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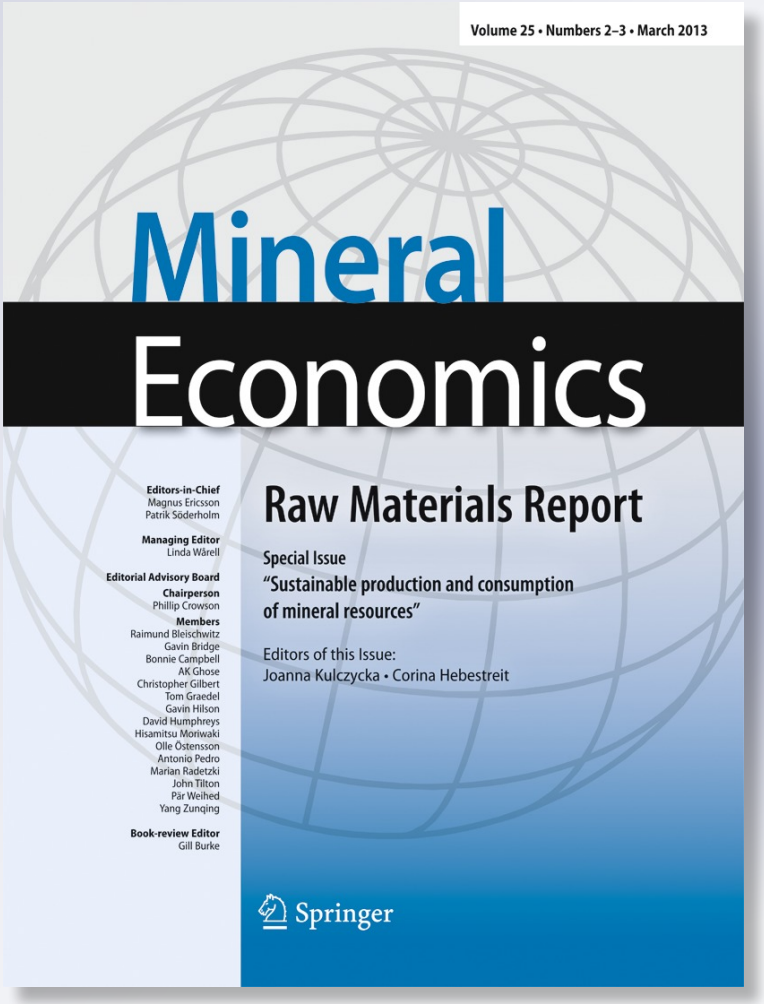

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ORIGINAL PAPER

The welfare impact of small-scale mining in the Talensi–Nabdam District of Ghana

A quantitative approach

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Abstract Over the last two decades, Ghana has experienced a rapid and unprecedented upsurge in small scale mining activities. Concerns of the impacts of small scale mining on the environment and welfare of small scale miners and communities have been raised by policy makers, implementers and the academia. This report examines the welfare impact of small scale mining in the Talensi–Nabdam District of the Upper East Region of Ghana using a quantitative approach. Two hundred people were sampled across five communities in the District. Two main welfare outcomes — income earnings and consumption expenditures were examined. The Difference-In-Difference approach was adopted and the model estimated using STATA (Version 10). It was found that there is a significant difference between small scale miners and non-small scale miners in terms of the welfare outcomes. Apart from small scale mining, household size, level of endowments, gender, access to credit and level of literacy among other unobserved factors account for the difference in welfare outcomes between small scale miners and non-small scale miners. It is concluded that small scale mining has positive impacts on the welfare of small scale miners.

Keywords Consumption · Ghana · Income · Mining · Welfare

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Introduction

Small scale mining in Ghana dates back to over six centuries. In pre-colonial times, Ghana produced and used gold for the manufacture of traditional artefacts. Present-day Ghana was one of the major sources of the gold that reached Europe through the Trans-Saharan trade routes with foiled attempts by most Europeans to locate and control the country's gold fortunes even before the era of colonialism (Hilson 2001). There is evidence that in the 15th century, Portuguese sailors tried to locate and control mining from the coast but were met with stiff resistance, failing which they turned their attention to the slave trade (ibid).

Since the regularization of small scale mining in 1989 in Ghana, the country has experienced a rapid and unprecedented upsurge in small scale mining activities. This has coincided with the implementation of successive structural adjustment programmes and concurrent policy reforms in the mining sector. The former resulted in numerous layoffs in the public sector and the latter made smallholder agriculture in many areas of the country unviable (Banchirigah 2008). This, in turn, led tens of thousands of university graduates, former mine employees and marginalized farmers and vulnerable people to pursue employment in the small scale mining sector (Aryee 2001, 2003; Banchirigah 2006). The initial aim of the structural adjustment programmes, carried out under the auspices of the World Bank, was to revitalize a deteriorated and under-funded large-scale mining sector. Though there are no precise small scale mining employment figures, it is estimated that about 200,000 people are involved directly in the extraction of gold and diamonds (Appiah 1998), the majority of who are operating illegally. It is also estimated that some 30,000 people are employed within the legalized segments of the Ghanaian small scale mining sector (Hilson 2001).

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Small scale mining therefore contributes to socio-economic development of individuals and communities since it is a source of both part-time and full-time employment. It has been reported that a license operator employs between 5 and 20 groups of people made up of 5–10 workers each that excavate ore and process gold (Appiah 1998). Apart from the direct employment contribution of small scale mining, it as well generates substantial numbers of indirect jobs in other sectors of the economy due to the demand created for productive inputs, transportation and other services. If all other people engaged in activities such as gold smiting, trading and food vendors are considered, the employment figures will be higher (Amankwah and Anim-Sackey 2003a). In the rural communities where mining takes place, the activity has reduced rural exodus, promoted local economic development and contributed towards poverty reduction. Furthermore, due to the low barriers to entry in terms of capital needs and formal education requirements, small scale mining offers a good opportunity for the evolution of indigenous entrepreneurs (Amankwah and Anim-Sackey 2003a, b).

The small scale mining sector experienced rapid growth after its legalization. At the end of 2003, the small scale sector had sold about 1.5 million ounces of gold and 8 million carats of diamond to licensed mineral agencies in Ghana (Ghana Government 2006). Though positive impacts of small scale mining on welfare have been reported in the literature (Hilson 2002a; Hilson and Garforth 2012), some negative effects such as atmospheric pollution, water pollution, land degradation and deforestation have also been reported (Yakubu 2002; Hilson 2002b; Amegbey et al. 1997; Tufour 1997; Suglo et al. 1998) and all of these affect the welfare of people and communities in mining areas.

In effect, different studies (see, e.g., Hilson and Garforth 2012; Hilson 2001, 2008; Banchirigah 2008; Aryee 2001, 2003) have been conducted in Ghana on small scale mining and its impacts on socio-economic development. However, almost all these studies only use qualitative methods which do not measure the impact of small scale mining on welfare in quantitative terms. This paper therefore examines the impact of small scale mining on welfare using a quantitative approach. Apart from the introduction, the rest of the paper is organised into four main sections. Section 2 presents the empirical issues in small scale mining. Section 3 presents the methodology employed in estimating the impact of small scale mining on welfare. Section 4 presents the results and discussion. Section 5 presents the conclusion and recommendations for policy and further research.

Empirical issues in small scale mining

At the global level, mining contributes to the socio-economic development of many countries. This is particularly so in the developing world and sub-Saharan Africa for that matter where the mining sector is dominated by small scale miners. Small scale mining in most areas of the developing world is largely a poverty driven activity. It is a main source of income to the poorest of the poor, the less educated, the unemployed, migrant workers and landless populations in remote areas of the developing world (Labonne and Gilman 1999; Labonne 2003). This has made small scale mining an important tool for poverty alleviation and a generator of national income. As noted by Hentschel et al. (2002), a number of national governments across the developing world have recognised the small scale mining as a strategic pathway for alleviating rural poverty and promoting sustainable livelihoods and household welfare. The activities of small scale miners in most cases form the foundation blocks for the socio-economic and politico-cultural development of mining communities mostly rural and deprived. This is because the small scale mining sector offers employment not only to people who are directly engaged in the mineral extractions but also to people involved in mining related local businesses among others, all of which are critical for socio-economic and politico-cultural transformation of mining communities and areas.

Nonetheless, there is no consensus on the importance of small scale mining to the development of mining communities. Whereas some writers think that small scale mining presents a window of opportunity for poor and vulnerable populations in the developing world to escape from poverty, the reverse is true for others. These divergent views of the relevance of small scale mining in the socio-economic and welfare development of mining communities has led to the emergence of the debate amongst the academia, policy makers and development agencies as to whether or not small scale mining has the potential to lift the poor out of poverty and vulnerability. The debate is made gloomier by the lack of exact statistics on the number of people engaged in small scale mining across the developing world (Chakravorty 2001).

Advocates of small scale mining argue that depending on the size of deposits, the economic significance of small scale mining can be considerable, particularly for communities lacking any alternative sources of employment or income. It is argued that small scale mining brings several benefits to developing countries, seen mainly in the area of employment, livelihoods and welfare development in general (Hilton et al. 2003) and this is particularly so in the rural areas of developing countries where there are limited employment opportunities (Ghose and Roy 2007). The advocacy for small scale mining as an alternative to small holder agriculture is based on the fact that farming is becoming less attractive as a result of the inherent risks associated with it. Farmers continue to get less and less income from their farming activities which make them to diversify their livelihood activities to include small scale mining (Hilson and Garforth 2012). The movements of

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rural dwellers, especially in developing countries into small scale mining and other non-farm livelihood activities are necessitated by the climate change menace which has made smallholder agriculture unsustainable as a result of erratic weather conditions and this has negative implications for rural livelihoods and welfare development (Akudugu et al. 2012). The negative consequences of climate change is exacerbated by the inadequate availability of well developed irrigation schemes across the developing world, especially Ghana where only about 20 % of farmers have access to irrigation facilities (Akologo 2009). The small scale mining sector is thus an important source of livelihoods to many poor and vulnerable people, especially women in rural areas. For instance, in Guinea, women comprise 75 % of those involved in the sector while in Mali, Ghana and Zambia, the estimated figures are 50 %, 44 % and 30 %, respectively (Hentschel et al. 2002). Small scale mining in rural areas is also said to have some impacts on the local economy as revenues are reinvested in the same area. As such, the sector generates a significant local purchasing power and leads to a demand for locally produced goods and services such as tools, food, equipment, housing and infrastructure (ibid).

However, those who doubt the efficacy of small scale mining as a critical poverty and rural welfare development tool argue that small scale mining, especially in developing countries and sub-Saharan Africa for that matter is a waste of the vast human and natural resource base of mining communities (Aspinall 2001). This argument is based on the fact that though small scale miners do almost the same amount of work as those in the more visible, large scale mining sector, most small scale miners gain a very meagre returns with some selling as little as US$1 worth of minerals at a time which cannot lift them out of poverty. They further contend that the activities of small scale miners tend to cause extreme negative environmental and social impacts and seldom contribute to government revenues. For opponents, the current states of small scale mining operations are not economically and environmentally sustainable (Ali 2006, 2009).

It is further argued that mining in general and small scale mining in particular is neither a necessary nor sufficient condition for sustained economic growth and transformation in the developing world. This is based on the premise that mining has been going on for decades in most developing countries, especially in sub-Saharan Africa but it has not helped countries in this region to escape from poverty. In some cases, livelihoods of people engaged in small scale mining are made worse by the use of open pits and dangerous chemical substances such as cyanide to extract minerals from the ore. These pits and chemicals tend to cause significant environmental and social damage. The negative consequences of small scale mining are to a large extent irreversible. Landscapes are permanently damaged by small scale mining activities, communities are displaced, drinking water sources are contaminated and farmlands and ecosystems are destroyed (Aryee 2003). Accidents and hazards abound in the small scale mining sector. These accidents and hazards according to Jennings (2000) are mostly caused by rock falls, lack of ventilation, misuse of explosives, lack of knowledge as a result of poor training, violations of regulations as well as obsolete and poorly maintained equipment. Most small scale miners are working under marginal economic conditions as hired labourers (Hentschel et al. 2002) which present a little opportunity for them to escape out of poverty.

Mining related fatalities have been recorded around the world and the poor and vulnerable are always the worse affected as they are the people directly involved in the mining activities as labourers. According to the ILO (2003), in China more than 6,000 fatalities are estimated to occur in small scale mines each year. In some regions, the death toll is even higher. For example, in the Balochistan province in Pakistan, a number of miners lost their lives in mining related accidents. Similar accidents resulting in fatalities have been reported in Colombia, Bolivia, Zimbabwe, and Ghana among others (ibid). Other studies carried out around the world report similar negative effects of small scale mining on the environment which negatively affects welfare development of people in mining communities (*see for instance* studies in China by Shen and Gunson 2006; in Ecuador by Sandoval 2001; in Zambia by Kambani 2003; among others). Most of these studies conclude that the activities of small scale mining have persisted in the natural environment, and have had severe ecological and negative human health effects in the long run.

Small scale mining activities lead to significant removal of vast quantities of surface vegetation and mass deforestation and in some cases miners abandoned pits and trenches present public health and welfare challenges. It is common in mining communities to find landscapes characterized by potholes and virtually devoid of vegetative cover (Hilson 2001; Aryee et al. 2003). Several landscapes worldwide have been heavily damaged as a result of bad practices of small scale mining activities. In the Chocó region of Colombia, for example, mining activities are reported to result in an estimated annual deforestation rate of 1,000 ha (Lacerda and Solomons 1998). Heavy mineral prospecting is reported to be contributing to mass deforestation in Zimbabwe where an estimated 100,000 ha of land are cleared annually in small scale mining regions (Maponga and Anderson 1995). Productive soils are generally left contaminated. Widespread precious metal extraction activities throughout the Brazilian Amazonian and southwest Colombia, for example, has left several terrains devoid of vegetation (Lacerda and Solomons 1998). In Ghana, the process of small scale mining is said to have rendered some lands unsuitable for any other purpose as

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a result of uncovered pits many of which are filled with stagnant water thereby serving as breeding grounds for malaria-infected mosquitoes (Aryee et al. 2003), and these have serious negative health effects on people in mining communities.

From the foregoing, it is clear that there is lack of consensus on the welfare impacts of small scale mining. Both positive and negative effects of small scale mining on welfare of small scale miners and mining communities have been reported in the empirical literature. This paper contributes to the debate on the potential of small scale mining in reducing rural poverty and promoting household welfare with specific focus on Ghana.

Methodology

Survey

The survey was conducted in the Talensi–Nabdam District of the Upper East Region of Ghana. A cross-sectional research design otherwise known as descriptive survey design was employed because of the fact that it allowed the researchers to gather primary data from a large number of people by asking them questions to tap their opinions, experiences and knowledge to assess the impact of small scale mining activities on the welfare outcomes of interest. This assertion is consistent with the observation made by Kreunger and Neuman (2006) and Neuman (2007) that survey researchers measure many variables, test multiple hypotheses, and infer temporal order from questions about past behaviour, experiences, knowledge, opinions, or characteristics. The adoption of the approach is further supported by Kerlinger (1973) and Fraenkel and Wallen (2003) who noted that descriptive survey method is the most appropriate means of obtaining data on personal and social facts when studying large populations and when the study involves selecting and studying samples chosen from the population to discover the relative distributions and interrelations of variables.

Small scale mining is an important livelihood activity in the Talensi–Nabdam District. This assertion is consistent with the finding of Hilson (2008) that small scale mining operations are widely dispersed in the Talensi/Nabdam District. Five communities where there is high concentration of small scale mining activities were sampled for the survey. These were Tongo, Duusi, Sekote, Sheaga, and Nangodi communities. In all, 20 small scale miners and 20 non-small scale miners were selected from each sampled community. This means that 100 small scale miners and 100 non-small scale miners were sampled for the survey which gave a sample size of 200. The main instrument for data collection was semi-structured questionnaires.

Analytical framework and specification of the empirical models

Almost all households in the study area are small scale farmers who also engage in non-farm livelihood activities including small scale mining. To assess the impact of small scale mining on welfare requires comparing the welfare outcomes of those who engage in it with those that are not engaged in it. The main welfare outcomes investigated were income earnings and consumption expenditures. Two main assumptions underlying the analytical framework were made in this paper. The first assumption is that there are no direct spillover effects between the sampled small scale miners and non-small scale miners. This assumption is premised on the fact that small scale miners maybe using incomes from their mining activities to take care of their relations who are not small scale miners. As such, non-small scale miners who had relationships with small scale miners were excluded from the study because they might be benefiting directly from small scale mining. This approach helped the researchers to isolate the direct effects of small scale mining on the welfare indicators of interest in this paper. The second assumption is that the indirect spillover effects of small scale mining on welfare development generated through demands for local goods and services are evenly spread across all economic agents in the mining communities. This is because both small scale miners and non-small scale miners are faced by the same socio-economic and politico-cultural circumstances created by small scale mining. For instance, both small scale miners and non-small scale miners can take advantage of the increased demand for food and other services triggered by small scale mining to increase their food production and to establish businesses to render the requisite services such as transport among others, cet. par. (all other things being equal).

Involvement in small scale mining is assumed to be a binary activity as an individual is either in it or out of it. People who engage in small scale mining were assigned a dummy value of 1 and those that are not engaged in it were assigned a dummy value of 0. Representing involvement in small scale mining with Z_i, implies that $Z_i=1$ for individuals who engage in small scale mining and zero otherwise. Letting the welfare outcomes of interest which are income earnings and consumption to be, Y, implies that an individual who engages in small scale mining is denoted Y_{i1} and the one who does not engage in small scale mining is denoted Y_{i0}. Thus, the difference between Y_{i1} and Y_{i0}, which is represented by π_i, is expected to measure the impact of small scale mining, cet. par. Mathematically, this is presented as:

$$\pi_i = Y_{i1} - Y_{i0} \quad (1)$$

This, however, cannot measure the true impact of small scale mining on welfare because of the issue of missing data

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and unobservability which must be dealt with. Missing data problems arise because of the fact that individual involvement or non-involvement in small scale mining is mutually exclusive. This implies that the true impact of small scale mining on certain parts of the welfare outcomes cannot be observed. As a result, the empirical specification in Eq. 1 is unable to capture this missing data. To circumvent this problem, Heckman (1997) recommends that group statistics such as the mean effect of treatment on the treated should be adopted to replace the missing data on individual subjects. This approach has been employed in a wide range of impact evaluation studies (see, e.g., Li et al. 2011; Nguyen 2007; Perry and Maloney 2007; Athey and Imbens 2006; Bertrand et al. 2004; among others). The true impact measure is therefore expressed as:

$$\gamma = E(Y_{i1}|Z_i = 1) - E(Y_{i0}|Z_i = 1) \quad (2)$$

where $E(\cdot)$ signifies expectation in the population of miners and non-miners. $E(Y_{i0}|W_i = 1)$ according to Dehejia and Wahba (2002) and Heckman (1997) as cited in Li et al. (2011) represents the counterfactual outcome for small scale mining individuals had they not involved in it. This, however, gives rise to the problem of unobservability because of the fact that $E(Y_{i1}|W_i = 1)$ can be estimated while the counterfactual $E(Y_{i0}|W_i = 1)$ cannot be estimated (ibid). This problem is addressed by constructing 'counterfactuals' based on a treatment/control framework where a group of non-small scale miners are selected as a control group and the observed outcomes of this control group are supposed to serve as 'counterfactuals' to the observed outcomes of small scale miners (treatment group). As such, the treatment/control framework is used to estimate the true impact of small scale mining on welfare as:

$$\gamma^* = E(Y_{i1}|W_i = 1) - E\left(Y_{j0}\middle|W_j = 0\right)(i \neq j \in N) \quad (2)$$

where γ^* is the estimation of γ; i and j denote two different individuals in a chosen sample of N individuals, where individual i is engaged in small scale mining and individual j does not; Y_{i1} is the welfare outcome of interest associated with individual i and Y_{j0} is the same outcome of individual j (Sarangi 2007). It is important to note that the estimated difference in Eq. 2 cannot be solely attributed to small scale mining. It is therefore important to model the different variables that have the potential to cause the difference to occur. Thus this paper examines the impact of small scale mining on the welfare outcomes of interest by modelling the different factors that may influence inter-individual differences in welfare outcomes. The empirical specification of the model employed in this paper is:

$$\gamma^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 \varepsilon_{it} \quad (4)$$

where γ^* is a natural logarithm of the difference in welfare outcome of interest between small scale miners and non-small scale miners; X_1 is the household size; X_2 is the level of endowment measured in Ghana Cedis; X_3 is gender of the miner measured as a dummy variable (female = 1; and 0 = otherwise); X_4 is involvement in small scale mining measured as a dummy variable (small scale miner = 1; and 0 = otherwise); X_5 is credit access measured as a dummy variable (has accessed credit = 1; and 0 = otherwise); X_6 is the literacy level and was measured as a dummy (literate = 1; and 0 = otherwise); ε_{it} is the stochastic error term which is assumed to be independent and identically distributed over households with zero mean and constant variance; and β_0, β_1, β_2, β_3, β_4, β_5, β_6, and β_7 are the parameters estimated. The differences in means of key variables between small scale miners and non-small scale miners were tested using t-test. These key variables are household size, endowments including asset holdings, income earnings and consumption expenditures.

Results and discussion

Differences in key variables between miners and non-miners

A number of key variables that influence the welfare of individuals and households were examined in the study. It was found that there are significant differences between small scale miners and non-small scale miners in terms of these key variables. The first key variable is household size. It was found that on the average, small scale miners fend for smaller family sizes than non-small scale miners (Table 1). The average household size of small scale miners was found to be statistically lower than that of non-small scale miners

Table 1 Comparison of household size between miners and non-miners

Household size	Small scale miners	Non-small scale miners
Mean	6.3	9.0
Standard deviation	2.78	4.20
Minimum	2	3
Maximum	13	18
Number of observations	100	100
Pearson correlation	0.025	
Hypothesized mean difference	0	
df	99	
t-Stat	−5.927	
$P(T \leq t)$ one-tail	0.000	
t Critical one-tail	1.658	
$P(T \leq t)$ two-tail	0.000	
t Critical two-tail	1.980	

Field Survey Data (2011)

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at the 1 % level of significance. Judging from the standard deviations, it is clear that there are higher variations in household sizes among non-small scale miners than small scale miners. Whereas the minimum and maximum household sizes of small scale miners were found to be 2 and 13, respectively, the minimum and maximum household sizes of non-small scale miners were found to be 3 and 18, respectively. A correlation coefficient of 0.025 though positive, means that there is very little relationship between small scale miners and non-small scale miners in terms of household size. In terms of endowments, it was found that small scale miners on the average are more endowed in assets than non-small scale miners. The average amount of endowments, measured in Ghana Cedis (GH¢), of small scale miners was found to be GH¢482.71 and that of non-small scale miners was found to be GH¢355.03 (Table 2). The levels of endowments between small scale miners and non-small scale miners were found to be statistically different at the 1 % level of significance. This implies that the average level of endowment of small scale miners in the study area is statistically higher than that of the non-small scale miners. On the basis of the standard deviations, there are higher variations in the levels of endowments among the small scale miners than the non-small scale miners. Whereas the minimum level of endowment of small scale miners was found to be about GH¢150.00 and a maximum of GH¢ 900.00, the minimum level of endowments for non-small scale miners were found to be about GH¢131.00 with a maximum of about GH¢585.00. A correlation coefficient of 0.123 though positive, suggests a weak relationship between small scale miners and non-small scale miners in terms of endowments.

It was further found that the average income earnings per month of small scale miners are statistically higher than the non-small small scale miners at the 1 % significance level. Whereas the small scale miners earned about GH¢287.44 per month, the non-small scale miners earned about GH¢ 223.91 (Table 3). In terms of variations, the standard deviations revealed that the earnings among small scale miners are more diverse than non-small scale miners. This is confirmed by the fact that the minimum and maximum monthly income earnings among small scale miners were found to be GH¢130.00 and GH¢475.00, respectively, and that of non-small scale miners were found to be GH¢115.00 and GH¢ 401.00, respectively. A correlation coefficient of −0.090 though negative suggests a weak relationship between small scale miners and non-small scale miners in terms of income earnings. In simple terms, the average income earnings of small scale miners do not have a significant relationship with the income earnings of the non-small scale farmers.

In terms of consumption expenditures, it was found that small scale miners on the average have higher consumption expenditures than non-small scale miners (Table 4). The consumption expenditures incurred by small scale miners and non-small scale miners were found to be statistically different at the 1 % level of significance. Judging from the standard deviations, there are high variations in terms of consumption expenditures among small scale miners than non-small scale miners. This is supported by the fact that the minimum and maximum consumption expenditures recorded among the small scale miners were found to be GH¢100.00 and GH¢474.00, respectively, while that of the non-small scale miners were found to be GH¢150.00 and GH¢405.00. A correlation coefficient of 0.394 though positive, also

Table 2 Comparison of endowments between miners and non-miners

Endowments	Small scale miners	Non-small scale miners
Mean	482.71	355.03
Standard deviation	210.44	111.52
Minimum	150	131
Maximum	900	585
Number of observations	100	100
Pearson correlation	0.123	
Hypothesized mean difference	0	
df	99	
t-Stat	6.195	
$P(T \le t)$ one-tail	0.000	
t Critical one-tail	1.658	
$P(T \le t)$ two-tail	0.000	
t Critical two-tail	1.980	

Source: Field Survey Data (2011)

Table 3 Comparison of income earnings between miners and non-miners

Income earnings	Small scale miners	Non-small scale miners
Mean	287.44	223.91
Standard deviation	63.73	38.29
Minimum	130	115
Maximum	475	401
Number of observations	100	100
Pearson correlation	−0.090	
Hypothesized mean difference	0	
df	99	
t-Stat	9.009	
$P(T \le t)$ one-tail	0.000	
t Critical one-tail	1.658	
$P(T \le t)$ two-tail	0.000	
t Critical two-tail	1.980	

Field Survey Data (2011)

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Table 4 Comparison of consumption expenditures between miners and non-miners

Consumption expenditures	Small scale miners	Non-small scale miners
Mean	283.29	266.77
Standard deviation	69.10	59.39
Minimum	100	150
Maximum	474	405
Number of observations	100	100
Pearson correlation	0.394	
Hypothesized mean difference	0	
df	99	
t-Stat	2.542	
$P(T \leq t)$ one-tail	0.006	
t Critical one-tail	1.658	
$P(T \leq t)$ two-tail	0.012	
t Critical two-tail	1.980	

Field Survey Data (2011)

suggests a weak relationship between small scale miners and non-small scale miners in terms of consumption.

Is small scale mining responsible for the difference in welfare outcomes?

To determine the impact of small scale mining on welfare, regression models were estimated. The first was to look at the influence of small scale mining on the difference in income earnings between small scale miners and non-small scale miners observed earlier. The Difference-in-Difference (DD) approach was adopted. The second was to examine the impact of small scale mining on the difference in consumption expenditures between the two groups. The factors modelled in the two estimations were the level of endowments, household size, gender, small scale mining, access to credit, and literacy level. The regression results are presented and discussed in the following sub-sections.

Impact of small scale mining on income earnings

The regression results of the estimation of factors influencing the difference in income earnings between small scale miners and non-small scale miners gave an *F*-statistic of 452.30, which was found to be significant at the 1 % level (Table 5). This implies that the variables included in the model jointly influence the difference in income earnings between small scale miners and non-small scale miners. An adjusted R^2 of 0.919 implies that the variables included in the model were able to explain about 92 % of the variations in the difference in income earnings between small scale miners and non-small scale miners.

In terms of individual variables, it was found that the level of endowments of households positively influences the difference in income earnings between small scale miners and non-small scale miners. This was found to be significant at the 1 % level of significance. From the regression results (Table 5), a percentage change in the level of endowments will lead to about 3 % change in the difference in income earnings between the two groups. Household size was also found to have a negative relationship with the difference in income earnings and was significant at the 1 % level. The implication of this is that as household size increases, the difference in income earnings decreases. According to the regression results, a percentage change in household size leads to about 0.6 % change in income earnings. This may explain why small scale miners earn more than non-small scale miners because the former have smaller household sizes than the latter.

Gender was also found to have a positive relationship with the difference in earnings. This implies that the difference in income earnings is likely to be high amongst women than in men. This is because women are more likely to earn less than men in the study area. This was however, found to be insignificant. Also, involvement in small scale mining, access to credit and literacy were all found to positively influence the difference in income earnings but were all statistically insignificant. The finding of positive relationship between small scale mining and income earnings is consistent with the empirical literature that small scale mining is an important source of income to people in rural areas (Labonne and Gilman 1999; Labonne 2003; Hilton et al. 2003). The constant term which accounts for variables that are unobserved by the researchers, was found to be significant at the 1 % level. This implies that there are other underlying variables apart from those captured in the model that are causing the difference in income earnings between small scale miners and non-small scale miners. Some of these may include entrepreneurial skills, risk attitudes, and cultural factors such as belief systems which are very difficult to measure but may be influencing the differences in income earnings between the two groups.

Impact of small scale mining on consumption

In examining the impact of small scale mining on consumption as a welfare outcome, a regression model was estimated. The *F*-statistic from the regression was significant at the 1 % level of significance (Table 6). This implies that all the variables included in the model jointly influence the difference in consumption between small scale miners and non-small scale miners. An adjusted R^2 of 0.817 from the regression results means that all the variables included in the model are able to explain about 82 % of the variations in the difference in consumption expenditures between small scale miners and non-small scale miners.

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Table 5 Regression results of factors influencing difference in income earnings

Dependent variable	Log(income difference)			Number of observations=240	
Independent variables	Coefficient	Std. err.	*t*-Stat	$p>\|t\|$	95 % conf. interval
Log(Endowments)	2.818374	0.0548102	51.42	0.000	2.710387 to 2.926361
Log(Household size)	−0.6106853	0.1135016	−5.38	0.000	−0.8343059 to −0.3870648
Gender	0.0168244	0.103262	0.16	0.871	−0.1866221 to 0.2202709
Involves in mining	0.116181	0.1016021	1.14	0.254	−0.0839953 to 0.3163573
Has accessed credit	0.0510343	0.095335	0.54	0.593	−0.1367945 to 0.2388631
Literacy Level	0.0126204	0.0896472	0.14	0.888	−0.1640022 to 0.1892431
Constant	−9.25046	0.4594351	−20.13	0.000	−10.15564 to −8.345282
Goodness of fit measures					
$F(6, 193)=452.30$					
Prob.>F=0.000					
R^2=0.921					
Adjusted R^2=0.919					
Root=0.646					

Field Survey Data (2011)

The level of endowments was found to have a significant influence on the difference in consumption between small scale miners and non-small scale miners. This was found to be significant at the 1 % level. A 1 % change in the level of endowments will lead to a 0.8 % change in the difference in consumption between small scale miners and non-small scale miners. Household size, gender, involvement in small scale mining, access to credit and literacy all positively influence the difference in consumption between miners and non-miners but none of them was found to be a significant factor. This implies that though small scale mining positively contributes to the difference in consumption between small scale miners and non-small scale miners, it is not a main determinant in statistical terms.

The constant term which was found to be significant at the 1 % level implies that with the exception of endowments, there are other factors which account for the difference in consumption between small scale miners and non-small scale miners which are difficult to capture by researchers.

Conclusion and recommendations for policy and further research

From the results, it is concluded that small scale mining has positive impacts on welfare of small scale miners. It contributes positively to the income earnings and consumption of small scale miners. These findings are in conformity with

Table 6 Regression results of factors influencing difference in consumption expenditures

Dependent variable	Log(Consumption difference)			Number of observations=240	
Independent variables	Coefficient	Std. Err.	*t*-Stat.	$p>\|t\|$ (95 % conf. interval)	
Log(Endowments)	0.8288918	0.0254588	32.56	0.000	0.7787329 to 0.8790507
Log(Household size)	0.0436139	0.0527204	0.83	0.409	−0.0602557 to 0.1474836
Gender	0.0006515	0.0479642	0.01	0.989	−0.0938475 to 0.0951505
Involves in mining	0.0073644	0.0471932	0.16	0.876	−0.0856157 to 0.1003444
Has accessed credit	0.0282099	0.0442822	0.64	0.525	−0.0590348 to 0.1154547
Literacy level	0.0026499	0.0416403	0.06	0.949	−0.0793897 to 0.0846894
Constant	0.8213305	0.2134033	3.85	0.000	0.4008838 to 1.241777
Goodness of fit measures					
$F(6, 193)=179.37$					
Prob.>F=0.000					
R^2=0.822					
Adjusted R^2=0.817					
Root MSE=0.300					

Field Survey Data (2011)

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some of the empirical literature discussed earlier that small scale mining presents an escape route for the poor and vulnerable to lift themselves out of extreme poverty. It is, however, important to note that, statistically, involvement in small scale mining is not a significant determinant of the observed difference in welfare outcomes between small scale miners and non-small scale miners in the Talensi–Nabdam District of the Upper East Region of Ghana. That notwithstanding, issues of welfare development, especially in rural communities of developing countries such as Ghana are so interrelated and complex to the extent that statistical tests and significance are unable to holistically capture them. Thus emphasis should not only be put on the conventional statistical significance which has to do with the magnitude of influence but also the direction of influence which is positive in this case. Based on the results, the following recommendations are made for policy and further research:

1. Endowments of individuals positively and significantly influence their income earnings and consumptions. It is therefore recommended that government and its development partners should formulate policies that aim to encourage people in the area to accumulate their capital assets as this allows them to invest confidently thereby bringing income and consumption benefits.
2. Household size was found to be a significant factor that negatively influences income earnings. It is recommended that the government of Ghana through the Ministry of Health should roll out strategies to promote family planning and birth control in the area.
3. It was found that there are certain factors which significantly contribute to the difference in welfare outcomes between small scale miners and non-small scale miners not captured in this paper. It is recommended that further research using mixed methods approach (i.e., a combination of qualitative and quantitative methods) should be carried out to determine these specific factors.

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