcomes, except in case of regional or international crisis). Thus, recipient households will have an external source of financing that will allow them to smooth their consumption, in contrast to other households. Additionally, since remittances received are exchanged from a foreign currency to the Ghanaian Cedi, a depreciation of the Cedi will increase the purchasing power of remittances denominated in another currency (Mandelman, 2013). Thus, recipient households can use remittances received from abroad to mitigate negative consequences from macroeconomic volatility. To assess this hypothesis, I run the following estimation:

$$\%\,exp\ on\ good_{\ i,d,t} = intl\ rem_{i,d,t} + pct\ change\ GH₵_{t} + intl\ rem_{i,d,t} * pct\ change\ GH₵_{\ i,d,t} + X_{i,d,t} + \delta_w + \delta_d + \delta_r + \varepsilon_{i,d,t} \quad (4)$$

with:

- $\%\exp\ on\ good_{i,d,t}$ either the log of total expenditures spent by household i living in district d at time t, or expenditures on either education, food or non-food items in percentage of total expenditures,

- $intl\ rem_{i,d,t}$ the value of remittances received from abroad by household i at time t and expressed in percentage of the recipient household's total income,
- $pct\ change\ in\ GH¢_t$ the annual percentage change in Ghanaian Cedi's exchange rate against the US Dollar. A positive change indicates a currency depreciation as it becomes more expensive to purchase one US dollar with Ghanaian Cedi,
- $X_{i,d,t}$ is the same vector of household controls as outlined in section a) above

Finally, I include GLSS wave, district and region fixed effects to account for unobserved heterogeneity across time periods and geographic areas. I also cluster standard errors at the regional level. Remittances received from abroad might help households decrease the food burden and increase spending on non-food and education categories. Additionally, I expect a depreciation in the national currency to increase the food and non-food burden in all households' expenses as some food items (rice and wheat) and non-food items (clothes, drugs, small electronic appliances, etc.) are largely imported. It could also decrease the percentage of expenses spent on education if total expenses increased faster than education's or if the household decreases education expenses due to the burden of other goods category (food and non-food). However, I expect the interaction variable between international remittances and currency depreciation to have a negative sign on food expenses and positive sign on other categories as remittances can be used as additional source of income and financing which would help households mitigate the negative impacts of the currency depreciation.

3.4.2 a) Identification

Equation (3) also suffers from a reverse causality problem as expected change in expenditures might bring households to ask for additional remittances. I instrument for international remittances received with the GDP per capita and unexpected negative shocks in currency exchange rates of the main Ghanaian migrants' destination countries.

I do not observe the specific country from which a remittance was sent. I do know however if it was sent from an ECOWAS country or from outside the African continent. According to the International Organization for Migration, Ghanaian migrants who settle in ECOWAS countries can mainly be found in Côte d'Ivoire, Burkina Faso, Nigeria and Guinea. On the other hand, Ghanaian migrants who settled outside of Africa migrated in majority to Canada, Germany, Italy, the Netherlands, United Kingdom and the United States. Using the stock of Ghanaian migrants in each of these countries in 2000 (IOM (2009), see Appendix B) as weight, I compute a weighted average of their annual GDP per capita, one for ECOWAS countries and another one for OECD countries. I also use their monthly exchange rates against the US Dollar and predict residuals using country-specific ARMA processes (see partial autocorrelations and autocorrelations in Appendix C). Similar to gold prices, I consider negative residuals to indicate unexpected negative shocks in the currency's exchange rate, which means that the currency appreciates, and compute the number of unexpected negative shocks over the last 12 months for each currency. Finally, I again use the Ghanaian diaspora stock in 2000 to create a weighted average of the number of unexpected negative exchange rate shocks, one for ECOWAS countries and another one for OECD countries. Because the diaspora stock is only available for the year 2000, I exclude households who were interviewed before 2000 from the estimations to alleviate endogeneity concerns as households' expenditures before 2000 might have influenced the stock of international migrants in 2000.In conclusion, I estimate the following two equations:

$$\widehat{intl\ rem}_{\ i,d,t} = weighted\ logGDPK_{i,d,t} + weighted\ neg\ shocks\ currency_{i,d,t} + weighted\ logGDPK_{i,d,t} * weighted\ neg\ shocks\ currency_{i,d,t} + X_{i,d,t} + \delta_w + \delta_d + \delta_r + \varepsilon_{i,d,t} \quad (5)$$

$$\%\ exp\ on\ good_{\ i,d,t} = \widehat{intl\ rem}_{i,d,t} + pct\ change\ GH₵_t + \widehat{intl\ rem}_{i,d,t} * pct\ change\ GH₵_{\ i,d,t} + X_{i,d,t} + \delta_w + \delta_d + \delta_r + \varepsilon_{i,d,t} \quad (6)$$

3.5 RESULTS

3.5.1 Exploratory results: Do gold prices impact remittances received from mining regions?

In this first section, I present exploratory results where I document how gold prices levels influence the amount of remittances received. The identification strategy outlined in section 3.4.1 above relies on the assumption that a surge in gold price will increase miners' income and the average income level in mining regions. Thanks to this increase in disposable income, miners will be able to send back additional remittances, assuming they are not budget constrained. This is shown in table 3.3 below which presents results from a fixed effects model in which remittances received over the last 12 months in percentage of total income are regressed on the average level of gold prices in the past year, the inverse distance between the household and the sender's region, the size of mining workforce in the region where the remittance sender lives, and the household level control variables described in section 3.4.1. I estimate the regression separately for the whole sample, the first quartile of income distribution, and the fourth quartile.

As expected, a 10% rise in average gold prices over the last 12 months will increase remittances received from mining regions in percentage of total income by 2.5 percentage points. The discrepancy can be explained by the fact that informal gold miners often sell their production to intermediaries in a parallel market at a price indexed on but lower than international market prices, mainly due to a lack of organization between miners and to asymmetric information between buyers and miners[51].

[51] Geological Society of London, 2005, "Sustainable Minerals Operations in the Developing World"

Table 3.3: Effects of gold prices levels on remittances received from mining regions

Dependent variable: remittances received from mining over total income	(1) Whole sample	(2) First quartile	(3) Fourth quartile
log (average gold price over the past 12 months)	0.253**	0.543*	0.212*
	(0.109)	(0.126)	(0.114)
Inverse of distance to sender's region	0.0668	0.237*	-0.0166
	(0.0528)	(0.112)	(0.0370)
Mining workforce in sender's region	0.0271***	0.0453**	0.0167**
	(0.00546)	(0.0150)	(0.00517)
Inverse of distance to sender's region*Mining workforce in sender's region	-0.0148	-0.0716**	0.0107
	(0.0143)	(0.0313)	(0.0121)
Male household head	-0.0119	0.0177	-0.0250***
	(0.00682)	(0.0151)	(0.00641)
Household head age	2.02e-05	0.000153	-0.000138
	(0.000112)	(0.000404)	(0.000139)
Household head finished primary school	0.00812**	0.0197	0.00596
	(0.00334)	(0.0150)	(0.00677)
Number of children	-0.00447***	-0.00594**	0.000600
	(0.000796)	(0.00211)	(0.000605)
Number of adult household members living away	-0.0253**	-0.0785	-0.0159**
	(0.00784)	(0.0675)	(0.00685)
Constant	72.34**	232.0	44.48**
	(23.18)	(202.8)	(19.56)
Observations	12,319	2,740	3,315
R-squared	0.236	0.415	0.387
District FE	YES	YES	YES
Region FE	YES	YES	YES
Year FE	YES	YES	YES

Clustered standard errors at regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Additionally, poorer households' remittances are more sensitive to gold price levels than wealthier households' as shown in columns (2) and (3). Following a 10% rise in the average gold price, remittances received from mining regions in percentage of total income will increase by 5.4 percentage points for households in the first quartile of income distribution, but only by 2.1 percentage points for households in the fourth quartile. As gold prices increase, remittances sent from mining regions will increase most significantly for poorer households as wealthier households have other financing options and rely less on these remittances. In our dataset, remittances received from mining regions represent on average 45% of total income for households in the first quartile of income distribution, but only 18% for households in the fourth quartile.

Hence, if other income sources are not likely to be impacted by the change in gold price, the weight of remittances in total income will increase more for poorer households than wealthier ones.

3.5.2 Effects of remittances sent from mining regions on households' expenditures in case of shocks in gold price

Since gold prices appear to significantly impact the amount of remittances received, I can now examine the effect of remittances received from mining regions on households' expenditures, and how this effect will be altered by a shock in remittances sources captured by the number of negative shocks in gold price over the last 12 months. Table 3.4 below presents results from estimating equations (2) and (3), with which I assess the effects of remittances received from mining regions at time t by household i living in district d on the household's expenditures. I then look at how these effects are impacted by a decrease in the supply of remittances, proxied by a negative shock in gold prices. I instrument for remittances sent from mining regions with the inverse distance between the household's district and the region from where the remittance was sent. I also use the number of households involved in mining activity in the sender' region as instrument to proxy for gold deposit size and labor competition in the region.

First stage results of the instrumental variable strategy indicate that households receive more remittances from the sender the closer the sender lives to the household. 68% of households surveyed reported to receive remittances in cash directly from the sender or from another person who was tasked with delivering the remittance on behalf of the sender. Thus, the closer the region where the sender lives, the more often he is likely to visit the recipient household. Similarly, the closer the sender's region, the greater the stock of migrants from the recipient household's city or village. Finding someone travelling to the household's place of residence and whom the sender trusts would be easier. This would increase the likelihood of receiving remittances carried by someone else other than the sender.

Table 3.4: Effects of mining remittances and gold price shocks on households' expenditures

VARIABLES	(1) Tot exp	(2) %Educ exp	(3) %Food exp	(4) %Non-food exp	(5) %Agri exp	(6) %Farm exp	(7) %Non-farm exp
Remittances sent from mining regions in percentage of total income	3.032	0.601**	-0.872	1.541***	-0.482*	-0.0619	-1.209
	(2.676)	(0.275)	(0.662)	(0.576)	(0.254)	(0.282)	(0.810)
Remittances sent from mining regions in percentage of total income * nb negative shocks in gold price in last 12 mo	-0.539	-0.101**	0.153	-0.242***	0.0733*	0.0128	0.178
	(0.404)	(0.0415)	(0.100)	(0.0873)	(0.0389)	(0.0431)	(0.122)
nb negative shocks in gold price in last 12 mo	0.0181	0.00838	-0.0364***	0.0259**	-0.00474	0.00330	-0.00123
	(0.0543)	(0.00558)	(0.0132)	(0.0114)	(0.00486)	(0.00548)	(0.0168)
Male household head	0.0456**	-0.0222***	-0.0170***	0.0222***	0.0234***	0.0277***	-0.0107
	(0.0228)	(0.00220)	(0.00529)	(0.00443)	(0.00178)	(0.00218)	(0.00696)
Household head age	-0.00752***	-0.000141**	0.00171***	-0.000460***	0.000107**	2.00e-05	-0.00113***
	(0.000666)	(6.89e-05)	(0.000162)	(0.000138)	(5.09e-05)	(6.33e-05)	(0.000195)
Household head finished primary school	0.266***	0.0176***	-0.0491***	0.0332***	-0.00802***	-0.0140***	0.0123*
	(0.0224)	(0.00232)	(0.00529)	(0.00483)	(0.00170)	(0.00198)	(0.00716)
Number of children	0.146***	0.0108***	-0.0102***	-0.00890***	0.00144***	0.00192***	0.00644***
	(0.00568)	(0.000546)	(0.00137)	(0.00115)	(0.000491)	(0.000561)	(0.00178)
Number of adult household members living away	0.0795***	-0.00485**	-0.00825	0.000296	0.00129	0.00812*	0.00468
	(0.0214)	(0.00225)	(0.00590)	(0.00428)	(0.00231)	(0.00444)	(0.00729)
Observations	7,677	7,677	7,677	7,677	7,677	7,677	7,677
R-squared	0.182	0.136	0.028	0.134	0.060	0.023	0.024
First stage results on Remittances sent from mining regions in percentage of total income							
Inverse of distance to sender's region			0.0843***				
			(0.0120)				
Mining workforce in sender's region			0.0486***				
			(0.00372)				
Inverse of distance to sender's region * Mining workforce in sender's region			-0.0239***				
			(0.00420)				

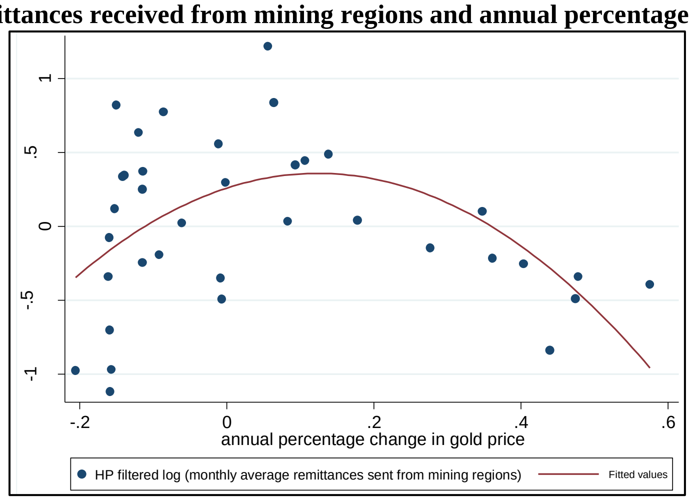
Clustered standard errors at regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Concerning the second stage, the amount of remittances received in percentage of total income appears to have a significant and positive effect on the shares of education and non-food items in households' total expenditures as a 1% increase in remittances in percentage of total income would increase education expenses by 0.6 percentage points in percentage of total expenditures, and by 1.54 percentage points for non-food expenditures. However, the effect on the level of total expenditures is positive but non-significant. The positive effects on the share of education and non-food items could result from expenses on education and non-food items increasing more rapidly than total expenditures. As documented in Combes & Ebeke (2011), by relaxing households' budget and capital constraints, remittances received from mining regions help recipients smooth their consumption over a longer period, enabling them to invest in human capital (Bansak and Chezum (2009)), durable and non-durable goods. This could also explain the negative effect of remittances on food expenditures (albeit nonsignificant): if households are assumed to already consume food at an adequate level, they wouldn't need to significantly increase their expenditures on food after receiving remittances. However, total expenditures would increase faster than food expenses, which would lead to a decrease in food burden in total expenditures.

Additionally, remittances are often studied in the literature as a way to provide an alternative source of financing but past studies have not really analyzed how a negative shock in remittances supply would impact households. To study this event, I use the number of negative shocks in gold price over the last 12 months of the household's interview date as an indicator for both macroeconomic and remittances volatility. Gold represents 49% of Ghana's exports and 27% of its foreign exchange source. An unexpected decline in gold price would decrease government's revenue because of lower exports value and lower royalties received from mining companies. Moreover, lower exports mean that demand for the Ghanaian currency (Cedi) will decrease and the Cedi will depreciate. This could increase the relative price of imported goods. This last point would explain why the effects of the number of unexpected shocks in gold price in the last 12 months has a strongly significant and positive impact on non-food items spending in percentage of total expenditure as non-food items listed in the survey include many imported goods (clothing, drugs, small electronic appliances, etc.). On the other hand, households seem to compensate for this increase in non-food items by decreasing expenditures on food which can be explained if they increase their consumption of domestically produced food (yams, plantains, etc.).

Looking at the interaction between remittances received and the number of unexpected negative shocks in gold price, positive effects of remittances on education and non-food items appear to be hampered by gold price shocks. The larger the share of remittances sent from mining regions in the household's total income, the more the household depend on these as a source of alternative financing and the more vulnerable it will be to negative changes in gold price. In fact, a decrease in gold price might lead remittances' senders working in the mining industry to either decrease the frequency at which they send these remittances or send less money overall as shown in figure 3.2 below. As gold prices decline (negative percentage change in gold price), remittances received from mining regions decline as well. Remittances increase during periods of gold price increase but after reaching a maximum around 20% increase in gold price; they decline again for the largest positive changes in gold price. In fact, following a large growth in gold price, the improvement of government's finances due to high commodities prices and general macroeconomic stability could reduce households' needs for remittances and help explain this non-linear relationship.

Figure 3.2: Log remittances received from mining regions and annual percentage change in gold price



So negative shocks in gold price will either decrease the level or stability of remittances sent from mining regions and a household which depends heavily on these for income will be negatively impacted. In particular, expenditures on education and non-food items in percentage of total expenses decline significantly. These households are penalized in two ways by the negative shock in gold prices: first, the macroeconomic environment may deteriorate and impact all households, but households which receive mining remittances may not able to mitigate this shock since part of their income sources is also tied to gold production.

Poorer households with few alternative sources of income and no savings option would be the most negatively impacted as shown below in table 3.5. This table presents results from the same estimating equations as table 3.4, but only for households in the first and fourth quartile of the income distribution. Remittances sent from mining regions appear to benefit households in both the first and fourth quartiles but in different ways. While remittances just increase the general level of expenditures for richer households without significantly changing the allocation of expenditures across categories, they seem to relieve poorer households' budget constraints as they significantly increase expenditures on education. However, a negative shock in gold price will decrease expenditures on education if the household depends heavily on remittances sent from mining regions as a source of income. These results remain the same when I use the level of expenditures (robustness test 1 in section 3.6 below) instead of categories expenses in percentage of total expenditures.

Table 3.5: Effects of mining remittances and gold price shocks on households' expenditures by quartiles

VARIABLES	(1) Tot exp	(2) %Educ exp	(3) %Food exp	(4) %Non-food exp	(5) Tot exp	(6) %Educ exp	(7) %Food exp	(8) %Non-food exp
	First quartile of income distribution				Fourth quartile of income distribution			
Remittances sent from mining regions in percentage of total income	0.785	0.794***	0.428	0.0403	23.65*	-0.417	-3.436	3.732
	(3.026)	(0.270)	(0.694)	(0.556)	(13.81)	(1.061)	(2.863)	(2.576)
Remittances sent from mining regions in percentage of total income * nb unexpected negative shocks in gold price in last 12 mo	-0.129	-0.117***	-0.0386	-0.00297	-3.486*	0.0650	0.559	-0.524
	(0.434)	(0.0391)	(0.0998)	(0.0799)	(1.973)	(0.151)	(0.412)	(0.369)
nb unexpected negative shocks in gold price in last 12 mo	0.0822	0.0176*	-0.0153	0.00124	0.0932	0.00397	-0.0279	0.0318
	(0.112)	(0.00988)	(0.0249)	(0.0200)	(0.107)	(0.00907)	(0.0243)	(0.0217)
Male household head	0.0110	-0.00962**	-0.0189*	0.0346***	0.0399	-0.0275***	-0.00728	0.0248*
	(0.0474)	(0.00410)	(0.0107)	(0.00779)	(0.0735)	(0.00586)	(0.0157)	(0.0136)
Household head age	-0.00930***	4.44e-05	0.000659*	0.000225	-0.00643***	-0.000122	0.00207***	-0.00119***
	(0.00144)	(0.000134)	(0.000364)	(0.000281)	(0.00208)	(0.000133)	(0.000488)	(0.000386)
Household head finished primary school	0.182***	0.00141	-0.0361***	0.0450***	0.147***	0.0315***	-0.0222*	0.0494***
	(0.0487)	(0.00463)	(0.0114)	(0.00960)	(0.0513)	(0.00433)	(0.0116)	(0.00965)
Number of children	0.159***	0.0115***	-0.00137	-0.00957***	0.117***	0.0128***	-0.00791***	-0.00424**
	(0.0126)	(0.00111)	(0.00300)	(0.00243)	(0.0108)	(0.000753)	(0.00222)	(0.00178)
Number of adult household members living away	0.183**	-0.0212***	0.0595***	0.0162	0.00591	-0.00309	-0.0209**	-0.00225
	(0.0747)	(0.00748)	(0.0193)	(0.0166)	(0.0467)	(0.00434)	(0.0104)	(0.00964)
Observations	1,758	1,758	1,758	1,758	2,097	2,097	2,097	2,097
R-squared	0.166	0.132	0.021	0.045	0.111	0.175	0.119	0.166

Clustered standard errors at regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

An interesting result is the increase in poorer households' education expenditures following an increase in negative gold price shocks. However, as gold price decreases, the government's revenues decline. To compensate, the central government may decrease public services provision or increase public services' costs to public, including education. In Ghana, school is compulsory until 15 years old and public schools are free. However, a recent report from the Results for Development Institute (2015) based on households and schools' surveys, found that public schools were actually relatively expensive for poorer households when including all adjacent and hidden costs. Households whose children are enrolled in public schools reported having to pay additional fees, mainly in meals and transportation. The government could try to compensate for a decline in expenditure in the education sector by increasing adjacent fees on households, which could help explain the increase in education spending.

3.5.3 Effects of remittances sent from abroad on households' expenditures in case of currency depreciation

In this section, I analyze results from equations (5) and (6) which estimate the effects of remittances received from abroad on households' expenditures pattern and how a currency depreciation, captured by the annual percentage change in the Ghanaian Cedi, might alter these effects. Results are presented in Table 3.6 below. In the first stage, remittances received from abroad increase significantly following a rise in the GDP per capita of Ghanaian migrants' main destination countries weighted by diaspora stock in 2000 (ECOWAS countries: Burkina Faso, Côte d'Ivoire, Guinea, Nigeria; and OECD countries: Canada, Germany, Italy, the Netherlands, United Kingdom, United States). Economic growth in a migrant's destination country can have positive impacts on his income as he may receive a higher wage or additional welfare from the government. This might translate in a larger level of remittances sent back home as the purchasing power and disposable income of the migrant increase. Additionally, a negative shock in destination countries' exchange rate (against the US Dollar and also weighted by diaspora stock in 2000) represents a currency appreciation which might increase remittances received in Ghanaian Cedi. For example, following an appreciation of the Euro, a Ghanaian migrant living in the Euro zone will be able to send higher levels of remittances denominated in Ghanaian Cedi compared to before the Euro appreciation, and for the same amount of Euros sent. Thus, the effect of a weighted foreign currency appreciation has a positive and significant effect on the amount of remittances received in percentage of total income. The interaction between the GDP per capita and currency appreciation is also positive but not significant.

Table 3.6: Effects of remittances sent from abroad on households' expenditures in case of currency depreciation

VARIABLES	(1) Tot exp	(2) %Educ exp	(3) %Food exp	(4) %Non-food exp	(5) %Agri exp	(6) %Farm exp	(7) %Non-farm exp
Remittances sent from abroad in percentage of total income	2.682	-0.0478	-0.0882	0.790*	-0.0918	-0.461*	-0.193
	(4.224)	(0.240)	(0.504)	(0.467)	(0.132)	(0.238)	(0.581)
Remittances sent from abroad in percentage of total income * annual percentage change of Ghanaian Cedis	43.79***	-1.100	-5.052**	-1.340	0.768	1.534*	5.958**
	(16.80)	(0.795)	(2.011)	(1.791)	(0.502)	(0.818)	(2.420)
annual percentage change of Ghanaian Cedis	-5.988**	0.139	0.628*	0.155	-0.152*	-0.247*	-0.674
	(2.962)	(0.138)	(0.360)	(0.314)	(0.0867)	(0.139)	(0.435)
Male household head	0.593*	-0.0359**	-0.0650*	0.0626*	0.0111	-0.0108	0.0491
	(0.306)	(0.0178)	(0.0387)	(0.0378)	(0.00942)	(0.0180)	(0.0438)
Household head age	-0.00755*	-9.27e-05	0.00178***	-0.000202	0.000529***	0.000713***	-0.00220***
	(0.00446)	(0.000185)	(0.000543)	(0.000472)	(0.000120)	(0.000233)	(0.000583)
Household head finished primary school	0.197	0.0214***	-0.00942	0.0126	-0.0142***	-0.0115	-0.0132
	(0.129)	(0.00770)	(0.0171)	(0.0160)	(0.00333)	(0.00731)	(0.0203)
Number of children	0.314***	0.0162***	-0.0322***	0.000531	-0.000428	-0.00519	0.0206**
	(0.0712)	(0.00398)	(0.00874)	(0.00844)	(0.00215)	(0.00413)	(0.0102)
Number of adult household members living away	0.000628***	1.29e-05***	-1.44e-05	7.59e-07	-2.05e-06	-1.36e-06	2.08e-06
	(7.74e-05)	(4.27e-06)	(1.01e-05)	(9.61e-06)	(2.29e-06)	(4.53e-06)	(1.14e-05)
Observations	1,977	1,977	1,977	1,977	1,977	1,977	1,977
R-squared	0.165	0.006	0.373	0.190	0.066	0.158	0.395

First-stage results on Remittances sent from abroad in percentage of total income	
log (weighted GDP per capita)	0.0124**
	(0.0309)
Number of unexpected negative shocks in weighted foreign currencies' exchange rates	0.00347*
	(0.0465)
log (weighted GDP per capita) * Number of unexpected negative shocks in weighted foreign currencies' exchange rates	0.000143
	(0.00529)

Clustered standard errors at regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

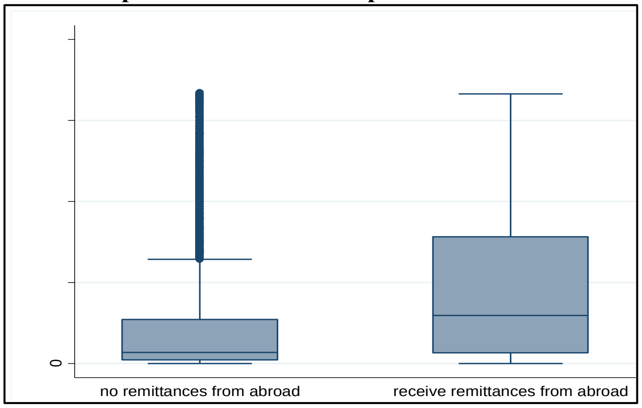
Secondly, remittances received from abroad appear to alleviate households' budget constraints as they significantly increase non-food expenses in percentage of total expenditures: a 1% increase in remittances in percentage of total income will increase non-food expenses in percentage of total expenses by 0.79 percentage points. Increase in total expenditures is also positive but not significant. Additionally, a depreciation in Ghanaian Cedi increases total expenditure and food items in percentage of total expenses. In fact, as the Cedi becomes weaker against the US Dollar, it becomes more expensive to purchase imported goods, which might comprise some food items (rice, wheat, etc.) and non-food items (clothing, small electronics, etc.). According to the USDA[52],

[52] USDA Foreign Agricultural Service, 2018, "Ghana, 2018 Grain and Feed Annual"

rice and wheat consumption in Ghana far exceed national production and the country imports respectively an estimated 620,000 and 820,000 tons annually. Consequently, following a 1% increase in the Ghanaian Cedi, food expenditures will increase by 0.63 percentage points of total expenses, and will decrease log of total expenditures by 6.

However, looking at the interaction between remittances received and currency depreciation, households appear to use these remittances as a way to mitigate the negative impacts of the shock. The larger the remittances received from abroad in percentage of income, the more households are able to mitigate the negative macroeconomic shock: food burden is lessened as an increase in 1% in remittances (in percentage of total income) will decrease food spending in percentage of total expenditures by 5 percentage points compared to households who don't have access to international remittances. Moreover, an increase of 1% in remittances received from abroad in percentage of total income will increase recipient households' total expenditures by 400% compared to households who do not have access to these remittances. While these estimates can seem large, the data exhibits great inequality in terms of consumption and household income (as shown in the boxplot 3.3 below). Additionally, table 3.2 with summary statistics on remittances shows that remittances sent from abroad are on average four times larger than domestic remittances. Finally, households who receive international remittances are better educated and might be more equipped to capitalize and maximize their use of the remittances.

Figure 3.3: Boxplot of households' expenditures in Ghanaian Cedi



Thus, remittances sent from abroad seem to allow recipient households to effectively mitigate negative national macroeconomic shocks as the source and availability of international remittances are not tied to the Ghanaian economic context, compared to the remittances sent from mining regions as described in the previous section.

This result holds particularly for poorer households as shown in table 3.7 which presents the estimation results for households in the bottom 50% and the fourth quartiles of the income distribution. While results are not significant for richer households who might have access to additional hedging options against macroeconomic shocks (savings, selling of durable assets, etc.), poorer households' results are similar to the whole sample's results. Their total expenditures decrease following a currency depreciation but they can mitigate these negative impacts if they have access to international remittances compared to poorer households who do not have access to international remittances. These results hold when I use level of expenditures instead of categories expenses in percentage of total expenditures in the robustness tests in section 3.6.

Table 3.7: Effects of remittances sent from abroad on households' expenditures in case of currency depreciation by quartiles

VARIABLES	(1) Tot exp	(2) %Educ exp	(3) %Food exp	(4) %Non-food exp	(5) Tot exp	(6) %Educ exp	(7) %Food exp	(8) %Non-food exp
	Bottom 50% of income distribution				Fourth quartile of income distribution			
Remittances sent from abroad in percentage of total income	-4.210	0.436	0.824	0.0387	1.522	-0.0597	-0.324	0.954
	(4.031)	(0.537)	(0.893)	(0.510)	(4.171)	(0.502)	(0.584)	(0.582)
Remittances sent from abroad in percentage of total income * annual percentage change of Ghanaian Cedis	20.49***	-0.551	-0.888	-0.714	37.21	-2.847	-2.344	-2.393
	(7.601)	(0.931)	(1.662)	(1.129)	(28.05)	(3.414)	(4.089)	(3.862)
annual percentage change of Ghanaian Cedis	-5.099*	0.238	0.172	0.369	-4.134	0.395	0.236	0.190
	(3.024)	(0.366)	(0.735)	(0.445)	(4.008)	(0.478)	(0.583)	(0.531)
Male household head	-0.0406	-0.0225	0.00182	-0.00177	0.503*	-0.0728**	-0.0592	0.0851*
	(0.193)	(0.0237)	(0.0388)	(0.0231)	(0.268)	(0.0323)	(0.0470)	(0.0441)
Household head age	0.00171	-0.00186	-0.000248	-0.000380	-0.000484	-0.000208	0.00166**	0.000193
	(0.0136)	(0.00194)	(0.00301)	(0.00177)	(0.00498)	(0.000466)	(0.000687)	(0.000637)
Household head finished primary school	0.528*	-0.000552	-0.0642	0.0159	0.170	0.0251*	0.00264	0.0288
	(0.298)	(0.0413)	(0.0654)	(0.0330)	(0.139)	(0.0146)	(0.0209)	(0.0180)
Number of children	0.125	0.0325*	0.00521	-0.0196	0.179***	0.0174***	-0.0178***	-0.00667*
	(0.123)	(0.0173)	(0.0282)	(0.0160)	(0.0224)	(0.00235)	(0.00399)	(0.00357)
Number of adult household members living away	0.000822***	-3.89e-06	-4.01e-05**	1.09e-05	0.000654***	2.51e-05***	-1.24e-05	2.28e-06
	(0.000106)	(1.21e-05)	(1.96e-05)	(1.22e-05)	(6.24e-05)	(7.88e-06)	(1.25e-05)	(1.13e-05)
Observations	355	355	355	355	1,087	1,087	1,087	1,087
R-squared	0.259	0.172	0.196	0.075	0.046	0.125	0.145	0.385

Clustered standard errors at regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

3.5.4 Comparison of results across remittances, households and types of shocks

Results presented earlier indicate that households who receive remittances (domestic or international) use these remittances as an additional source of income as documented in Banzak & Chezum (2009) or in Qin & Liao (2016). Both richer and poorer households increase total expenditures, and while households in the higher quartiles of the income distribution do not alter their expenditures pattern, credit constrained households are able to relax their budget constraint and use remittances to increase relative spending in education and non-food items. However, a key difference between poorer and richer households is the type of remittances they have access to. 19% of poorer households receive remittances sent from abroad, compared to 32% of households in the fourth quartile of income distribution, signaling that transportation and migration costs are still too high for some households. In comparison, 15% of households in the first quartile of income distribution receive remittances sent from mining regions, compared to 12% in the fourth quartile. The fact that richer households receive larger international remittances compared to poorer households which receive smaller domestic remittances might explain the positive effects of remittances on inequality observed in some articles (Möllers & Meyer (2014), Adams et al. (2008), Taylor et al (2005)). A consequence of this disparity in remittances origin is that poorer households rely on remittances that are tied to domestic economic conditions while richer households receive remittances which are not (as long as international and regional conditions are not correlated with Ghana's economic outcomes). In case of a shock in the domestic economy, poorer households will be doubly penalized as they have less financing and savings options as richer households, but the remittances they receive are also likely to decrease compared to wealthier households. For the latter, international remittances would not be tied to national economic context and would either stay stable or even increase depending on the altruism of the remittance sender. Thus, while expenditures decline for poorer households receiving internal remittances (primarily in discretionary categories such as education that would hamper human capital accumulation), expenditures increase for richer households receiving international remittances. Several past studies have found that international remittances could reduce inequality, as transportation costs decline and out-migrations become cheaper. However, these results could be overturned with macroeconomic instability and domestic economic shocks. Poorer households would then gain from receiving additional safety nets from governments to help them smooth consumption by compensating for the decline in internal remittances received.

3.6 ROBUSTNESS TESTS

3.6.1 Using levels of expenditures

The tables in Appendix D present robustness test 1 in which I use the level of expenditures per category, instead of categories' expenditures in percentage of total expenses. Results in Table D.1 present estimations from the mining remittances and are similar to section 3.5.2 above. As households receive additional remittances from mining regions, they are able to relax their budget and capital constraints which become less binding. This enables them to spend more in education and non-food items (which include drugs and many discretionary spending categories such as small household furniture, electronic appliances, etc.). These results are encouraging as households are able to invest in human capital accumulation and health. This supports earlier findings in the literature showing that remittances improve health outcomes and educational attainments (Banzak & Chezum (2009), Amega (2018), Zhunio et al (2012)). However, these gains are decreased in the case of negative domestic shocks, mainly for households which depend heavily on remittances as an additional source of income. Following a negative shock in gold price, an increase in the amount of remittances received by 1% from mining regions decreases their spending level in education and non-food items by 0.01% and 0.03% respectively. This could be due to the foreseen instability in remittances tied to gold prices. This result is reversed for households receiving international remittances following a currency depreciation: larger amounts of remittances received from abroad will protect recipient households and mitigate the negative effects of challenging economic conditions.

3.6.2 Using gold price volatility instead of unexpected shocks

The table in Appendix D.2 presents results from the effects of remittances sent from mining regions following a change in gold price. Instead of using the number of unexpected negative shocks in gold price, I use the standard deviation in gold price over the past 12 months of the household being interviewed. Over the time period of the surveys used in this paper (1988-2013), gold price has increased dramatically as shown in figure 3.4 below, especially following the 2008 financial crisis as gold was considered a safer asset than other markets assets. As a result, higher volatility in the dataset is associated with higher gold prices (figure 3.5 below).

Figure 3.4: Monthly gold prices, 1988-2013

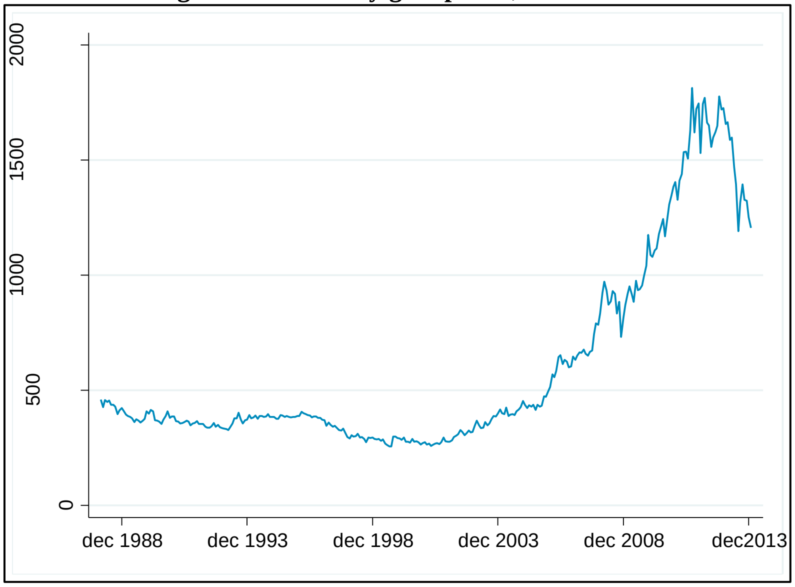


Figure 3.5: Monthly gold prices, levels and standard deviation, 1988-2013

While coefficients for the effects of remittances in percentage of total income are approximately of the same size and sign as in the main regressions, interaction coefficients between remittances and gold price standard deviation become significantly positive, specifically for food and non-farm business expenses. The larger the volatility in gold price (and thus the larger the increase in gold price), the larger government's revenue and the stronger the improvement in economic conditions, which explains the negative effect of gold price volatility on food burden. Additionally, food burden will also decrease for households receiving remittances from mining regions. However, the interaction coefficient between gold price volatility and remittances received as a percentage of total income is positive. This somewhat puzzling result can be explained by the lifecycle theory: as the volatility in income source increases, households will smooth out consumption in food and thus the decline in food expenditure will be smaller compared to less volatile periods.

3.7 Conclusion

In this paper, I study the effects of remittances on recipient households' expenditures by categories in Ghana with two different type of remittances (remittances received from mining regions and from abroad). There is a rich literature on how remittances impact poverty level and other development outcomes in recipient countries. However, the majority of the literature focuses on the impact of international remittances whereas internal remittances might also improve households' welfare but are more likely to be unstable, tied to national economic conditions and in general much smaller than remittances received from abroad. As a result, effects on poverty might be less obvious as budget and capital constraints of recipient households can still be binding. To study the effects of internal remittances on households' expenditures, I use the remittances sent from Ghanaian gold producing regions and address endogeneity with an instrumental variable strategy using both the inverse distance between the sender's region and the recipient household's district, and the mining workforce in the sender's region as instruments for the amount of remittances received from mining regions. These remittances significantly alleviate households' budget constraints as expenditures in education and non-food items increase in percentage of total expenses, notably for poorer households. However, an increase in the number of unexpected negative shocks in gold price will increase mining revenue's instability and make future remittances more uncertain. This will decrease the rise in education and non-food items expenditure and will hamper the positive impacts of mining remittances.

I then look at the effects of remittances received from abroad on household's expenditures by controlling for endogeneity with another instrumental variable strategy: I instrument for the amount of remittances received from abroad using the average GDP per capita and negative unexpected shocks in the exchange rate of the main destination countries of Ghanaian migrants, weighted by the diaspora stock in 2000. An increase in international remittances has large positive impacts on total expenditures and expenses on non-food item, mainly for households in the lower 50% of income distribution. In case of economic instability, captured with the percentage change in national currency's exchange rate, households receiving remittances from abroad appear to fare much better than households which do not receive these types of remittances. Recipient households appear to be protected from economic downturn and currency depreciation by the remittances they receive. In fact, these remittances are not tied to Ghana's economic conditions and could prove more stable than other sources of income in case of economic volatility. Additionally, because of the currency depreciation, remittances sent from another country will be worth more compared to before the depreciation and recipient households' purchasing power will increase.

These results indicate that the effects of remittances on households' expenditures will be different depending on the source of the remittances. Remittances sent from mining regions appear to relax recipient households' budget constraints as they increase the expenses in education and non-food items, and reallocate their expenditures more optimally. This is less the case for households who receive remittances from abroad: their overall expenditure level increases but they do not reallocate expenses across categories. This might be explained by households' characteristics as households who receive remittances from abroad are better educated and wealthier than those who receive remittances from mining regions. Richer households might have non-biding budget constraints compared to poorer households and thus might already have near-optimal expenditure allocations even without remittances. Additionally, the results in this paper indicate that wealthier households are better protected than poorer ones during periods of economic instability: not only do they have access to more savings options, but they also receive stable, supplementary income from abroad compared to poorer households whose additional financing options (internal remittances) are tied to macroeconomic conditions. Remittances could then be another source of inequality if governments do not correct for this additional income source discrepancy.

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APPENDIX A - PARTIAL AUTOCORRELOGRAM AND AUTOCORRELOGRAM OF GOLD PRICE FOR ARMA PROCESS SPECIFICATION

Figure A.1: Partial Autocorrelogram

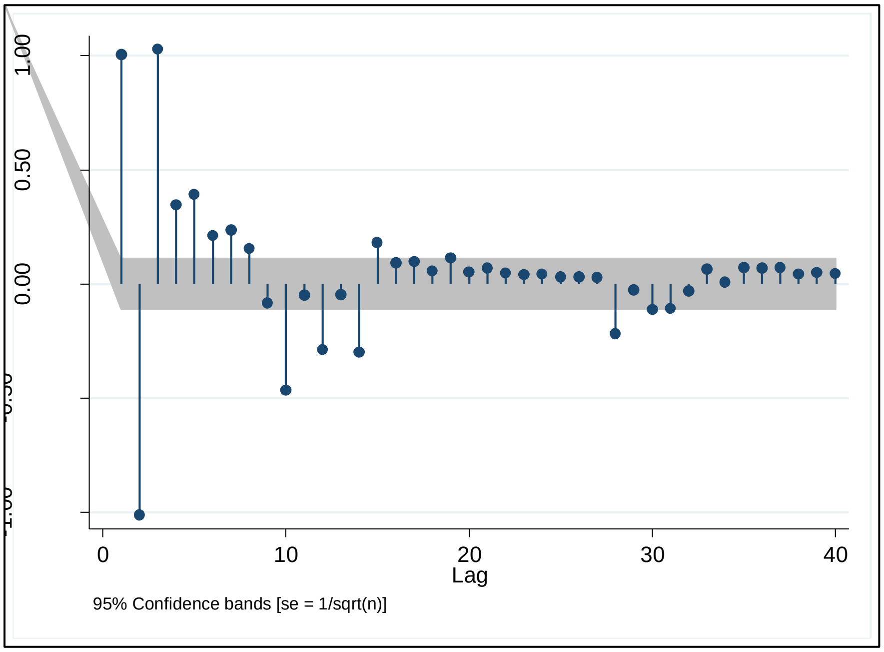
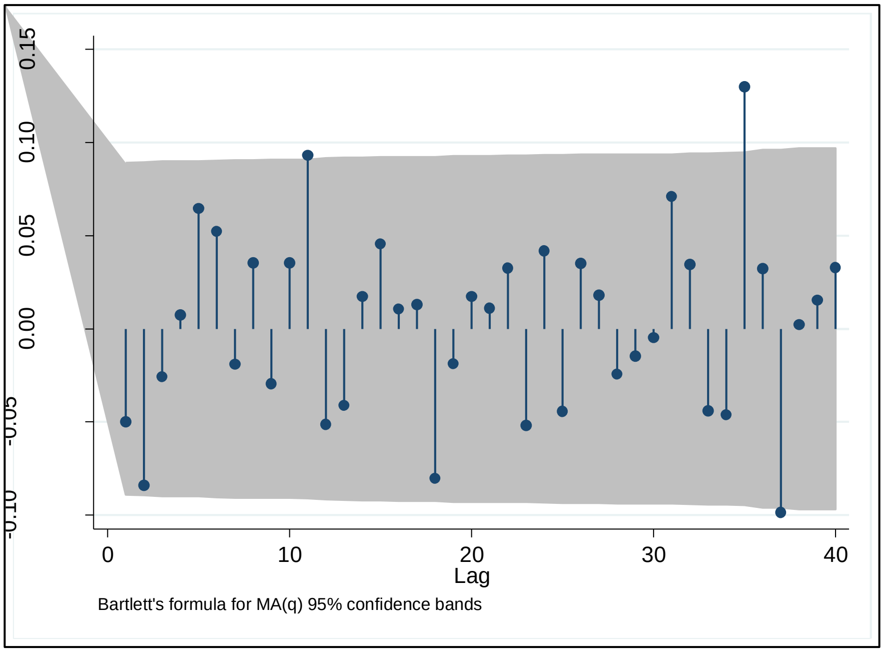


Figure A.2: Correlogram



APPENDIX B – GHANAIAN DIASPORA STOCK IN 2000

Figure B.1: Ghanaian diaspora in main ECOWAS countries

ECOWAS countries	
Burkina Faso	93,320
Côte d'Ivoire	305,648
Guinea	86,209
Nigeria	125,052

Source: OIM, 2009

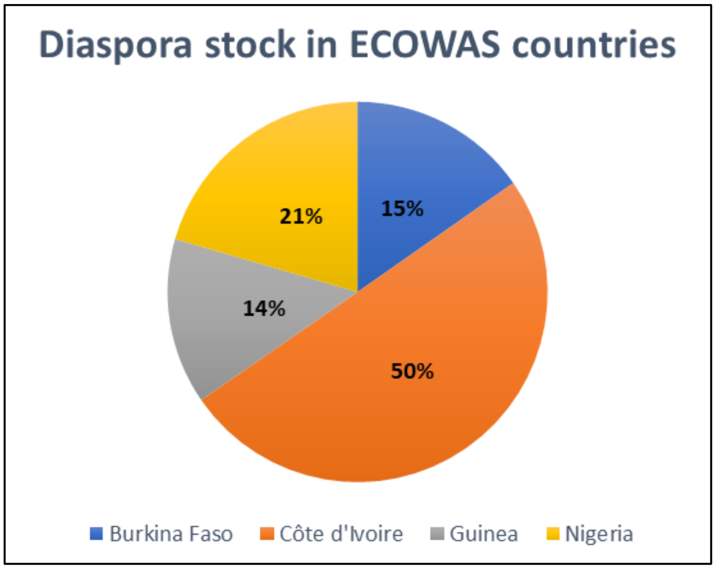
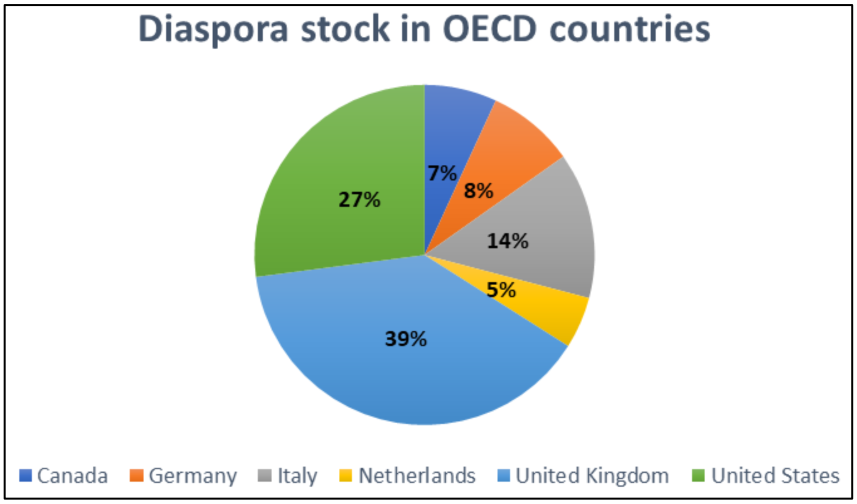


Figure B.2: Ghanaian diaspora in main OECD countries

OECD countries	
Canada	17,070
Germany	20,636
Italy	34,499
Netherlands	12,196
United Kingdom	96,650
United States	67,190

Source: OIM, 2009



APPENDIX C – PARTIAL AUTOCORRELOGRAMS AND AUTOCORRELOGRAMS OF ECOWAS AND OECD COUNTRIES' EXCHANGE RATES FOR COUNTRY-SPECIFIC ARMA PROCESS SPECIFICATION

Figure C.1: ECOWAS countries

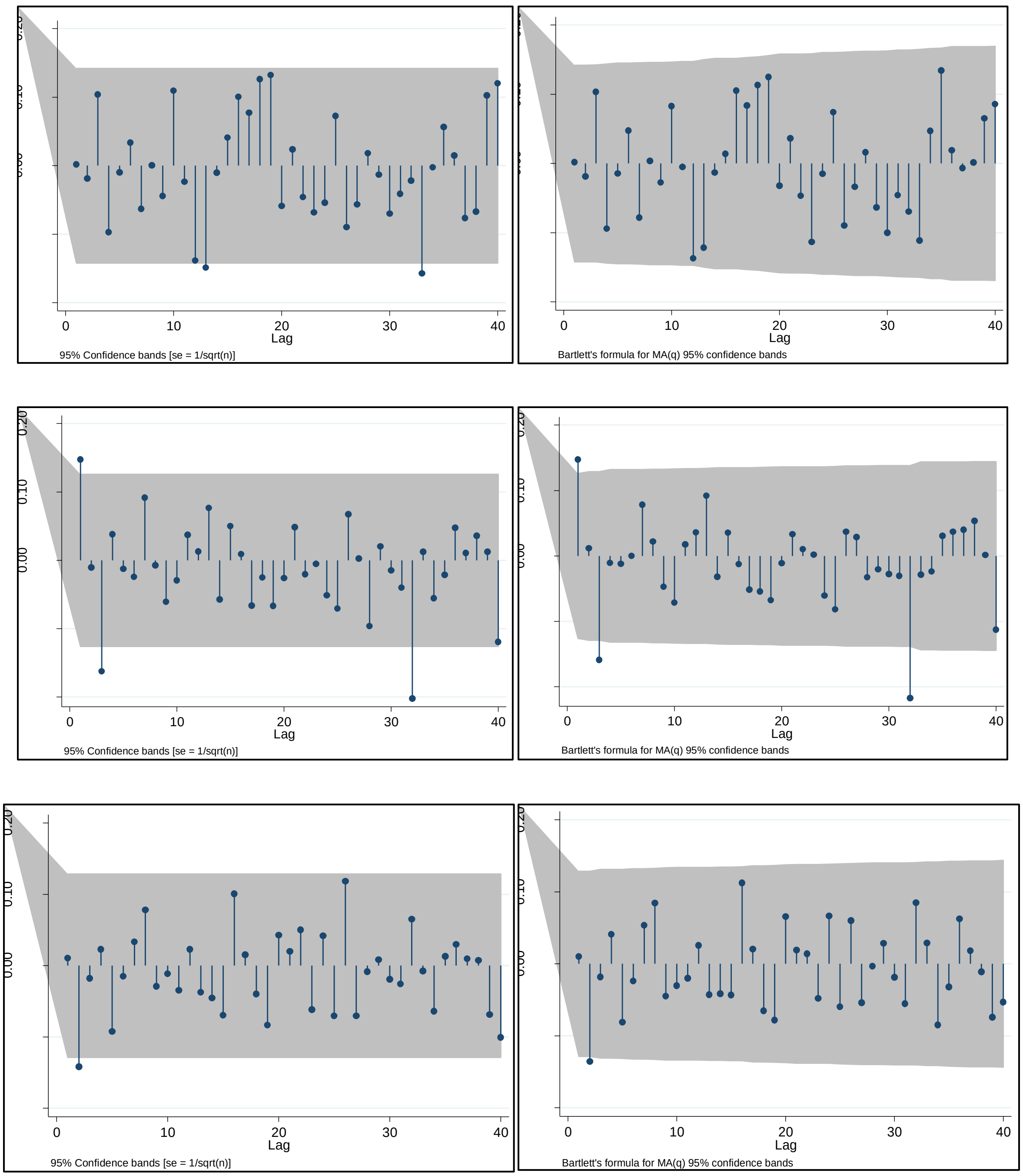
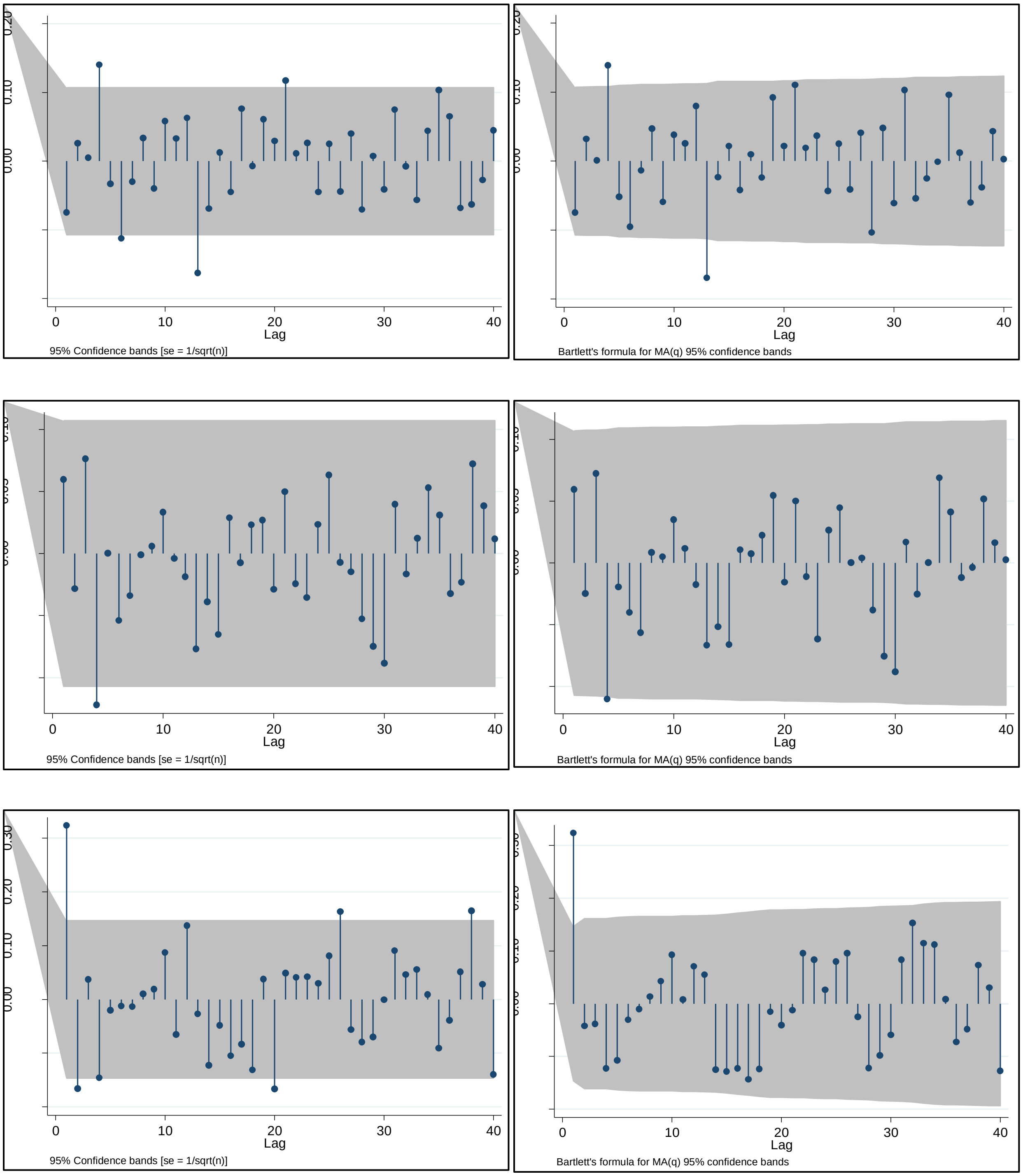
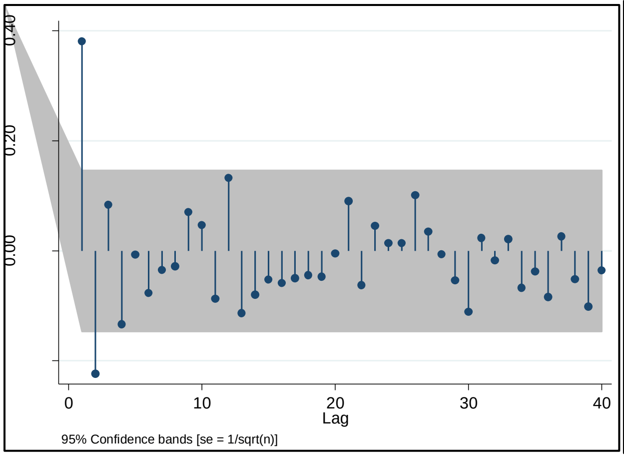
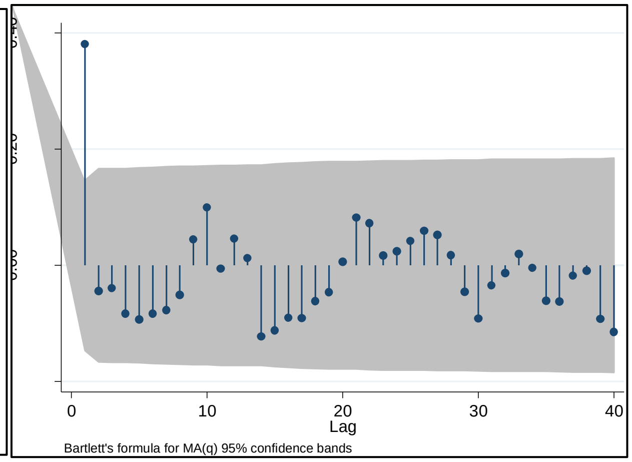
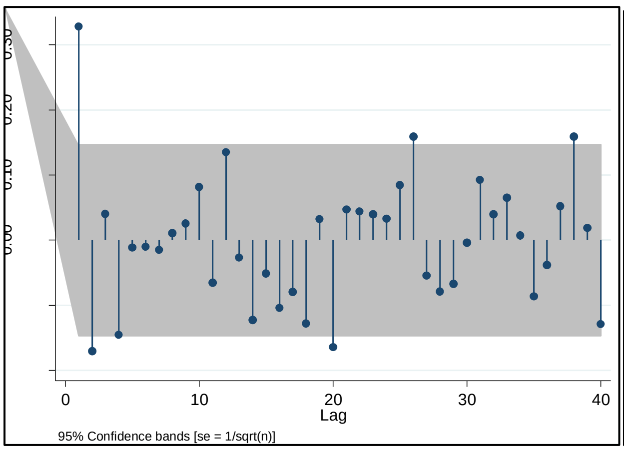


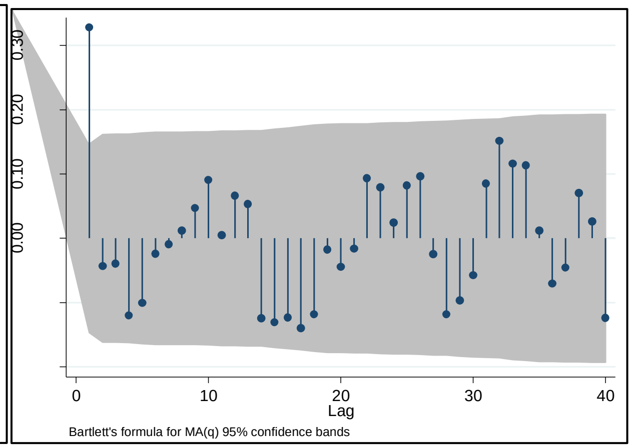
Figure C.2: OECD countries

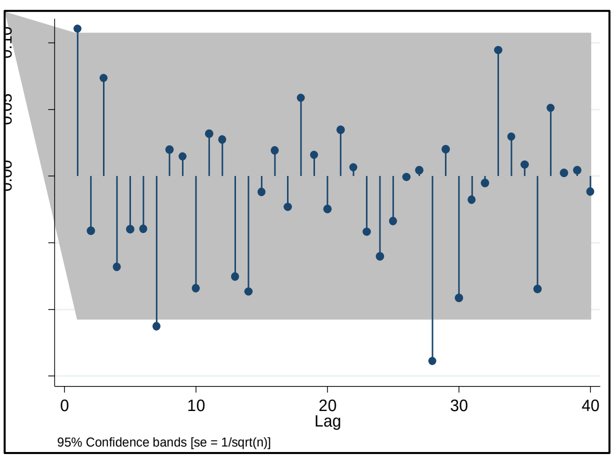


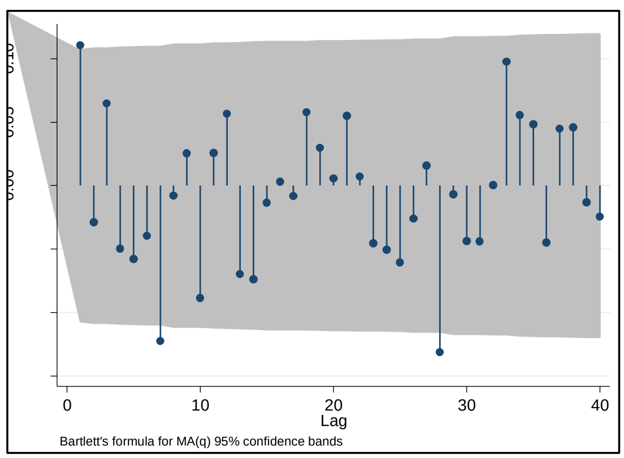

0.40
0.20
0.00
0
10
20
30
40
Lag
95% Confidence bands [se = 1/sqrt(n)]


0
10
20
30
40
Lag
Bartlett's formula for MA(q) 95% confidence bands


0
10
20
30
40
Lag
95% Confidence bands [se = 1/sqrt(n)]


0.30
0.20
0.10
0.00
0
10
20
30
40
Lag
Bartlett's formula for MA(q) 95% confidence bands


0
10
20
30
40
Lag
95% Confidence bands [se = 1/sqrt(n)]


0
10
20
30
40
Lag
Bartlett's formula for MA(q) 95% confidence bands

APPENDIX D – ROBUSTNESS TESTS

D.1 ROBUSTNESS TEST 1

Table D.1.1: Mining remittances – Using levels of expenditures and levels of remittances

VARIABLES	(1) Tot exp	(2) Educ exp	(3) Food exp	(4) Non-food exp	(5) Agri exp	(6) Farm exp	(7) Non-farm exp
Log (remittances received from mining regions)	0.121	0.0190***	-0.0373*	0.0477***	-0.0139*	-0.00397	-0.0254
	(0.0794)	(0.00705)	(0.0197)	(0.0154)	(0.00717)	(0.00819)	(0.0226)
Log (remittances received from mining regions) * nb unexpected negative shocks in gold price in last 12 mo	-0.0187	-0.00290***	0.00573**	-0.00702***	0.00201*	0.000630	0.00356
	(0.0115)	(0.00102)	(0.00286)	(0.00223)	(0.00105)	(0.00119)	(0.00328)
nb unexpected negative shocks in gold price in last 12 mo	0.0700	0.0139**	-0.0529***	0.0363***	-0.00698	0.000792	0.00189
	(0.0654)	(0.00590)	(0.0162)	(0.0127)	(0.00576)	(0.00657)	(0.0190)
Male household head	0.0607***	-0.0197***	-0.0210***	0.0264***	0.0222***	0.0272***	-0.0128**
	(0.0206)	(0.00187)	(0.00480)	(0.00384)	(0.00145)	(0.00189)	(0.00620)
Household head age	-0.00771***	-0.000164**	0.00178***	-0.000507***	0.000118**	3.21e-05	-0.00114***
	(0.000715)	(6.50e-05)	(0.000167)	(0.000134)	(5.06e-05)	(6.50e-05)	(0.000197)
Household head finished primary school	0.267***	0.0172***	-0.0493***	0.0327***	-0.00780***	-0.0139***	0.0133*
	(0.0224)	(0.00219)	(0.00529)	(0.00462)	(0.00166)	(0.00196)	(0.00702)
Number of children	0.152***	0.0118***	-0.0118***	-0.00720***	0.00102***	0.00173***	0.00550***
	(0.00462)	(0.000407)	(0.00108)	(0.000860)	(0.000344)	(0.000400)	(0.00140)
Number of adult household members living away	0.0976***	-0.00197	-0.0135**	0.00493	-3.20e-05	0.00717*	0.00339
	(0.0205)	(0.00201)	(0.00586)	(0.00400)	(0.00199)	(0.00435)	(0.00699)
Observations	7,682	7,682	7,682	7,682	7,682	7,682	7,682
R-squared	0.152	0.163	0.130	0.161	0.017	0.029	0.007
First stage results on log (remittances received from mining regions)							
inverse of distance to sender's region					4.547***		
					(0.282)		
Mining workforce in sender's region					3.002***		
					(0.101)		
c.inverse of distance to sender's region#c.Mining workforce in sender's region					1.151***		
					(0.101)		

Clustered standard errors at regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table D.1.2: Mining remittances – Using levels of expenditures and levels of remittances, by quartile

VARIABLES	(1) Tot exp	(2) Educ exp	(3) Food exp	(4) Non-food exp	(5) Tot exp	(6) Educ exp	(7) Food exp	(8) Non-food exp
	First quartile of income distribution				Fourth quartile of income distribution			
Log (remittances received from mining regions)	0.0415	0.0448***	-0.0125	0.00939	-0.0411	0.00696	0.0341	0.0943***
	(0.174)	(0.0164)	(0.0418)	(0.0306)	(0.130)	(0.0108)	(0.0334)	(0.0318)
Log (remittances received from mining regions) * nb unexpected negative shocks in gold price in last 12 mo	-0.00679	-0.00675***	0.00292	-0.00130	0.00423	-0.000918	-0.00419	-0.0131***
	(0.0261)	(0.00247)	(0.00629)	(0.00461)	(0.0177)	(0.00148)	(0.00456)	(0.00434)
nb unexpected negative shocks in gold price in last 12 mo	0.0909	0.0288**	-0.0375	0.00738	-0.107	0.0110	0.0149	0.0594***
	(0.149)	(0.0132)	(0.0351)	(0.0257)	(0.0855)	(0.00779)	(0.0232)	(0.0226)
Male household head	0.00889	-0.0114**	-0.0153	0.0340***	0.107**	-0.0292***	-0.0274***	0.0355***
	(0.0500)	(0.00446)	(0.0114)	(0.00810)	(0.0437)	(0.00433)	(0.0102)	(0.00949)
Household head age	-0.00933***	6.44e-06	0.000690*	0.000210	-0.00438***	-0.000181	0.00165***	-0.00121***
	(0.00146)	(0.000146)	(0.000377)	(0.000281)	(0.00146)	(0.000111)	(0.000350)	(0.000329)
Household head finished primary school	0.182***	0.00195	-0.0337***	0.0452***	0.140***	0.0322***	-0.0194*	0.0594***
	(0.0484)	(0.00477)	(0.0114)	(0.00954)	(0.0481)	(0.00439)	(0.0117)	(0.0106)
Number of children	0.161***	0.0123***	-0.00173	-0.00985***	0.114***	0.0129***	-0.00706***	-0.00501***
	(0.0114)	(0.00108)	(0.00277)	(0.00218)	(0.00951)	(0.000739)	(0.00210)	(0.00180)
Number of adult household members living away	0.187**	-0.0237***	0.0573***	0.0131	0.0145	-0.00320	-0.0258***	0.00291
	(0.0775)	(0.00765)	(0.0197)	(0.0169)	(0.0363)	(0.00431)	(0.00846)	(0.00926)
Observations	1,758	1,758	1,758	1,758	2,097	2,097	2,097	2,097
R-squared	0.156	0.165	0.005	0.048	0.115	0.205	0.031	0.166

Clustered standard errors at regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table D.1.3: International remittances – Using levels of expenditures and levels of remittances

VARIABLES	(1) Tot exp	(2) %Educ exp	(3) %Food exp	(4) %Non-food exp	(5) %Agri exp	(6) %Farm exp	(7) %Non-farm exp
log (remittances received from abroad)	0.217**	-0.00495	-0.0177	0.0339**	-0.00295	-0.0195**	0.00828
	(0.0892)	(0.0105)	(0.0183)	(0.0155)	(0.00566)	(0.00788)	(0.0240)
log (remittances received from abroad) * annual percentage change of Ghanaian Cedis	1.308***	-0.0295	-0.158**	-0.107	0.0435*	0.108***	0.187*
	(0.355)	(0.0390)	(0.0735)	(0.0680)	(0.0257)	(0.0361)	(0.0982)
annual percentage change of Ghanaian Cedis	-16.47***	0.356	1.938*	1.399	-0.620*	-1.475***	-2.217
	(4.883)	(0.534)	(1.015)	(0.939)	(0.353)	(0.497)	(1.352)
Male household head	0.151***	-0.0259***	-0.0300***	0.0185*	0.0126***	0.0107***	0.0267*
	(0.0483)	(0.00567)	(0.0109)	(0.00950)	(0.00316)	(0.00391)	(0.0145)
Household head age	-0.00565***	-0.000128	0.00164***	-1.64e-05	0.000522***	0.000625***	-0.00212***
	(0.00146)	(0.000137)	(0.000312)	(0.000271)	(0.000109)	(0.000143)	(0.000382)
Household head finished primary school	0.179***	0.0217***	-0.00545	0.0272***	-0.0178***	-0.0229***	-0.0205
	(0.0492)	(0.00541)	(0.0106)	(0.00926)	(0.00292)	(0.00400)	(0.0144)
Number of children	0.184***	0.0190***	-0.0216***	-0.0131***	8.90e-05	0.00144	0.0142***
	(0.0106)	(0.00132)	(0.00228)	(0.00197)	(0.000683)	(0.000892)	(0.00305)
Number of adult household members living away	0.000528***	1.50e-05**	-3.75e-06	-5.08e-06	-3.36e-06	-3.84e-07	-5.78e-06
	(5.47e-05)	(6.30e-06)	(1.19e-05)	(1.02e-05)	(3.36e-06)	(4.75e-06)	(1.42e-05)
Observations	1,976	1,976	1,976	1,976	1,976	1,976	1,976
R-squared	0.700	0.179	0.137	0.017	0.016	0.107	0.046
First-stage on Remittances sent from abroad in percentage of total income							
log (weighted GDP per capita)					0.708***		
					(0.174)		
nb unexpected negative shocks in weighted foreign currencies					0.769***		
					(0.265)		
c.log (weighted GDP per capita)#c.nb unexpected negative shocks in weighted foreign currencies					0.0663**		
					(0.0301)		

Clustered standard errors at regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table D.1.4: International remittances – Using levels of expenditures and levels of remittances, by quartile

VARIABLES	(1) Tot exp	(2) %Educ exp	(3) %Food exp	(4) %Non-food exp	(5) Tot exp	(6) %Educ exp	(7) %Food exp	(8) %Non-food exp
	Bottom 50% of income distribution				Fourth quartile of income distribution			
log (remittances received from abroad)	-0.210	0.0531*	0.0312	-0.00711	0.242**	-0.0135	-0.0293	0.0478**
	(0.209)	(0.0274)	(0.0475)	(0.0460)	(0.109)	(0.0170)	(0.0229)	(0.0216)
c. log (remittances received from abroad)#c.annual percentage change of Ghanaian Cedis	2.237***	-0.140**	-0.114	-0.0544	0.917*	-0.0693	-0.0532	-0.0817
	(0.512)	(0.0576)	(0.136)	(0.127)	(0.514)	(0.0759)	(0.0961)	(0.0957)
annual percentage change of Ghanaian Cedis	-26.32***	1.676**	0.903	0.854	-11.64	0.959	0.635	1.040
	(6.574)	(0.719)	(1.818)	(1.688)	(7.257)	(1.065)	(1.354)	(1.339)
Male household head	-0.0972	-0.0141	0.00108	-0.000774	0.194**	-0.0516***	-0.0255	0.0381**
	(0.108)	(0.0149)	(0.0268)	(0.0242)	(0.0816)	(0.0120)	(0.0192)	(0.0163)
Household head age	-0.00349	-0.00116**	0.00176**	-0.000456	-0.00719***	0.000253	0.00223***	-4.48e-05
	(0.00408)	(0.000513)	(0.000848)	(0.000872)	(0.00223)	(0.000245)	(0.000480)	(0.000414)
Household head finished primary school	0.272**	0.0159	-0.0339	0.0263	0.139**	0.0277***	0.00222	0.0422***
	(0.119)	(0.0194)	(0.0287)	(0.0244)	(0.0674)	(0.00836)	(0.0150)	(0.0130)
Number of children	0.171***	0.0240***	-0.0141*	-0.0191***	0.166***	0.0184***	-0.0167***	-0.00695**
	(0.0363)	(0.00446)	(0.00782)	(0.00725)	(0.0155)	(0.00192)	(0.00318)	(0.00280)
Number of adult household members living away	0.000774***	-2.49e-05	-4.10e-05	1.80e-05	0.000502***	3.34e-05***	4.54e-06	-2.03e-05
	(0.000133)	(1.80e-05)	(3.25e-05)	(2.93e-05)	(7.80e-05)	(1.24e-05)	(1.79e-05)	(1.53e-05)
Observations	350	350	350	350	1,087	1,087	1,087	1,087
R-squared	0.752	0.053	0.259	0.084	0.671	0.156	0.051	0.021

Clustered standard errors at regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

D.2 ROBUSTNESS TEST 2

Table D.2.1: Mining remittances – Using standard deviation of gold price

VARIABLES	(1) Tot exp	(2) %Educ exp	(3) %Food exp	(4) %Non-food exp	(5) %Agri exp	(6) %Farm exp	(7) %Non-farm exp
Remittances sent from mining regions in percentage of total income	1.226	0.209	-1.703***	0.164	0.0692	-0.128	1.876***
	(1.887)	(0.170)	(0.471)	(0.363)	(0.150)	(0.180)	(0.631)
Remittances sent from mining regions in percentage of total income * standard deviation of gold price in last 12 mo	-0.670	0.0441	0.624***	-0.0830	-0.0186	0.0574	-0.642***
	(0.619)	(0.0554)	(0.154)	(0.120)	(0.0489)	(0.0582)	(0.207)
Standard deviation of gold price in last 12 mo	0.000368	-0.00461	-0.0543***	0.00537	-0.00381	-0.0106**	0.0642***
	(0.0557)	(0.00496)	(0.0136)	(0.0103)	(0.00421)	(0.00507)	(0.0182)
Male household head	0.0494**	-0.0201***	-0.0179***	0.0265***	0.0220***	0.0281***	-0.0166**
	(0.0206)	(0.00186)	(0.00548)	(0.00390)	(0.00147)	(0.00200)	(0.00691)
Household head age	-0.00752***	-9.22e-05	0.00179***	-0.000386***	8.29e-05*	4.44e-05	-0.00136***
	(0.000675)	(5.96e-05)	(0.000187)	(0.000126)	(4.65e-05)	(6.38e-05)	(0.000214)
Household head finished primary school	0.266***	0.0156***	-0.0511***	0.0299***	-0.00692***	-0.0147***	0.0202***
	(0.0219)	(0.00207)	(0.00566)	(0.00444)	(0.00169)	(0.00204)	(0.00749)
Number of children	0.148***	0.0116***	-0.0105***	-0.00727***	0.000911***	0.00201***	0.00418***
	(0.00468)	(0.000442)	(0.00122)	(0.000901)	(0.000348)	(0.000428)	(0.00158)
Number of adult household members living away	0.0877***	-0.00445**	-0.0153**	0.00298	0.00113	0.00803*	0.00874
	(0.0222)	(0.00226)	(0.00622)	(0.00436)	(0.00222)	(0.00456)	(0.00800)
Observations	7,677	7,677	7,677	7,677	7,677	7,677	7,677
R-squared	0.180	0.121	0.218	0.002	0.030	0.018	0.136
First stage results on Remittances sent from mining regions in percentage of total income							
inverse of distance to sender's region						0.0756***	
						(0.0122)	
Mining workforce in sender's region						0.0333***	
						(0.00354)	
Inverse of distance to sender's region * Mining workforce in sender's region						-0.0153***	
						(0.00427)	

Clustered standard errors at regional level in parentheses: *** p<0.01, ** p<0.05, * p<0.1