The effects of Mining on Health: Evidence from Copper Mining in Zambia*† 1

Chomba Kalunga
Coventry University

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Abstract

Many recognize the opportunities natural resources provide for economic growth and development and thus ensuring that natural resource wealth leads to sustained economic growth and development. Mining can be an engine and catalyst for economic growth, but often results in heavy metal releases, that could negatively impact human health. High levels of pollution may cause temporary illness, which in turn may cause lost work hours. Using a novel dataset of repeated cross-section survey data on living conditions in constituencies in Zambia and panel data analysis, this paper analyzed the impact of copper mining on health in Zambia during the 1996-2010 period. It explored changes in health outcomes for constituencies located within 200km to nearest mine as these are the ones to be greatly affected by pollution in a 2SLS fixed effects approach. It was observed that an increase in copper mining which led to a copper boom from 2003 induced some changes in health outcomes for constituencies located close to the mining operations after the privatization of the mines. Findings also show that the probability of suffering from general sicknesses becomes less likely if a constituency is located close to an open pit mine or in a rural area while it increases if a constituency is located close to an underground mine. The results illustrate that copper mining somehow reduces the prevalence of certain health conditions, for example, anaemia and chest infections.

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* Department of Economics, School of Economics, Finance and Accounting, Coventry University, 320 William Morris Building, Gosford Street, Coventry, CV1 5DL; email ad2458@coventry.ac.uk.

† The researchers' own analyses were conducted based on the Living Conditions and Monitoring Surveys (LCMS) in Zambia, Central Statistical Office in Zambia, Mining A
And Westmetall. The conclusions drawn from these sources are those of the researcher and do not reflect the views of CSO. CSO is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

1. Introduction

The global market has been hit by a surge in mineral prices which has resulted into an increase in mining activities culminating into economic growth for low-income and middle-income, mineral rich countries (McMahon and Moreira, 2014). Although few, multinational mining companies that are earning billion-dollar profits in Zambia have had a massive impact on its environment and people. For almost 100 years, Zambia has been highly dependent on copper and the mining industry, and the country is a living proof that progress leaves its mark on both the environment and peoples' health. Land degradation, increased deforestation and water and air pollution from particles of sulphuric acid, which affects those residing near the mines are some of the main concerns by the environmental authorities. The lifecycle of mining consists of exploration, mine development, mine operation, decommissioning and land rehabilitation. There could, however, also be some negative spillovers from this. Often, the start of an extractive industry, say, the opening of a mine, will attract workers from other districts. This could temper the rise in wages; put a strain on local services such as health and education (World Bank, 2015). All types of mining can pollute and cause environmental damage unless carefully managed. But even when carefully managed, there are still substantial risks to local communities.

A body of literature has been documented from research and studies on the effects the mining industry has on human health. Goltz and Barnwal (2019) observed that there is limited work in economics on the issue of mining and its effects on health. In addition, even though studies have been conducted to analyse the effects of mining on Zambias' economy and most developing economies, the available evidence on the effects of copper mining tells us very little on the consequences at local level such as pollution. The major borne of contention in developing countries such as Zambia especially after the privatization of the mines is whether there is a trade-off between the benefits from copper mining and the health of the communities living around the mines. This paper filled this gap in literature by investigating whether copper mining affects health outcomes by exploring the mechanisms for this to happen. The case of Zambia, a large copper mining country, is used as a testing ground and further evaluate the effects of copper mining on health outcomes of the local population. In contrast to the existing literature, it also focuses on the effects of copper mining on health outcomes for constituencies located close to the mines after the privatization of the copper mines.

Although copper mining yields huge revenues for both the mining companies in form of profits and the government in form of revenue from taxes, it often results in water and air pollution that affects the health of the surrounding population. It is known that the main channel of copper exposure is through the sulphuric acid that is released as a by-product of copper production and mainly affects those that are directly involved in the production process. However, there is scant evidence on the magnitude and extent of the effect of copper production on the health of the surrounding populations, and whether the benefits of copper mining could compensate for any damage. Most copper mining operations in Zambia are large polluters and are at risk of weak environmental regulation and enforcement because they are very important sources of revenue, foreign exchange and employment. It should be however noted that there is atleast no indication that ill health is caused by deprivation as living in mining communities is assumed to lead to economic gains which are generally expected to outweigh the cost of health impacts. Some copper mines are however, located in the vicinity of urban centres were the population is not sparse and the circulation of air is compromised.

I examine the causal effects of the increase in mining activities on the health of local communities in Zambia. In order to overcome the issue of endogeneity, I utilize a strategy that addresses the source of bias. I particularly use an instrumental variable strategy that relies on the international copper price as an instrument for the levels of pollution (where copper output is used as a proxy for pollution). I use a collapsed novel dataset that allows me to estimate the strategy in a panel format and conduct a static analysis A main empirical challenge in such a study was the possibility of the endogeneity of natural resources extraction. The main identification assumption is that the change in health outcomes is affected by the pollution of the mines. This followed the strategy used by Arceo-Gomez et al (2015), which is the closest study to this paper. Unlike Arceo-Gomez et al (2015), this paper uses the international copper price to instrument for the mine level copper production. The main dependent variable is whether the general health of people has changed and if there has been an increase in respiratory infections highly related with mining, both aspects which capture the possibility of a low life expectancy. A rich dataset with all infections and types of diseases by gender and age was used; this was constructed from the Living Conditions and Monitoring Surveys (LCMS).

My paper speaks to three strands of literature. The most notable contribution made is to the empirical literature on reverse causality; where it is assumed that higher levels of copper production may lead to higher levels of pollution which can negatively affect health outcomes and when there is generally poor health among the labour force in the mine, this is likely to lead to lower levels of copper production. Secondly, it contributes to the rare literature in developing countries on mining and health by presenting a micro-data study of the comparative health effects of an important industry in a single developing country. Lastly, a contribution is made to the growing body of literature on the effects and externalities of mining, specifically to the literature on mining in developing countries and its effects on health outcomes. Although there has been an active literature on the health effects of pollution, most of it has been using developed countries' data (Greenstone and Jack, 2015), this paper therefore seeks to add on to the scant literature in developing economies.

The observed results show evidence of a significant but modest decline in general health outcomes with, especially, diarrhoea cases increasing as a result of pollution. The potential vehicle of such relationship is through air and soil pollution with the quality of food is deteriorating, while, at the same time, the general health and immunity of the people in the constituencies is deteriorating leading to the higher number of diarrhoea cases. Results also show a significant increase in chest infections and the prevalence of anaemia shows a reduction after the privatization of the copper mines. Chest infection and anaemia one can easily name among the straightforward results of the air pollution. In terms of mine type, there seems to be an improvement in the general health of populations living close to open-pit mines in comparison with those living near underground mines, however. The estimates suggest that a one per cent increase in the copper production measure is associated with a 0.136 percent increase in the prevalence of chest infections for constituencies located close to underground mines. This can be attributed to the fact that the effects of the pollution are much stronger for the workers of the underground mines. They are under the direct influence of the pollution for most of the time of their day, while in an open-pit mine there is more air circulation, reducing the concentration of pollutants increasing chest infections. On the other hand, the underground mines are located closer to the urban areas rather than open-pit types, suggesting that the health problems are coming from the urban life-style as well. The results tend to be insignificant when the observations are restricted to constituencies located closer to open pit mines. Lastly, including the real income to the regressions reduces a potential omitted variable bias and validates the results showing that changes in incomes have a significant impact on health outcomes as well.

1.1 Background

The empirical analysis followed in this paper pertains to the case of copper mining in Zambia. Most of the copper is extracted by modern large-scale mines located in the north-western part of Zambia. These mines, similar to other modern mines in the world, are capital intensive, highly mechanised operations. They are located within urban vicinities though with somehow elusive interactions with the local economies; they hire few locals especially in the top positions, buy few local products, their profits are not distributed among local residents and there is no fraction of the fiscal revenue that is allocated to local authorities (Aryeetey et al, 2007).

Due to data availability, the focus for this chapter was on five years: 1996, 1998, 2004, 2006 and 2010. As shown in figure 1, copper production was increasing before 2003 after the privatization of the mines. This was mostly driven by the re-opening of two new mines, Kansanshi and Lumwana mines. After 2003, copper production continued to increase but at a higher level. The aggregate cumulative copper production was almost tripled between 1996 and 2010 and there is a substantial variation across mines. It therefore exploited these differences in copper production in the empirical analysis.

People living near and around mining constituencies in Zambia are exposed to a variety of pollutants some of which undermine the right to their health and livelihoods (Tanimowo, 2000). Air pollutants, such as SO_2 (sulphuric acid) being released into the atmosphere during copper smelting and subsequent production of sulphuric acid is associated with respiratory problems. Children, the elderly and those already suffering from respiratory ailments, such as asthmatics are especially at risk. Although there has been a substantial decline in the concentration of SO_2 in the vicinity of the emissions source compared to what the smelter discharges into the atmosphere, Ncube et al, (2012) found that the air pollution measurements in most cases exceeded the Zambia's annual ambient SO2 value of 50 $\mu g/m^3$.

Since there is no data on the concentration of pollutants around the mining operations, we borrowed from Aragon and Rud (2016) and used the cumulation of mine-level copper[2] output over the relevant period as a proxy for the generation of pollutants that accumulate in the environment over time.

[2] Movements in the cumulative levels of mine-level copper output are shown in figure 1. This clearly shows a boom in copper production from around 2001 reaching a peak in 2011.

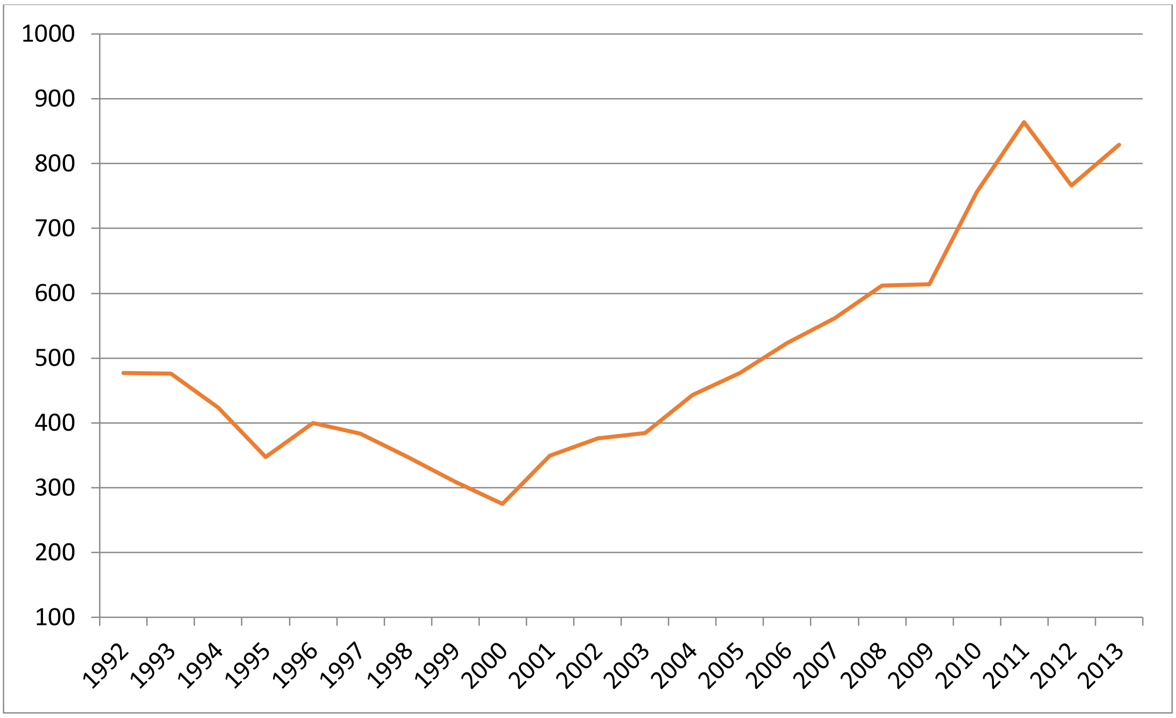

Figure 1: Total copper production (in metric tons), by Year

This paper is organized as follows: Section 2 presents some literature on past studies and links this with the instrumental variable techniques used in the paper. Section 3 describes the health and mine level data. Section 4 presents the two-stage least squares empirical approach to estimate the effect of copper mining pollution on health outcomes in in Zambia. Section 5 presents the main results using the instrumental variables technique with additional estimation using the real incomes on constituencies. Section 6 concludes.

2. Review of Literature

A look at the previous literature on natural resources (such as Caselli and Michaels (2013), Monteiro and Ferraz (2012), or Arceo-Gomez et al (2015)) provides an indication that could inform us about the inherent possible sources of such endogeneity.

To resolve this problem, following the most influential papers of the field (Caselli and Michaels (2013), Monteiro and Ferraz (2012) and Arceo-Gomez et al (2015) and well-established books on econometrics (e.g. Wooldridge 2016) the use of IV-type estimators in this chapter is proposed. This approach handles the endogeneity bias that may arise through the following vehicle.

It is commonplace in the resource curse literature to view natural resources as more or less fixed and exogenously-given endowment – or "manna from heaven" (Dunning, 2008). Some constituencies are assumed to have natural capital in abundance, and others not. I seek to join a small but important literature that challenges this conventional understanding by recognizing that there may be a critical endogeneity in the development of natural resource wealth that serves to deepen the differences between the positive and negative resource-induced equilibria (e.g., David and Wright 1997; Stijns 2006). Rather than being a 'gift of nature' from which states obtain substantial revenue, effective resource endowments may be endogenous to the technology used to detect and extract them. Only copper that is both discovered and extracted can become a developmental resource, and both conditions are heavily shaped by the technology of exploitation that is available and locally employed. Such technology, in turn, should be related to domestic industrial capacity and human capital investments in the country. Domestic human capital thus should be associated with a higher likelihood of identifying natural resource endowments and employing them in economically developmental ways.

To give a particular example, the copper mine production can have a direct impact on the health of the individuals living nearby through pollution of various sorts, what was explained in the previous chapters, while at the same time, bad health consequences can have negative impact on the further development of the mines, since, for example, some staff employed at these mines might consider it to be unbearable for them and/or their families to continue their presence around a polluting mine, and vice versa. Through such channel, the further expansion of mine production can be deteriorated, even to the extent of contraction or seizure. This can be especially significant if those individuals are valuable decision makers, or higher or medium level professionals.

Thus, adoption of the 2SLS FE estimation is justified by the current trend in the related literature and proposed direct vehicle, bringing endogeneity of the main explanatory variable determination. The Fixed Effects estimation method is useful to incorporate and use the properties of the panel data, having two "dimensions": cross-sectional and time. Thus, by using the within estimation the endogeneity coming from correlation of the individual time-invariant characteristics of the constituencies with one or more explanatory variables is avoided. For example, it is impossible to imagine that such characteristic as the geographical distance from the copper deposits must be correlated with the access to clean water, population density, or even government spending.

The second channel of endogeneity that can be related to the current study is an omitted variable bias, which is possible in this case as the model may not be able to adequately control for the inherent variations at the lower administrative levels of the mines, related to the cultural dimension (such as at ward level and other cultural patterns). That can be correlated to the production levels of the mines and, thus, could seemingly pose empirical challenges. Instrumental variables may help to overcome such bias. The argument, in this case, is that the previous periods' international copper prices are correlated with the per capita mine level copper output but not correlated to any mine management problems. δ in equation (2) represents the per capita mine level copper output response to exogenous international copper price changes.

The final source of endogeneity that the IV instrumental variable helps us mitigate here is the error-in-variables bias. In case if there are any potential errors in the way the data on the mine production levels are collected then our estimation approach in this chapter should be able to handle it as well as the two biases explained above. The assumption that the IV variable – international copper prices – is uncorrelated with any type of error, makes sense since the errors in data should, most probably, come from the subnational level (CSO, 2010), while the international prices are determined on the international market as a result of the aggregate demand and supply for copper. Thus, the use of the international copper price as an instrument for the per capita mine level copper output is supported as the way to avoid a potential omitted variable bias; as the past prices are likely to later culminate into an increase in copper production, and, furthermore, be related to the health outcomes only through the per capita mine level copper output.

From the above, it is not difficult to see a potential limitation of the current estimation approach. Any IV estimation is not without a bias in estimates to a certain degree. According to Wooldridge (2016) in small samples, a FE IV estimator can have a substantial bias that is why the large samples are preferred. In our case, the sample reaches 750 observations, which can be considered large enough and similar to the empirical studies carried out in the area of my research *(Dube ad Vargas, (2013), Lippert, 2014 and Aragon and Rud, (2013)).*

3. Data

3.1 Socio-economic and health data

The socio-economic and health data for this chapter are obtained from the Living Conditions and Monitoring Surveys (LCMS) from Zambia available at the time of writing this chapter. The number of households and individuals captured differs in each survey year. Due to the unavailability of panel data on socio-economic and health data in Zambia, the obtained data was aggregated at constituency level to form a panel dataset. This helped to capture the same constituencies' health outcomes for all the survey years.

The LCMS data has some notable strengths: it covers a very broad range of households and individuals; surveys have been conducted for nearly 15 years; individual surveys are fairly comparable and there is strong data on the specific health outcomes such as chest infections and anaemia. In addition, the data also captures the socioeconomic status and provides information on health outcomes. These currently make the LCMS an obvious choice to study health and development at a micro level in a single country. Unlike other studies that have constructed pooled cross-section pseudo panels, this strategy is avoided in this paper as the data was not collected from the same individuals in all the survey years. A balance is thus struck by instead resorting to aggregating the data at constituency level with 150 constituencies being used over a period of 5 survey years.

The detailed data on health from all the households surveyed was obtained from the LCMS. The core indicators are the proportion of the population that suffered from any chest infections which include tuberculosis. In addition to the core outcomes, data is collected on a range of health outcomes, employment and occupation. The range of health outcomes includes the proportion of the population that suffered from anaemia and diarrhoea in each constituency. The proportion of the population that suffered from any other general illnesses which represent levels of poor health outcomes is also taken into consideration.

3.2 Mining data

Information on the location and characteristics of mine and mineral production was drawn from three main data sources for. These include data collected from the mine annual reports, the Ministry of Mines and Minerals Development and Westmetall. In total, all the 10 large copper mines were observed in the cross-section. All the mines are located in the north-western part of Zambia. Even though issues may be raised on selection bias, this is not a limitation for this study as copper mining in Zambia is concentrated in the north-western part of the country which is largely endowed with copper deposits as all the 10 mines were taken into account.

Table 1- Summary Statistics for Health Outcomes

Variables	Mean N=750	Standard Error
Household head		
% of literate household heads	81.22	10.91
Average age	42.12	3.15
% of female headed households	20.13	9.17
Household		
% of the population that had chest infections	17.5	0.8
% of the population that had diarrhea	39.03	19.77
% of the population that had anemia	4.322	2.09
% of population that were generally sick	60.84	20.08
% of population with access to electricity	35	1
% of population with access to clean water	77.2	0.6
Number of household members	5.4	0.03
Mining data		
Per capita Copper production	3881.33	7314.50
% of population living close to the mines	26.67	44.25
Constituency data		
Distance to nearest mine(km)	419	12.2
Population	81350	3003.6
Observations (Constituencies)	150	

3.2. Summary Statistics

Table 1 reports the summary statistics with column 1 showing the mean values of each variable for the whole sample while column 2 reports the corresponding standard errors. The variables are reported in different categories, firstly at household head level. Secondly, there is a focus on the average outcomes at household level. The third category reports statistics from the mining data and lastly statistics on constituency data are presented. The number of observations in this case (which represents the constituencies is 150). A striking feature to note from the summary statistics of the per capita mine level copper output is that the mean in this case seems to be much lower that the corresponding standard error. This unique result could be attributed to the manner in which the copper output is assigned to each constituency. The assignment of copper output values in this case is based on the distance between a constituency and a mine. Constituencies located within a distance of 200km to the nearest mine are in this case taken to be close to a mine while those farther than 200km to the nearest mine are regarded as being far away from mining operations and therefore considered as having no mine presence. With this assumption as borrowed from previous literature, it is imperative to only assign copper output values to constituencies considered as having a mine presence while those with no mine presence are assigned a zero-copper output value. Further summary statistics for all the data can be found in the appendix.

Overall, the summary statistics indicate two main points. Firstly, some constituencies faced higher percentages of general sickness leading to a higher mean, while there was generally lower prevalence of anemia which has also been observed in the regression estimations. Secondly, diarrhea cases seem to also be on a higher side. The results section further provides formal regressions tests on the relationship between health outcomes and copper output during the survey period.

4. Econometric Specification

Coming back to the research question, it is at least plausibly the case that the copper wealth accruing to a constituency is not entirely a gift of nature but rather amenable to change based on public policies—affecting industrialization, human capital formation, and the like—it remains to consider a strategy that can connect this insight to an examination of impact of the extraction of this wealth on health outcomes. The basic question that frames this discussion—does natural resource wealth tend to promote poor health outcomes? —is quite simple. But successive efforts to examine the question empirically, and the prevailing dissensus that appears in the literature, make clear that adequately specifying and examining this relationship is anything but simple. As much as it is common practice to find the probabilities of an outcome in health economics, making it necessary to use probability models, this may not be possible with this study. This is because probability models require the use of binary data and in our case the unit of analysis, which is the constituency cannot provide that binary data. It would have been possible to make use of a probit model if the unit of analysis was either the household or individual. As such, this paper makes use of the 2SLS IV model with the international copper price being used an instrumental variable.[3]

4.1 Baseline model

In the baseline investigation of health impacts, there was no distinction between different types of mines. As such the main concern was with the health consequences of environmental contamination with heavy metals, precisely, copper and traces of lead that may be found in the mining operation process.

The baseline model (the Structural Equation) is as follows.

$$\boldsymbol{ln(y_{c,t}) = \alpha_c + \beta_t + \beta_1 lnM_{c,t} + \beta_2 X_{c,t} + \varepsilon_{c,t}} \qquad \textbf{(1)}$$

Where $\boldsymbol{ln(y_{c,t})}$ denotes the natural logarithm of constituency c health outcomes at year t (for example, ln of the proportion of the population that suffer from general sicknesses, anaemia, chest infections and diarrhoea), $\boldsymbol{lnM_{c,t}}$ represents the natural log of the [4]per capita

[3] Not being able to use a probability model is one of the major limitations of this chapter.

[4] Per capita mine level copper output is used in this case so that the effect on the population is made clearer as I am measuring the probability of poor health at constituency level.

mine level copper output on health outcomes in constituency c at time t, $\boldsymbol{X_{c,t}}$ is a vector of exogenously determined constituency *c* characteristics that vary over time such as population density at time t, $\boldsymbol{\alpha_c}$ is a constituency fixed effect, $\boldsymbol{\beta}_t$ is a year fixed effect.[5] All fixed effects are missing in the estimation results presented further as they are removed routinely with the Two-Stage Least Squares Fixed Effects (2SLS FE) estimation in STATA statistical software. Finally, $\boldsymbol{\varepsilon_{ct}}$ denotes the error term for constituency *c* at time *t*. The functional form chosen to be the full elasticity model in order to make the data observations smooth and additionally mitigate any potential problem of heteroscedasticity in the data, furthermore the full elasticity model has a very useful feature of interpreting the causal relationship in terms of the 1 percentage change leading to the $\boldsymbol{\beta_1}$ percentage change ceteris paribus.

By removing fixed cross-country differences from the estimation of the effect of human capital or industrialization on copper output, I avoid the problem of correlation of the copper production with underlying physical copper endowments and other country-level characteristics (for example, geology, climate, and copper ore deposits and quality, inter alia). In all my specifications, I employ constituency fixed effects. The principal reason is that one should take into account the inherent characteristics of the constituencies that do not change over time. In addition to that, the research concentrates on the in-country variations, rather than taking into account different countries is related to the following. The claims of the resource-curse literature are about changes in health outcomes that are driven by changes in natural resource output at the constituency level. Relying on cross-national variation (which is typically much larger than within-country variation) to assess the thesis would be exceedingly indirect, and critically misspecified if the health outcome-relevant (static or slow-moving) cross-national differences are not all correctly modelled. There is a wide agreement on such a specification in recent work—strong supporters and opponents of the resource curse thesis alike have come to focus on within-country temporal variation.[6]

The estimation approach used is the Two-Stage Least Squares with fixed effects for panel data. The reason for using the 2SLS, as usual in many empirical studies (Card (1995), Caselli and Michaels (2013), Monteiro and Ferraz (2012), or Arceo-Gomez et al (2015)), is a potential problem of endogeneity. The source of concern in the use of the instrumental variable

[5] Per capita mine level copper output was used as proxy for pollution due to the unavailability of data on pollution.

[6] See Andersen and Ross (2014); and Haber and Menaldo (2011), respectively.

identification is whether the mine level copper output is independent of the confounders that affect health outcomes in the constituencies located closer to the mines. If this is the case, then there would be a violation of the exclusion restriction assumption. To examine this possibility, I test the exogeneity of the instrument in the context of Zambia and consider the possible consequences of mine level copper output on the health outcomes. I equally test whether the variation in health outcomes is conditionally independent of the unobserved channels such as the environmental conditions of the constituencies. If this is the case, then the estimation of the effects of mine level pollution (which is measured by the mine level copper output) will be unbiased. Therefore, the first stage regression model (or a Reduced Form equation) is as follows:

$$\boldsymbol{lnM_{c,t} = \gamma_c + \tau_t + \delta lnIntCP_{t-1} + \beta_2 X_{c,t} + u_{c,t}} \qquad \textbf{(2)}$$

Where $\boldsymbol{lnIntCP_{t-1}}$ is the natural log of the international copper price in period *t-1*. $\boldsymbol{X_{c,t}}$ denotes a vector of all the exogenous explanatory (control) variables in the second stage for constituency *c* at time *t*, while $\boldsymbol{u_{c,t}}$ is the error term for constituency *c* at time *t*.

I define exposure to mining as being geographically close to a mine. This choice is immediate for the study of economic impacts. Previous studies e.g. Goltz and Barnwal (2019) have used distances of between 40-200km, using similar distances in this study takes into account the effects of the use of water that has been polluted by mine discharges into the nearby rivers, mostly the Kafue river and the air pollution (WHO, 1999).[7] I select the distance of 200km to the nearest mine in order to take into consideration the effects of the pollutants from the mines that are located in the rural areas (away from residential housing), yet discharge their waste effluents into the water deposits that are used to supply water to residents in nearby constituencies. It can therefore be argued that the use of such a range of distance is reasonable as it will enable me to effectively study the impact of mining on health. Shorter distances such as those employed by Goltz and Barnwal (2019) may not be able to adequately capture all the affected constituencies. It is therefore more plausible to go up to a distance of 200km because the effects of pollution as reported in past literature may extend to such distances, as the pollution may spread over a 200km radius.

[7] Disease outbreaks such as cholera which killed close to 500 people on the Copperbelt town of Kitwe in 1992 have previously been linked to the pollution of the mines.

The per capita mine level copper output represents the output of the mine assigned for the nearest constituency (located within 200km). While the output for constituencies located further than 200km away was assigned to be zero for all years. Extracting minerals from the ground, breaking them up, and processing them generates a flow of pollution. At the same time though, the stock of tailings dumped after processing will in many cases continue to pollute. This will, therefore, have an impact on the health of people living around the vicinity of a mine or a mine dumpsite (WHO, 1999).[8]

The controls always include some appropriate socio-economic measures such as the age of the respondent or the household head. As a result of the LCMS being repeated cross-sections (CSO, 2010), my model allows for repeated measurements of effects near the same mine, while accounting for year-specific and constituency effects in each round of measurements. I account for the residual serial correlation by clustering errors at the constituency level and using the Robust Standard Errors for estimates at both stages.

4.2 The Examination of Instrumental Variable

I take as given that copper wealth is at least in part related to industrial strategy and human capital formation, which can themselves be connected to health outcomes, as an ample body of research suggests. But this raises the possibility of a potential (at least indirect) endogeneity between the health outcomes and the actual level of copper output. If good higher wages lead to better health outcomes, ceteris paribus, and this, in turn, helps make copper mining more viable, then standard treatments of the relationship between copper wealth and health outcomes are potentially biased. I take two strategies to examine this potential endogeneity, with an eye to producing a more appropriate estimate of the actual effect of copper wealth on health outcomes.

My main strategy for examining the causal linkage between natural resources (copper output) and the health outcomes net of the effect of endogeneity in this relationship is to employ an instrumental variable to purge the copper output measure of its endogenous component. Of course, such strategies can themselves cause difficulties if the quality of the instrument is not high. In this case, my instrument for per capita mine level copper output, as earlier stated, is the natural log of the international copper price. The instrument needs to be exogenous—that

[8] Mines in most cases dump their waste from extraction or processing of copper very near their operating site.

is, have an effect on health outcomes that operates only through its association with mine level copper output per capita. Although it is comforting that my instrument is not correlated with the outcome at a bivariate level, exogeneity is itself essentially a theoretical matter—a claim about the exclusivity of the pathway of the effect of the instrumental variable.

The principal issue is whether I would have reason to believe that international copper price is itself associated with other causal pathways leading to health outcomes. There are good reasons to think not. First, the international copper price has not been commonly theoretically identified in any of the voluminous literature on resource curse itself. This literature has focused almost entirely on income or exports, not the prices. Moreover, there is no theoretical reason to believe that international copper price would have any connection either to health outcomes or to any of the commonly identified correlates or causes of poor health outcomes. Another way is to account for the possibility of copper entering into the prices of all electrical medical equipment and computers. Meaning that higher international copper prices might be correlated with the health outcomes but very little, like in the case of the sample used for this study. Even the literature on country-size effects focuses on population, not geographic area.
If the claims of resource-curse scholars are accurate, then higher levels of copper output should be associated with changes in the health outcomes in a more positive direction, regardless of the starting point.

There may be possible issues with the health expenditure in each constituency. This is not likely to cause any omitted variable bias as health expenditures allocated to government health facilities are not dependent on whether a constituency has any mining operations in place or not. Instead, government budgetary allocations to each constituency are centrally distributed by the Ministry of health on the basis of the size and number of health facilities in an area. In addition, some mining companies also run their own health facilities which are not funded by the government.

Finally, the results tables in the next section provide additional diagnostic tests' p-values for the instrument used in the First-Stage regression. The Kleibergen-Paap is a test of under-identification distributed as chi-square under the null hypothesis of under-identification. The Anderson Rubin and Stock-Wright LM statistic are weak instrument-robust inference tests, which are distributed as F-test and chi-square respectively, under the null hypothesis that coefficients of the endogenous regressors in the structural equation are jointly equal to zero, and the over-identifying restrictions are valid. In all regression estimations, we do not find any evidence with the problems related to under-identification or presence of weak instruments. In addition to that, the possibility of multicollinearity is taken into account. The sample size in this case was large enough to make sure that multicollinearity does not bring any problems to the estimation.

5. Main Results

This section provides evidence that the expansion (or presence) of mining activities is associated with a significant adverse effect on health outcomes. These health outcomes represent the proportion of those that have been suffering from each health outcome in each constituency over the survey period. The results were tested against different samples and showed at least qualitative robustness. While unable to measure mining-related pollution directly, I use copper production levels for people living close to the mines to show that pollution concentrates around mining areas.

5.1 Effect of copper production on Health Outcomes

Table 2 presents the main results. In column 1, I explore the relationship between living close to a mine and general sickness, column 2 focuses on anaemia, column 3 on chest infections and lastly column represented the results on the relationship between copper output and diarrhoea. The commentaries concentrate mostly on the causal relationship between log of per capita copper output and the log of each of the four specific health outcomes.

The result from the Table 2 above shows, at first glance, the surprising decrease in general sickness associated with the growth of the production of copper. From the estimated coefficients it is clear that holding other factors fixed, one percent increase in copper production leads to the 0.076% decrease in the population with general sickness in an average constituency. That supports the claim stated before, suggesting that the increase in copper production may lead to the provision of better infrastructure, whose effect on the constituencies' habitants goes in the opposite direction with the usual negative impact on the them through the depreciation of the environment around.

Similar results are also obtained for anaemia, where the 2SLS FE estimation shows a statistically significant reduction in presence of anaemia. Thus, holding other factors fixed, a percentage increase in per capita mine level copper output leads to a 0.167 per cent decline in the proportion of the population that suffers from anaemia. This result is also not consistent with mining affecting specific health outcomes through pollution. This may be attributed to better employment possibilities, what makes people being able to afford food that may help improve their red blood cells levels. However, one should note that the effect is very small, and combined with statistical significance, it seems that the positive effect of infrastructure for both, general sickness and anaemia, in particular, is stronger than the negative externality expected, but only marginally.

According to the estimation, the additional percent of production of copper on average results in 0.076 percent decrease in general sickness of the constituencies' inhabitants, ceteris paribus. On the other hand, as it can be observed, the ceteris paribus effect of a slight increase in copper production is, as expected a priori, on average increase the chest infections and diarrheal cases ceteris paribus. The magnitude of the coefficients seems to be similar to the coefficient in Table 4.2 (0.088% and 0.079% respectively).

Table 2: Effect of Ln (Copper Output) on the Health Outcomes

Panel 1-Second Stage	**Dependent Variables**			
	General Sickness	Anaemia	Chest infections	Diarrhea
	(1)	(2)	(3)	(4)
Independent Variables	2SLS FE	2SLS FE	2SLS FE	2SLS FE
Ln (Per capita mine level copper output)	-0.076***	-0.167***	0.088***	0.079***
	(0.019)	(0.036)	(0.023)	(0.021)
R-squared	0.218	0.421	0.642	0.482
Observations	750	750	750	750
Constituency FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Controls	ALL	ALL	ALL	ALL
Panel 2-First Stage				
Instrumental Variable				
International Copper Price	*2.750****	*2.750****	*2.746****	*2.756****
	-0.468	*-0.468*	*-0.468*	*-0.469*
F-statistic	*34.47****	*34.47****	*34.47****	*34.53****
P-Value	*0.000*	*0.000*	*0.000*	*0.000*
Kleibergen-Paap	*0.000*	*0.000*	*0.000*	*0.000*
Anderson Rubin	*0.000*	*0.000*	*0.000*	*0.000*
Stock-wright	*0.000*	*0.000*	*0.000*	*0.000*

Notes: Robust standard errors in parenthesis. Standard errors are clustered at constituency level. *denotes significance at 10%, **significant at 5% and *** significant at 1%. All regressions include year and constituency fixed effects. The full set of control variables includes: constituency level age, average household size and population density.
Panel 2 of the table provides diagnostic tests for the IV regression model reported in Table 2. The Kleibergen-Paap is a test of under-identification distributed as chi-square under the null of under-identification. The Anderson Rubin and Stock-Wright LM statistic are weak instrument-robust inference tests, which are distributed as F-test and chi-square respectively, under the null that coefficients of the endogenous repressors in the structural equation are jointly equal to zero, and the over-identifying restrictions are valid.

5.2 Effects of copper mining on health by mine type

In table 3, I look at the effect that the mine type has on specific health outcomes. This basically analyses the effect that open pit mines and underground mines have on health outcomes respectively. Both mine types have their individual consequences with higher risks of chest infections expected in constituencies close to underground mines due to effects of dust that is released underground during the mining of the copper ore from the ground. Both types of mines are likely to be releasing effluents into the nearby rivers as well as sulphuric acid during the copper processing phase.

In respect to the results, it can be seen that after the partition done the results are similar in magnitude and sign to the results from a pooled sample presented above (Table 3). Thus, the estimations show that one per cent increase in per capita copper production on average decrease the general sickness cases by 0.098% ceteris paribus for the underground subsample. The estimations on the open pit subsample show statistically significant estimates.

This could be attributed again to the fact that developing of a mine requires the appropriate infrastructure to be built around, increasing the level of life for inhabitants, while the open pit type of mines does not require such infrastructure. These improvements generally lead to better health facilities provided by the mining companies and the ability to afford a better lifestyle due to the increase in employment levels by the mines during the study period which may have culminated into higher wages and thereby improved living standards as observed in chapter one of this thesis. This is supported by the World Bank (2015) in their study on the local effects of gold mining. They observed that Higher income could improve household health by reducing the disease environment through making it possible for the household to buy better-quality housing with proper sanitation and clean water. Higher incomes can also directly buy better health care. This evidence further lends support to the results being significantly different between underground mines and open pit mines. In the case of Zambia, research by labour experts has proved that underground workers tend to get higher wages than open pit workers, so their health may be generally better as they can afford to consume more healthy food and also maintain a better and healthier lifestyle. The wages in underground mining tend to be higher due to the greater risk. In addition, some of the underground work is subcontracted to other firms like Atlas Copco and Sandvik that seem to pay their workers higher wages than what is paid out for example currently by most mining companies that originate in China. This is due to the fact that Chinese firms are globally known to use cheap labour in comparison to western firms whose countries of origin have a minimum wage law which requires decent wages to be paid to all employees. In A report for the Human Rights Watch (2011), Matt Wells observed that even though there has been substantial investment and job creation by Chinese-run copper mines, workers suffer from abusive employment conditions that fail to meet domestic and international standards and fall short of practices among copper mining industry elsewhere in Zambia. In addition, miners at several Chinese-run companies reported of poor health and safety standards, including poor ventilation that can lead to serious lung diseases, hours of work in excess of Zambian law, the failure to replace workers' protective equipment that is damaged while at work, and the threat of being fired should workers refuse to work in unsafe places. In general, injuries and negative health consequences are not uncommon.

However, one should take into account the asymmetric usage of different types of mines. Due to concentrating on Zambia only, the sample consists of only those mines that are present in the country. Thus, as the underground mining is more popular in the country, there are more underground mines present in the sample. While partitioning of the sample by the mine type can be interesting from policy maker's perspective, it produces not comparable results. There are only 165 constituencies that lie geographically close to the open pit mines, what restricts the degrees of freedom and available information for producing robust estimation results, implying that the cause of the insignificance of estimates (including the coefficient of interest) can also be due to the lack of observations apart from the case that open pit mines have no statistical effect on the health outcomes of the nearest constituencies. This is also supported by the dropping of the significance of the instrument (F-stat) in the first stage regression estimation results. A similar situation can be seen in all regressions on the partitioned sample, that is considered as a limitation of the current research and discussed more in the limitation section below.

Table 3: Effect of Ln (Copper Output) on Health Outcomes by Mine Type

Panel 1-Second Stage	General Sickness	General Sickness	Chest Infections	Chest Infections	Anaemia	Anaemia	Diarrhoea	Diarrhoea
Independent Variables	2SLS FE	2SLS FE	2SLS FE	2SLS FE	2SLS FE	2SLS FE	2SLS FE	2SLS FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Per capita mine level copper output	-0.052	-0.098***	0.01	0.136***	-0.087	-0.225***	0.072	0.088***
	(0.035)	(0.019)	(0.041)	(0.026)	(0.054)	(0.036)	(0.043)	(0.024)
Mine Type	***Open pit***	***Underground***	***Open pit***	***Underground***	***Open pit***	***Underground***	***Open pit***	***Underground***
R-squared	0.048	0.032	0.17	0.126	0.17	0.187	0.645	0.056
Observations	165	585	165	585	165	585	165	585
Panel 2-**First Stage**								
Instrumental Variable								
International Copper Price	*3.824***	*2.206****	*3.824***	*2.206****	*3.824***	*2.206****	*3.824***	*2.204****
	-0.1785	*-0.24*	*-0.1785*	*-0.24*	*-0.1785*	*-0.24*	*-0.1785*	*-0.24*
F-statistic	*4.59***	*84.73****	*4.59***	*84.73****	*4.59***	*84.73****	*4.59***	*84.83****
P-Value	*0.04*	*0.000*	*0.04*	*0.000*	*0.04*	*0.000*	*0.04*	*0.000*
Kleibergen Papp	*0.04*	*0.000*	*0.04*	*0.000*	*0.04*	*0.000*	*0.04*	*0.000*
Anderson Rubin	*0.006*	*0.000*	*0.003*	*0.000*	*0.003*	*0.000*	*0.000*	*0.000*
Stock Wright	*0.003*	*0.000*	*0.002*	*0.000*	*0.002*	*0.000*	*0.000*	*0.000*

Notes: Robust standard errors in parenthesis. Standard errors are clustered at constituency level. *denotes significance at 10%, **significant at 5% and *** significant at 1%. All regressions include year and constituency fixed effects. The full set of control variables includes: constituency level age, average household size and population density.
Panel 2 of the table provides diagnostic tests for the IV regression model reported in Table 2. The Kleibergen-Paap is a test of under-identification distributed as chi-square under the null of under-identification. The Anderson Rubin and Stock-Wright LM statistic are weak instrument-robust inference tests, which are distributed as F-test and chi-square respectively, under the null that coefficients of the endogenous repressors in the structural equation are jointly equal to zero, and the over-identifying restrictions are valid

Similarly, in column 2, it can be observed that open pit mining does not have any significant effect on chest infections while underground mining has a significant effect on chest infections with a percentage increase in per capita mine level copper output leading to 0.136 percentage increase in the proportion of population that suffers from chest infections such as tuberculosis.

On the other hand, column 3 shows that underground mining has a negative and significant effect on anaemia with anaemia cases reducing on average by -0.225 per cent for a per cent increase in per capita copper production holding everything else fixed. Results from column 4 propose that a 1 per cent increase in copper production led to an average 0.088 per cent increase in diarrhoea cases, ceteris paribus.

4.5.3 Effects of copper mining by Rural/Urban Status

This section analyses the effect of copper mining on health outcomes by rural or urban status. This is an important classification as some mines in Zambia tend to be located nearer to rural areas where there seems to be more open land. In our sample there are mines that are close to both rural and urban areas, thus it is necessary to check if the effect of mines on the constituencies depends on the type of settlement.

Beginning with general sickness (in column 1 of table 4), one can see that in both cases there is a significant positive effect on this health outcome (negative effect on cases of general sickness). The elasticity coefficients of interest are both negative for rural and urban areas (-.155 and -0.043), what is consistent with our previous estimates, but different in magnitude, implying that the effect of copper extraction on the general sickness in the rural areas can be higher than in the urban areas. This, potentially, suggests that the positive externalities through the infrastructure development are more efficient for the rural areas. On the other hand, this reduction could also be attributed to the lower levels of pollution found in rural areas as well as the fresh air that is created as a result of the presence of nature such as trees surrounding the rural areas. Further, both coefficients are statistically significant, and, despite the smaller subsample size for the rural areas (230 vs 520), the per capita copper production coefficient for rural areas has a bit higher T-statistic than a T-statistic for the same coefficient in the second subsample. At the same time, it is important to keep in mind that the effects are still small, less than one per cent decrease in general sickness cases per one per cent increase in the copper production. In addition, the asymmetry of the sample sizes should be mentioned as a limitation of the work. It is present in here for the same reasons that were described in the previous subsection.

Results in columns 5 and 6 of table 4 show similar results and similar magnitude difference is present for the regressions of the anaemia cases. This could be attributed to the type of diet found in rural areas which most of the times seems to be richer in essential nutrients than that found in urban areas. Despite that difference, the effects are also larger in magnitude to the estimates in the previous regression (columns 1 and 2). Another point that requires attention is the occasional significance of the coefficient on the population density in the 2SLS FE regressions in columns 1-4 of the table. The coefficients are weakly statistically significant and negative. The potential explanation for that can be that the higher population is correlated with the development of a settlement, thus higher development of infrastructure, what may lead to the better health outcomes. This sentiment is supported by Lippert (2014) who observed that constituencies located close to infrastructure such as transport links are likely to benefit from the linkages with the mining industry.

On the other hand, following the patterns from the previous subsection, the regressions of the other health outcomes show opposite results. The elasticities of chest infections (columns 3 and 4) are statistically significant in urban areas only; with a percentage increase in copper production leading to 0.145 per cent increase in chest infections on average, ceteris paribus (CP). This result could be attributed to fact that most mine workers (who are likely to be directly exposed to the mining processes) tend to live in urban areas (Fraser and Lungu, 2007). [9] Results in columns 7 and 8 of table 4 further show a statistically non-zero increase in diarrheal cases in the urban areas with a percentage increase in copper production leading to a 0.071 per cent increase in the prevalence of the disease (CP), while the effect is even larger in the rural areas, 0.112 per cent (CP). Such difference in the estimates between rural and urban areas could be attributed to the lack of access to safe clean water in rural areas, as well as, to the poor sanitation that may be found in certain parts of the urban areas where people live in slums and may not afford to live in houses with flushable toilets. Access to clean flushable toilets has been previously found to affect the prevalence of diarrhea in developing countries (World Bank, 2015)

[9] Living in urban areas makes it easier to get to work as there is easier access to transport and better roads in urban areas.

Table 4: Effect of Ln (Copper Output) on Health Outcomes by Rural/Urban Status

Panel 1-Second Stage	General Sickness	General Sickness	Chest Infections	Chest Infections	Anaemia	Anaemia	Diarrhoea	Diarrhoea
Independent Variables	2SLS FE	2SLS FE	2SLS FE	2SLS FE	2SLS FE	2SLS FE	2SLS FE	2SLS FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Per capita mine level copper output	-0.155**	-0.043**	0.018	0.145***	-0.293**	-0.120***	0.112**	0.071*
	(0.049)	(0.016)	(0.034)	(0.041)	(0.089)	(0.036)	(0.035)	(0.027)
Mine Type	***Rural***	***Urban***	***Rural***	***Urban***	***Rural***	***Urban***	***Rural***	***Urban***
R-squared	0.087	0.827	0.1	0.193	0.161	0.215	0.753	0.395
Observations	230	520	230	520	230	520	230	520
Panel 2-**First Stage**								
Instrumental Variable								
International Copper Price	*2.990****	*2.457****	*2.990****	*2.457****	*2.299****	*2.457****	*2.990****	*2.472****
	(0.743)	*(0.571)*	*(0.743)*	*(0.571)*	*(0.743)*	*(0.571)*	*(0.743)*	*(0.573)*
F-statistic	*16.17****	*18.48****	*16.17****	*18.48****	*16.17****	*18.48****	*16.17****	*18.58****
P-Value	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Kleibergen Papp	*0.001*	*0.000*	*0.001*	*0.000*	*0.000*	*0.000*	*0.001*	*0.000*
Anderson Rubin	*0.000*	*0.000*	*0.632*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Stock Wright	*0.000*	*0.000*	*0.519*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*

Notes: Robust standard errors in parenthesis. Standard errors are clustered at constituency level. *denotes significance at 10%, **significant at 5% and *** significant at 1%. All regressions include year and constituency fixed effects. The full set of control variables includes: constituency level age, average household size and population density.

Panel 2 of the table provides diagnostic tests for the IV regression model reported in Table 2. The Kleibergen-Paap is a test of under-identification distributed as chi-square under the null of under-identification. The Anderson Rubin and Stock-Wright LM statistic are weak instrument-robust inference tests, which are distributed as F-test and chi-square respectively, under the null that coefficients of the endogenous repressors in the structural equation are jointly equal to zero, and the over-identifying restrictions are valid

5.4 Effects of copper mining and real income on health outcomes

In Table 5, I look at the effect that copper mining has on specific health outcomes in relation to the real incomes. In this case; the variable real income represents the average per capita real income in each constituency. This, basically, analyses whether including real incomes to the baseline regressions has any influence on the various health outcomes. Results in the tables listed below lend support to the earlier findings with evidence of reverse causality being exhibited. The instrument-international copper price is still highly valid as observed in panel 2 of all the tables.

Table 5 Effect of Ln(Copper output) and Ln(Real Incomes) on Health outcomes

Panel 1-Second Stage	General Sickness	Chest Infections	Anaemia	Diarrhoea
	2SLS FE	2SLS FE	2SLS FE	2SLS FE
Independent Variables	(1)	(2)	(3)	(4)
Ln (Per capita mine level copper output)	-0.061***	0.080***	-0.139***	0.059***
	(0.013)	(0.018)	(0.026)	(0.016)
Ln (Real income per capita)	-0.147***	0.095	-0.281***	0.137***
	(0.038)	(0.054)	(0.078)	(0.037)
R-squared	0.467	0.396	0.883	0.491
Observations	750	750	750	750
Panel 2-First Sage				
Instrumental Variable				
International Copper Price	*3.367****	*3.367****	*3.367****	*3.373****
	(0.479)	*(0.479)*	*(0.479)*	*(0.479)*
F-statistic	*49.42****	*49.42****	*49.42****	*49.49****
P-Value	*0.000*	*0.000*	*0.000*	*0.000*
Kleibergen-Paap	*0.000*	*0.000*	*0.000*	*0.000*
Anderson Rubin	*0.000*	*0.000*	*0.000*	*0.000*
Stock-wright	*0.000*	*0.000*	*0.000*	*0.000*

Notes: Robust standard errors in parenthesis. Standard errors are clustered at constituency level. *denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and constituency fixed effects. The full set of control variables includes: constituency level age, average household size and population density.
Panel 2 of the table provides diagnostic tests for the IV regression model reported in Table 2. The Kleibergen-Paap is a test of under-identification distributed as chi-square under the null of under-identification. The Anderson Rubin and Stock-Wright LM statistic are weak instrument-robust inference tests, which are distributed as F-test and chi-square respectively, under the null that coefficients of the endogenous regressors in the structural equation are jointly equal to zero, and the over-identifying restrictions are valid.

Column 1 of table 5 shows similar patterns of elasticity to the per capita copper production that were evident for general sickness in the estimations above. The increase in such production leads to the decrease in the proportion of the population with general sickness on average and ceteris paribus. This improvement in the prevalence of general sicknesses could also be attributed to the quick and efficient response to curb such diseases in mining towns by the mining companies. In most mining companies, there are frequent programs laid down to deal with disease prevention at the community level through environmental health specialists. An example of this is the fumigation that takes place to control the spread of malaria, provision of mosquito nets and at times community health education to teach local communities how to prevent certain diseases. In addition to that, the coefficient of the natural log of the real income is highly significant and negative. Thus, according to the estimation with a one per cent increase in the real income, as expected, the cases of general sickness decrease by 0.147 per cent.

In the case of anaemia, results still show a reduction in the proportion of the population that suffer from anaemia. Even if the magnitudes of the coefficients on the per capita mine level copper output shows a decline, this remains significant. In addition, an increase in real incomes also reduces the proportion of the population that suffered from anaemia during the study period. As for chest infections, the impact of per capita mine level copper output on chest infections is still significant. On the other hand, the real income has an insignificant impact on chest infections.

Slightly unusual and unexpected results are present in column 4. As usual, the increases in copper output seem to increase the prevalence of diarrhoea, however, the increase in real incomes also increases the proportion of the population that are affected by diarrhoea. This could partly be attributed to the fact that the higher incomes are reported in urban areas, where an increase in the population can lead to intense competition for limited good sanitation and clean water. This may, in turn, affect the provision of services and compromise their quality leading to an increase in diseases. Thus, the urban areas in Zambia have a higher prevalence of communicable diseases such as diarrhoea as was the case in the rainy season of 2017-2018 where there was a catastrophic cholera outbreak in mostly urban areas of Zambia such as Lusaka (Sladoje, 2018). Another example is the cholera outbreak that affected the mining towns on the Copperbelt after the contamination of their major sources of clean water. This outbreak led to several deaths, especially in Kitwe (WHO, 1999).

The above results validate the earlier findings that only levels of anaemia and general sickness experience an improvement from increases in copper mining. Similar results are observed in table 6 when the measure of wellbeing is changed to poverty. The non-poor show resilience to anaemia and chest infections while the poor are more likely to suffer from such illnesses because of not being able to afford healthy food that can be used to prevent the diseases assessed in this chapter. In the most recent past, there has been a shift in the type of diseases affecting urban wage-earning populations. Diseases such as high blood pressure, arthritis, diabetes and conditions such as stroke and heart problems seem to be more prevalent in urban areas. This is an area for future research.

Table 6: Effect of Ln (Copper output) and Poverty(poor) on Anemia and chest infections

Panel 1-First Stage	Anemia	Chest Infections
	2SLS FE	2SLS FE
Independent Variables	(1)	(2)
Ln (Per capita mine level copper output)	-0.115***	0.090***
	(0.025)	(0.024)
Non-Poor	-0.653***	0.0002
	(0.071)	(0.056)
R-squared	0.547	0.66
Observations	750	750
Panel 2-First Stage		
Instrumental Variable		
International Copper Price	*2.786****	*2.786****
	(0.484)	*(0.484)*
F-statistic	*33.17****	*33.17****
P-Value	*0.000*	*0.000*
Kleibergen-Paap	*0.000*	*0.000*
Anderson Rubin	*0.000*	*0.000*
Stock-wright	*0.000*	*0.000*

Notes: Robust standard errors in parenthesis. Standard errors are clustered at constituency level. *denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and constituency fixed effects. The full set of control variables includes: constituency level age, average household size and population density.
Panel 2 of the table provides diagnostic tests for the IV regression model reported in Table 2. The Kleibergen-Paap is a test of under-identification distributed as chi-square under the null of under-identification. The Anderson Rubin and Stock-Wright LM statistic are weak instrument-robust inference tests, which are distributed as F-test and chi-square respectively, under the null that coefficients of the endogenous regressors in the structural equation are jointly equal to zero, and the over-identifying restrictions are valid.

6 Conclusion

This paper examined an important externality that polluting industries may impose on local communities, effects on health outcomes. It finds robust evidence that general health outcomes are better in constituencies located closer to the mining areas relative to areas in the same region but located at a greater distance from mining activities. In addition, general health outcomes became better for people living closer to open pit mines relative to those living in constituencies located closer to underground mines. It also documents a general reduction in anaemia cases for those living close to mines associated with an increase in copper production. The magnitude of these effects is however, specific to the Zambian case and should not be extrapolated to other contexts. Evidence from this chapter conclusively reveals that the real economic benefits generated in mining constituencies go hand in hand with reduced levels of anaemia and general sicknesses. This just shows significant evidence that all change in an economy brings costs and benefits; gainers and losers. But in most cases the national benefit tends to outweigh the costs.

References

Acemoglu, D., Finkelstein, A., and Notowidigdo, M. J. (2013). Income and health spending: evidence from oil price shocks. *Review of Economics and Statistics*, 95(4):1079–1095.

Alex Duncan; Hugh Macmilla, Simutanyi Neo. "Drivers of pro-poor change: an overview." Oxford Policy Management, Oxford, 2003.

Alexaar, Michael and Conrad, Robert. "The elusive curse of oil", *Review of economics and Statistics*. 91 no.3, 2009, 586-98

Allcott, Hunt and Keniston, Daniel. (2012.) Dutch Disease or Agglomeration? The Local Economic Effects of Natural Resource Booms in Modern America. OxCarre

Alvarez, R., Resources Policy (2018), Commodity price shocks and poverty reduction in Chile https://doi.org/10.1016/j.resourpol.2018.04.004

Almeida, H., Campello, M., Galvao Jr., A.F., (2010). Measurement Errors in Investment equations, *Review of Financial Studies* 20, pp3279-3328

Andersen JJ, Ross ML. (2014). The big oil change: a closer look at the Haber-Menaldo analysis. *Comp. Polit.Stud.* 47(7):933–1021

Arrelana, Yanguas. "Aggravating the resource curse: decentralization, mining and conflict in Peru." *Journal of Development Studies*. JDD-Abingdon, Oxfordshire: Roulledge. Vol. 47, 2011, 617-638

Aragón, F. M. and Rud, J. P. (2016). Polluting Industries and Agricultural Productivity: Evidence from Mining in Ghana. *The Economic Journal*, 126 (November)

Aragón, F. M. and Rud, J. P. (2013). Natural resources and local communities: evidence from a Peruvian gold mine. *American Economic Journal: Economic Policy*, 5(2):1–25.

Arellano, Pablo, J. (2012). "Copper mining and its impact on Chiles' development". *Integration and Trade Journal*, vol 32, issue 16, 45-57

Arceo-Gomez, E. O., Hanna, R., and Oliva, P. "Does the Effect of Pollution on Infant Mortality Differ Between Developing and Developed Countries? Evidence from Mexico City" (2016) The *Economic Journal,* 126(591): 257-280.

Aryeetey, E., Bafour, O. and Twerefou, D.K. (2007) Impact of mining sector reforms on output, employment and incomes in Ghana, 1982-2002, Institute of Statistical, Social and economic research (ISSER)

Axtmann, E.V and Luoma. S.N. 1991. Large scale distribution of metal contamination in fine grained sediments of the Clark Fork River, Montana. U.S.A. Appl. Geochem., 6: 75-88

Auty, Richard M. 2003. *Resource Abundance and Economic Development*. Oxford: Oxford University Press.

Balli, H.O., Sørensen, B.E. Interaction effects in econometrics. *Empir Econ* **45**, 583–603 (2013). https://doi.org/10.1007/s00181-012-0604-2

Baltagi, B., (2008). *Econometric Analysis of Panel Data*. Fourth Edition. New York, Wiley.

Bank of Zambia, 2016

Bannon, Ian; Collier, Paul. 2003. Natural Resources and Violent Conflict: Options and Actions. Washington, DC: World Bank. © World Bank.

Bazzi, S. and C. Blattman (2014). Economic shocks and conflict: evidence from commodity prices. *American Economic Journal*: Macroeconomics 6(4), 1–38.

Birabi, Timothy (2016) *Essays on cultural and institutional dynamics in economic development using spatial analysis.* PhD thesis.

Brooks, M. Sarah and Kurtz, J. Marcus. Oil and Democracy: Endogenous Natural Resources and the Political “Resource Curse”. *International Organization* 70, 2016, vol. 70, issue 02, 279-311

Card, David (1995): "Using Geographic Variation in College Proximity to Estimate the Return to Schooling," in *Aspects of Labour Market Behacio~lr:E ssays in Honour of John Vanderkamp,* ed, by Louis N. Christofides, E. Kenneth Grant, and Robert Swidinsky. Toronto: University of Toronto Press, 201-222.

Cameron A. Colin and Trivedi Pravin K. *Microeconometrics Using Stata*, Revised Edition (2010) Stata Press.

Cavalcanti, Tiago; Daniel, Da Mata and Toscani, Fredrick. (2015). *Winning the Oil Lottery: The Impact of Natural Resource Extraction on Growth*. International Monetary Fund. Working Paper series 16/61

Caselli, Francesco, and Guy Michaels. “Do oil Windfalls Improve Living standards? Evidence from Brazil.” *American Economic Journal: Applied Economics* vol.5 No.1, January, 2013

Central Statistical Office [Zambia]. 2011. Living Conditions and Monitoring Survey Report 2006 and 2010.Central Statistical Office, Lusaka, Zambia.

Central Statistical Office [Zambia] and Ministry of Labor and Social Security. 2013. Zambia Labor Force Report. Central statistical Office, Zambia.

Chen, Y., Ebenstein, A., Greenstone, M., and Li, H. (2013). Evidence on the impact of sustained exposure to air pollution on life expectancy from China’s Huai River policy. Proceedings of the National Academy of Sciences, 110(32):12936–12941.

Christiaensen, L., L. Demery, and J. Kühl. (2011). "The Role of Agriculture in Poverty Reduction: An Empirical Perspective." *Journal of Development Economics* 96: 239–254.

Conrad. F. Robert. (2012). Zambias' Mineral Fiscal Regime. International Growth Centre. Working Paper 12/0653

Corden, W. Max and J. Peter Neary (1982), "Booming Sector and De-Industrialisation in a Small Open Economy." *The Economic Journal*, 92, 825–848.

Corno, L. and DeWalque, D. (2012). Mines, migration and HIV/AIDS in Southern Africa. Journal of African Economies, 21(3):465–498.

Cust J, Rusli RD. (2014). The Economic Spillovers from Resource Extraction: A Partial Resource Blessing at the Subnational Level? EGC Report. 2014/02.

Cust, J and Harding, T; 2014. "**Institutions and the Location of Oil Exploration**," OxCarre Working Papers 127, Oxford Centre for the Analysis of Resource Rich Economies, University of Oxford.

Cust, J. and Poelhekke. S. (2015). The local economic impacts of natural resource extraction. *Annual Review of Resource Economics* (0).

Cust, J; Harding, T and Vezina, P. (2017), Dutch Disease Resistance from Indonesian Firms. OxCarre Research Working Paper Series Number 192

Deaton, Angus and Miller, Ronald. "International commodity prices, macroeconomic performance and politics in Sub-Saharan Africa." *Journal of African Economies*, Vol. 5 1996. 99-191

Dell, M. (2010). The persistent effects of Peru's mining mita. *Econometrica*, 78(6):1863–1903.

DikGang Johane and Muchapondwa Edwin." The effect of Land restitution on poverty reduction among the Khomani San 'Bushmen' in South Africa. *South African Journal of Economics*. 2015

Ding, N., Field, B.C. (2005). ''Natural Resource Abundance and Economic Growth.'' *Land Economics*, 81(4): 496–502.

Dinkelman, Taryn, David Lam, and Murray Leibbrandt. 2007. Household and community income, economic shocks and risky sexual behaviour of young adults: Evidence from the Cape Area Panel Study 2002 and 2005. AIDS, 21(supplement 7): S49-S56.

Donoghue, A.M. Occupational health hazards in mining: an overview *Occupational Medicine* 2004; **54:283**–289

Draca, Mirko; Koutmeridis, Theodore and Machin, Stephen. "The Changing returns to Crime: Do Criminals Respond to Prices?" Center for Economic Performance. Discussion Paper no.1355

Dube, O and Vargas, J.N. "Commodity price shocks and civil conflict: evidence of Colombia". *Review of Economic Studies*, 2013:80, 1384-1421

Dymond, Abi. 2009. Cursed by resources, institutions and multinationals?: In what ways have domestic institutions impacted on the relationship between MNCs and Economic growth and poverty in Zambia, and how significant has this contribution been? University of Manchester.

Dube, O and Vargas, J.N. "Commodity price shocks and civil conflict: evidence of Colombia". *Review of Economic Studies*, 2013:80, 1384-1421

Ebenstein, A. (2012). The consequences of industrialization: Evidence from water pollution and digestive cancers in China. *Review of Economics and Statistics*, 94(1):186–201.

Economics Association of Zambia (EAZ), *Impact of the Constituency Development Fund in Zambia, 2011*

Erickson, Timothy and Whited, Toni M., Measurement Error and the Relationship between Investment and Q. Available at SSRN: https://ssrn.com/abstract=284428 or http://dx.doi.org/10.2139/ssrn.284428

Esarey, Justin. 2015, September). Using Interaction Terms as Instrumental Variables for Causal Identification: Does Corruption Harm Economic Development? Rice University Working Paper.

Factor-Litvak, P., Slavkovich, V., Liu, X., Popovac, D., Preteni, E., Capuni-Paracka, S., Hadzialjevic, S., Lekic, V., LoIacono, and N., Kline, J.(1998). Hyperproduction of erythropoietin in nonanemic lead-exposed children. *Environmental Health Perspectives*, 106(6):361.

Factor-Litvak, P.,Wasserman, G., Kline, J. K., and Graziano, J. (1999). The Yugoslavia prospective study of environmental lead exposure. Environmental Health Perspectives, 107(1):9.

Fafchamps, M; Koelle, M and Shilpi, F. "Gold mining and pro-urbanization in Ghana: Recent evidence from Ghana", *World Bank Policy Research*. June 2015. Working Paper No. 7347

Fenton, Lynda. (2004). Preventing HIV/AIDS through poverty reduction: The only sustainable solution. Lancet, 364: 1186-87.

Fisher, E., Mwaipopo, R., Mutagwaba, W., Nyange & Yaron. “The Ladder that Sends us to Wealth: Artisanal Mining and Poverty Reduction in Tanzania”, *Resources Policy*, 34 (1): 1-7.

Fraser, A. and Lungu, J. (2007). For whom the wind falls? Winners and Losers in the Privatization of Zambia’s Copper Mines. *Mine Watch Zambia*

Goltz van der Jan and Barnwal, P. “Mines: the local effects of mineral mining in developing countries. *Journal of Development Economics* 139 (2019) 1–16

Grandjean, P., Jensen, B. M., Sandø, S., Jøgensen, P., and Antonsen, S. (1989). Delayed blood regeneration in lead exposure: an effect on reserve capacity. American journal of public health, 79(10):1385–1388.

Greenstone, M. and Hanna, R. (2011). Environmental regulations, air and water pollution, and infant mortality in India. Technical report, National Bureau of Economic Research.

Greenstone, M. and Jack, B. K. Envirodevonomics: A research agenda for a young field. *Journal of Economic Literature* 2015, 53(1), 5–42

Gylfason, T; Hebbertsson, T.T and Zoega, G. “A mixed blessing: Natural Resources and economic growth.” *Macroeconomic Dynamics* 3, 1999, 204-225

Haber S, Menaldo V. 2011. Do natural resources fuel authoritarianism? A reappraisal of the resource curse. *Am. Polit. Sci. Rev.* 105(1):1–24

Hanna, R and Oliva, P. (2015) The effect of pollution on labor supply: Evidence from a natural experiment in Mexico City. *Journal of Public Economics* 122 (2015) 68–79

Harding, T. and A.J.Venables (2016, June).The Implications of Natural Resource Exports or Non resource Trade. *IMF Economic Review64* (2), 268–302.

Heady Derek. “Food Prices and Poverty Reduction in the Long Run.” IFPRI Discussion Paper 01331, March 2014

Hendryx, M. Mortality from heart, respiratory, and kidney disease in coal mining areas of Appalachia. *Int Arch Occup Environ Health* (2009) 82:243–249

Hilson, Gavin and Yakovleva, Natalia “Strained relations: a critical analysis of the mining conflict of Prestea, Ghana.” *Political Geography* 26, 1(2007)

Hilson, Gavin “Once a miner, always a miner’, poverty and livelihood diversification in Akwatia, Ghana.” *Journal of Rural Studies*. Vol.28 Issue 3, July 2010, 296-307

Howard Hu, Mauricio Hernandez-Avila; Invited Commentary: Lead, Bones, Women, and Pregnancy—The Poison Within?, *American Journal of Epidemiology*, Volume 156, Issue 12, 15 December 2002, Pages 1088–1091, https://doi.org/10.1093/aje/kwf164

James Cust & Torfinn Harding & Pierre-Louis Vezina, 2017. "Dutch Disease Resistance: Evidence from Indonesian Firms," OxCarre Working Papers 192, Oxford Centre for the Analysis of Resource Rich Economies, University of Oxford.

Jonathan Robinson and Ethan Yeh: Transactional Sex as a Response to Risk in Western Kenya. *American Economic Journal: Applied Economics 3 (January 2011): 35–64*

Kitula, A.G.N “The environment and social impacts of mining on local livelihoods in Tanzania: a case of Geita district”. Journal of Cleaner production 14, 2006, 405-414

Kumah, A. “Sustainability and gold mining in the developing world.” *Journal of cleaner production*, vol.14 issues 3-4, 2006, 315-328

Lippert, A. Spill-Overs of a Resource Boom: Evidence from Zambian Copper Mines. OxCarre Research Paper 131. January 2014

Lobao, Linda; Partridge, Mark; Braum, Lawrence; Belz, Michael and Farren, Michael. “The mining industry and community poverty across Appalachia”. *Environmental considerations in energy, production, society for mining, metallurgy and exploration,* 2013

Lundstol Olav, Raballand Gael and Nyirongo Fuvya. “Low Government Revenue from the mining sector in Zambia and Tanzania: Fiscal design, Technical capacity or political will?” *International Tax and Development*. Working Paper No.9, April 2013

McConachie, Roy and Binns, Tonny. “Farming miners’ or ‘mining farmers’? Diamond mining and rural development in post-conflict Sierra Leone.” *Journal of rural studies*, volume 23, issue 3, July 2007, 367-380

McMahon, Gary; Moreira, Susana. 2014. The Contribution of the Mining Sector to Socioeconomic and Human Development. Extractive industries for development series; no. 30. World Bank, Washington, DC. © World Bank.

Mamo, N; Bhattabharyya, S; Moradi, A and Arezki, R. Intensive and Extensive Margins of Mining and Development: Evidence from Sub-Saharan Africa. CSAE Working Paper WPS/2017-05

Manley, D. A guide to mining taxation in Zambia. Zambia Institute for Policy Analysis and Research. June 2013.

Masumbu, Gibson and Mahrt, Kristi.2014. Comparison of Welfare Status in Districts in Zambia. Zambia Institute for Policy Analysis and research Working Paper series no.17

McCulloch Neil, Baulch Bob and Cherel-Robson Milasoa. “Poverty, inequality and growth in Zambia during the 1990s.” *World Institute for Development Economics Research*. Discussion Paper No. 201/123. November, 2001

Meller, Patricio and Simpasa, M. Anthony. 2011. *Role of Copper in the Chilean and Zambian Economies: Main Economic and Policy Issues*. Global Development Network. Working Paper series no.43

Ménard, Claude and George R. G. Clarke, "A Transitory Regime: Water Supply in Conakry, Guinea," in Mary Shirley, editor, Thirsting for Efficiency: The Economics and Politics of Urban Water System Reform (Washington, DC: The World Bank, 2002).

Milimo, T. John; Shilito, Toby and Brock, Karen. The poor of Zambia speak, who would ever listen to the poor? Zambia Social Investment Fund, 2002

Monteiro, Joanna, and Claudio Ferraz. 2012:" Does oil Make Leaders Unaccountable? Evidence from Brazil offshore oil boom," mimeograph, PUC-Rio

Nathan P. Hendricks, Joseph P. Janzen, Aaron Smith; Futures Prices in Supply Analysis: Are Instrumental Variables Necessary?, *American Journal of Agricultural Economics*, Volume 97, Issue 1, 1 January 2015, Pages 22–39

Ncube, E; Banda, C and Mundike, J Air Pollution on the Copperbelt Province of Zambia: Effects of Sulphur Dioxide on Vegetation and Humans. Journal of Natural & Environmental Sciences Nat Env Sci 2012 3(1): 34-41.

Nellis, J. 2005 Privatization in Africa: What has happened? What is to be done? Center for Global Development Working Paper No. 25

Paul J. Gertler, Sebastian W. Martinez and Martha Rubio-Codina. (2012) "Investing cash Transfers to Raise Long-Term Living standards" *American Economic Journal: Applied Economics*, Vol. 4, No. 1 (January, 2012), pp.206-204

Pellandra, Andrea. The commodity price boom and regional workers in Chile: natural Resource blessing?. Lacea, March, 2015

Pegg, Scott. "Mining and Poverty Reduction: Transforming rhetoric into reality." *Journal of cleaner Production* 14 (2006) 376-387

Ramey, Garey and Valerie A. Ramey (1995), "Cross-country Evidence on the Link Between Volatility and Growth." *The American Economic Review*, 85, 1138–1151.

Ran Abramitzky and Victor Lavy. "How Responsive is Investment in Schooling to Changes in Redistributive Policies and in Returns?" *Econometrica*. Volume 82, Issue 4, pages 1241-1272, July 2014.

Ravallion Martin, Chen Shaohua and Sangraula Prem. "Dollar a Day Revisited". Review of Income and Wealth. Volume No. 59, Issue 1, pages 1-28, March, 2013

Ringen, S. Poverty in Welfare State. The Scandinavian Model: Welfare States and Welfare Research. *International Journal of Sociology*. Vol.16 No.314 (Fall, 1986-Winter 1987) pp122-138

Roberto Álvarez & Álvaro García Marín & Sebastián Ilabaca, 2017. "Commodity Prices Shocks and Poverty Reduction in Chile," Working Papers wp449, University of Chile, Department of Economics

Roberts, Michael J., and Wolfram Schlenker. 2013. "Identifying Supply and Demand Elasticities of Agricultural Commodities: Implications for the US Ethanol Mandate." *American Economic Review*, 103 (6): 2265-95.

Robinson, James, Ragnar Torvik, and Thierry Verdier (2006), "Political Foundations of the Resource Curse." *Journal of Development Economics*, 79, 447–468.

Rosenbaum, P. and Rubin, D.B. (1983), The central role of the propensity score in observational studies for causal effects, *Biometrika*, 70, 41-55.

Ross, Michael (2003) How Does Mineral wealth affect the Poor? Philadelphia: Paper presented to the 2003 meeting of the *American Political Science Association*.

Rosenbaum, P. and Rubin, D.B. 1983. The central role of the propensity score in observational studies for causal effects, Biometrika, 70, 41-55.

Ross, Michael (2003) How Does Mineral wealth affect the Poor? Philadelphia: Paper presented to the 2003 meeting of the American Political Science Association, 2003

Sachs, Jeffrey D., and Warner, Andrew M. 1995. "Natural Resource Abundance and Economic Growth." NBER Working Paper No. 5398, December 1995

Sachs, Jeffrey D., and Warner, Andrew M., 2001, "Natural Resources and Economic Development: The Curse of Natural Resources," *European Economic Review*, Vol. 45, pp. 827-838.

Salomons, W. Environmental impact of metals derived from mining activities: Processes, predictions, prevention. *Journal of Geochemical Exploration* 52 (1995) 5-23

Sikamo, J; Mwanza, A and Mweemba, C. Copper mining in Zambia-History and Future. *Journal of the Southern African Institute of Mining and Metallurgy.* Vol.16 June, 2016

Simler, R. Kenneth. 2011. Micro-Level Estimates of Poverty in Zambia. International Food Policy Research Institute, Washington, DC

Simubali, M.G and Chileshe,P.R.K (2013) The impact of technology changes on production and performance of Konkola Copper Mines, Zambia, before and after privatization. *The Southern African Institute of Mining and Metallurgy Base Metal Conference.*

Sladoje, Miljan. Cholera Outbreak in Zambia: An Institutional Perspective. March 2018 International Growth Center

Smith, P. Jones. Healthy Bodies and Thick Wallets: The Dual Relation Between Health and Economic Status. *Journal of Economic Perspectives*. Vol. 13, No.2, Spring 1999

Stephan Litshing and Kevin M. Morrison, (2013) "The Impact of Intergovernmental Transfers on education Outcomes and Poverty Reduction. *American economic Journal: Applied Economics*, Vol. 5, No. 4 (October, 2013), pp.206-204

Stevens, Paul, Glada Lahn and Jaakko Kooroshy. The Resource Curse Revisited: Energy, Environment and Resources | August 2015

Strauss, John and Thomas, Duncan. Health, Nutrition and Economic Development. *Journal of Economic Literature*. Vol. 36, No.2 (June, 1998), pp766-817

Stuart, E.A., 2010. Matching methods for Causal Inference: A Review and a look Forward, *Statistical Science* 25(1), pp1-21.

Tanimowo M.O, (2000). Air Pollution and Respiratory Health in Africa, University of Zambia Teaching Hospital, Lusaka

Tolonen, A. 2016. "Mining Booms in Africa and Local Welfare Effects: Labour Markets, Women's Empowerment and Criminality." Mimeo. University of Gothenburg, Gothenburg.

United Nations Development Program (UNDP). "Millennium Development Goals (MDGs) Report for Zambia.2013

USAID. 2012. Country Development Cooperation Strategy 2011-2015

Van Ark, B.; McGuckin, R.H. "International comparisons of labor productivity and per capita income", in U.S. Dept. of Labor Monthly Labor Review, July 1999, pp. 33-41.

Van der Ploeg, F., and Poelhekke, S. (2010), 'The pungent smell of 'red herrings': subsoil assets, rents, volatility and the resource curse', *Journal of Environmental Economics and Management*, 60(1), 44-55.

Venables, J. Anthony. Using Natural Resources for Development: Why has it proven so difficult? *The Journal of Economic Perspectives*. Vol.30, No.1 (Winter, 2016)

Vickers, J., Yarrow, G., 1988. Privatization: An Economic Analysis. MIT Press, Cambridge.

Waldinger Fabian. "Quality Matters- the Expulsion of Professors and Ph.D. student Outcomes in Nazi Germany", Centre for Economic Performance Discussion Paper No.985, June 2010

Wells, M. (2011) "*You'll be fired if you refuse": Labour abuses in Zambia' Chinese state-owned copper mines*. New York: Human Rights Watch

Whitworth, A. 2014. Explaining Zambian Poverty: A History of (nonagriculture) Economic Policy since Independence. *Journal of International Development*. Vol 27, Issue 7

WHO Zambia Country Profile:www.who.int/cholera/countries/ZambiaCountryProfile2001.pdf

Wilson, N. (2012). Economic booms and risky sexual behaviour: Evidence from Zambian copper mining cities. *Journal of Health Economics*.

Woolridge, J.M. (2002), Econometric analysis of cross-section and panel data. Cambridge: MIT-press.

Wooldridge, J. (2008). Introductory Econometrics: South Western College (2008)

Wooldridge, J. *Introductory Econometrics: A Modern Approach*. 6th ed. Cengaga Learning. (2016).

World Bank. 2011. *Zambia - What would it take for Zambia's copper mining industry to achieve its potential?)*. Washington, DC: World Bank.

World Bank (2015) Socioeconomic Impact of mining on Local communities in Africa. June 25, 2015

Yonas, Alem, "Poverty persistence and intra-household heterogeneity in occupation: Evidence from urban Ethiopia". Environment for Development Discussion Paper series, EfD DP-14-05, February 2015

Yoruk, B.K., 2008. The power of asking in Volunteering: Evidence from Matched sample, *Economic Letters* 99(1, pp79-84