



AIDDATA

A Research Lab at William & Mary

WORKING PAPER 80

June 2019

Mining, Rural Livelihoods and Food Security: A Disaggregated
Analysis of Sub-Saharan Africa

Tim Wegenast
Universität Konstanz

Jule Beck
Universität Konstanz

Abstract

The potential impacts of extractive industries on local food security are difficult to predict. On the one hand, resource extraction may generate more employment opportunities, provide farmers with better market access and increase fiscal transfers to resource-producing regions. On the other hand, mineral production may contribute to the marginalization of poor smallholders by encouraging land grabs, environmental degradation and structural labor market shifts. Combining geocoded survey data from the Demographic Health Survey and Afrobarometer with novel information on the control rights of gold, diamond and copper mines in Sub-Saharan Africa, this paper is the first attempt to systematically test the effect of mining activities on local populations' access to food. Results from logistic models using individual mines as level of analysis suggest that the impact of mineral extraction on food security is gender- and ownership-specific. Mining operations decrease food availability among women in a substantial way, while – at the same time – showing no significant or even a positive effect on men's access to food. Our instrumental variable models further reveal that particularly multinational mining companies are linked to increased food insecurity, while domestic firms are not. Finally, our fixed effects estimates demonstrate that mining is also related to poorer nutritional diversity. Relying on detailed information on children's food consumption patterns from the Demographic Health Survey, we find that children living in districts hosting multinational mining firms eat a less diverse diet compared to other districts.

Author Information

Tim Wegenast

Universität Konstanz

Tim.Wegnast@uni-konstanz.de

Jule Beck

Universität Konstanz

Jule.Beck@uni-konstanz.de

Keywords: *mining, food security, nutritional diversity, gender, control rights, sub-Saharan Africa*

The views expressed in AidData Working Papers are those of the authors and should not be attributed to AidData or funders of AidData's work, nor do they necessarily reflect the views of any of the many institutions or individuals that may acknowledged in this work.

Acknowledgements

The authors would like to thank Albert Martinez Sequero and Pawel Komendzinski for their excellent research assistance as well as Carlo Koos, Anke Hoeffler, Sebastian Koos, Florian Weiler and Karsten Donnay for their comments on this version of the manuscript. Research support from the German Research Foundation is gratefully acknowledged (WE4850/1-2)

Introduction

Mining investments are believed to curtail communities' access to food in many regions worldwide. According to an NGO report, residents from a mining town in Limpopo, South Africa, for example, lost access to ploughing fields and grazing land as well as other natural resources including fruits, trees and firewood due to the activity of a Platinum mine (ActionAid 2016). The authors conclude that rural households in this area have thereby experienced a "crisis of livelihood", as they became unable to grow their own food and faced widespread food insecurity. Similar negative impacts of extractive industries on food security¹ are reported for coal mining in Bangladesh (Bedi 2015), Nickel mining within Inuit territories in Canada (Mills *et al.* 2017), copper mining in Zambia's Mazabuka and Solwezi districts (The Zambian Analyst 2013) and metal mining in Palawan, Philippines (Philippine Daily Inquirer 2011).

Although the mining-food nexus has received broad attention from non-governmental organizations and the media, it has not been academically studied in a systematic comparative way so far. The link between industrial mining and food security is seemingly driven by the confluence of multiple factors. Mining activities, on the one hand, may generate direct or indirect jobs and provide better market access to farmers living in remote rural areas by encouraging infrastructural development. The consequential increase in household income is likely to promote food security among mining communities. On the other hand, extractive industries may increase the vulnerability of rural livelihoods by prompting large-scale land dispossession, by lowering agricultural productivity through pollution or water shortage, by raising living expenses or by causing structural labor market shifts.

In order to examine this bundle of different and potentially offsetting mechanisms, it seems indispensable to rely on a disaggregated research design and to take contextual factors into account. We assume that – particularly under weak institutional settings as observable in most Sub-Saharan African countries – the negative impacts of mining on food security prevail. Moreover, we show that this effect is gender- and ownership-specific. As the traditional role of women in rural societies is often closely intertwined with the cultivation of subsistence crops and as they rarely find jobs in the industrial mining sector, women seem to

¹ Food security encompasses many different dimensions and has been defined in a variety of ways. This manuscript employs the widely-accepted definition established during the 1996 World Food Summit according to which "food security, at the individual, household, national, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" Food and Agriculture Organization of the United Nations (1996). Thereby, a country is considered food secure if food is available, accessible, nutritious, and stable across the other three dimensions Food and Agriculture Organization of the United Nations (2008). As criticized by some authors, this definition does not consider other important dimensions including food self-sufficiency and food sovereignty c.f. Clapp (2017).

be more vulnerable to dispossession, environmental degradation or structural labor market shift compared to men. In addition, we argue that particularly multinational mining companies are likely to aggravate food insecurity as they generate fewer employment opportunities and invest less in human capacity building than domestic, state-owned firms.

To the best of our knowledge, our study is the first to empirically test the effect of industrial mining on food security employing disaggregated survey data for a large number of countries. Combining information on the control rights of copper, diamond and gold mines in sub-Saharan Africa with survey data from Afrobarometer and the Demographic Health Survey (DHS), we test the effect of mining activities on respondents' access to food both at the mine and district level of analysis. Results from logistic and instrumental variable probit models largely confirm our assumptions: while men are not negatively affected by industrial mining projects, proximity to mines increases women's risk of facing food insecurity. Particularly women living in the vicinity of internationally-controlled mines seem to suffer from food shortage. Relying on detailed data on children's diet, our fixed-effects models further reveal that international mining companies reduce the diversity of food consumed by children within the respective districts.

The Potential Impacts of Mining on Food Security

Relying on geospatial analysis, scholars have recently begun to assess the local impacts of mining companies' ownership structure on different political and socio-economic outcomes. Using a matched difference-in-difference strategy, Bunte *et al.* (2018), for example, find that – in contrast to US mining firms – Chinese companies are associated with more regional economic growth in Liberia. Also concentrating on contractor's nationality, Wegenast *et al.* (2019) show that – compared to other mining companies – Chinese firms generate less local employment opportunities in sub-Saharan Africa. Other authors have found that particularly multinational oil or mining companies promote social conflict such as protest or repression (Wegenast & Schneider 2017; Christensen 2019).

The potential impacts of industrial mining on local food security remain poorly understood though. Extractive activities may affect food accessibility through different pathways. On the one hand, mining may enhance access to food by generating new income opportunities for rural households (e.g. by promoting local employment and regional economic growth). Profiting from improved local infrastructure such as new roads or railways, farmers in remote rural areas may gain better market access. Furthermore, populations within mining areas may benefit from resource-related fiscal transfers and the implementation of social policies by mineral extracting companies or by the state.

On the other hand, mining may adversely affect food security among local populations by constraining subsistence farming and agricultural productivity (e.g. through pollution, water shortage and displacement). Food insecurity may also be aggravated by increased living costs due to a large influx of immigrant workers or by structural labor market shifts in which farmers abandon agriculture and livestock raising in order to pursue (rather precarious) jobs in the service, unskilled manual labor or petty trading sectors. The present section elaborates on these mechanisms and underlines the importance of employing comparative, disaggregated data and considering context-specific factors when analyzing the mining-food nexus.

A direct channel through which industrial mining may improve local living conditions is by creating jobs and raising household incomes. Off-farm income sources may greatly contribute to food availability in rural areas (Frelat *et al.* 2016). However, extractive industries are generally skill- and capital-intensive. As the labor to capital ratio is comparably low in large-scale mining, its capacity to generate direct jobs is rather limited (Gamu, Le Billon & Spiegel 2015:168). Kotsadam & Tolonen (2016) for example, show that only a limited number of the local male population find a job in the mining industry. In contrast to that, mineral extraction may encourage economic forward and backward linkages as well as multiplier effects (Aragón & Rud 2013:2). Shifts in the demand for labor within the commodity sector may spillover into the non-resource economy. In this context, the extractive industry facilitates the development of local industrial production and capabilities building (Hanlin & Hanlin 2012:468–469). The local demand for labor and nominal wages may increase due to a multiplier effect (eds. Chuhan-Pole, *et al.* 2017:7). In fact, some studies show that every job created in the resource sector leads to additional jobs in other sectors of the local economy (Marchand 2012; Morris, Kaplinsky & Kaplan 2012; Marchand & Weber 2018) .

In addition to employment-generating effects, extractive companies may contribute to local food security by providing transportation, power or water-based infrastructure (Adewuyi & Oyejide 2012). Weng *et al.* (2013), for example, shows how mining is prompting infrastructural corridors (e.g. roads and railways) that penetrate into areas where agriculture has been hampered by the lack of market access in African countries. By improving market access and off-farm opportunities, mining may effectively tackle food insecurity. In addition, mining communities may benefit from increased subnational resource-related fiscal transfers. Under wealth sharing agreements, for example, regional governments may benefit from resource revenues accruing to states' coffers. Local officials may use these fiscal windfalls to invest in health or education or to promote infrastructure projects, thereby increasing the wellbeing of mining communities. Different studies show that – particularly under good governance – fiscal transfers may in fact benefit local communities (Hinojosa, Bebbington & Barrientos 2012; Cust & Rusli 2014; Mosley 2018). Finally, resource-extracting firms may

contribute to communal development (by for example providing basic services such as water infrastructure or medical assistance) through corporate CSR practices (Tordo, Tracy & Arfaa 2012; Wegenast & Krauser 2018).

Mining, however, may also be negatively linked to food security through various channels. Advocates of the enclave nature of natural resources, for example, assert that there are almost no links between mining activities and the local economy (Eftimie, Heller & Strongman 2009:12; Hirschman 1964; Pegg 2006). Ferguson (2005:378) notes that the Nigerian oil industry is characterized by imports of virtually all its equipment and materials. Forward linkages are relatively weak as mineral products are mostly exported and often not processed in the countries where they have been extracted (United Nations Economic Commission for Africa 2011:102–105). According to this view, an increased access to food due to mining-related income effects is highly unlikely.

Apart from that, the socio-environmental impacts of mining may lead to profound changes in local livelihoods (Lu & Lora-Wainwright 2014). Exploitation of mineral deposits often prompts natural resource use conflicts by destroying forests (Mwitwa *et al.* 2012) as well as crop and pasture land (Schueler *et. al.* 2011; Pijpers 2014). Shrinking water supplies may constitute a further threat to food security (Isla 2002; Aragón & Rud 2016; Nguyen, Boruff & Tonts 2018). Water resources in mineral extracting areas are found to be greatly overexploited and may thereby severely hamper farming activities (Vela-Almeida *et al.* 2016).

Furthermore, mining activities require the use or storage of hazardous substances including heavy metals or cyanide that may diffuse into the soil, pollute the air and water. The lack of waste management and dumps may negatively affect agricultural land use (United Nations Economic Commission for Africa 2011:46). Aragón & Rud 2016, for example, show that mining-induced pollution decreases local agricultural productivity in a substantial way. As crop production in the context of smallholder farms is of great importance for the food security of rural populations in Sub-Sahara Africa (c.f. Frelat *et al.* 2016:458), mining-induced pollution or water shortage may severely limit communities' access to food.

Apart from generating pressure on environmentally sensitive farming areas, mining concessions are commonly accompanied by land dispossession. This type of dispossessions implies the loss of entitlement to land on which households have commonly made a living through subsistence agriculture. Focusing on Ghana's mining sector, Andrews (2018), for example, shows that mining-related dispossessions curtails the sustainable livelihood of people in host communities. Land dispossession linked to industrial mining has been described for various African states, including the DRC (Geenen 2014) and Sierra Leone (Maconachie 2014).

Another potential detrimental effect of mining on food security concerns rising costs of living. Attracted by increases in nominal wages and employment opportunities, workers from other regions migrate to the mining locations and thereby costs for housing, services and goods may rise (Weber-Fahr *et al.* 2002:452; Chuhan-Pole, *et al.* 2017:7), posing an additional risk to food security. Different studies underline how industrial mining has increased pressure on housing costs and community services (Petkova *et al.* 2009). Finally, mining booms may prompt structural changes of the labor market, leading individuals to abandon agriculture and look for jobs particularly in the service sector. Thereby, particularly female unemployment may increase as agriculture is a larger sector than services (Kotsadam & Tolonen 2016). Moreover, once mineral extraction is no longer lucrative and the non-tradable sector shrinks, local residents are often unable to resume former farming activities. Howieson *et al.* (2017) demonstrate how the productive agricultural use of post-mining lands has proven to be particularly challenging.

The Gender- and Ownership-Specific Effects of Mining on Food Security

As evidenced by the last section, a bundle of different and potentially offsetting mechanisms links mineral extraction to food security. The institutional context may determine which type of effect will prevail: mining communities confronted with weak regulatory capacity, corruption, poor administration and unresponsive local governments are particularly likely to suffer from food insecurity. Considering the poor quality of local institutions across many Sub-Saharan countries, we expect mining activities to have an overall negative impact on local food security for this continent. Moreover, we contend that the mining-food nexus is gender- and ownership-specific. For the reasons outlined below, we hypothesize that women within extractive regions are more affected by food insecurity compared to men and that international mining firms contribute more to local food scarcity than state-owned, domestic companies.

Women constitute the majority of the agricultural workforce in developing countries (SOFA Team & Doss 2011). They are largely responsible for household food production and agricultural activities such as fertilizing and harvesting in various countries including Nepal (Mishra & Sam 2016:361), Nigeria (Ogunlela & Mukhtar 2009) and South Africa (Hart & Aliber 2012). In their role as child-bearer, women are considered to be responsible for the food crop production and nutrition of their families in many rural societies worldwide. However, women's traditional role as "giver of food" (Bryson 1981:37) may be challenged by the negative impacts of mine openings described above. Considering their high involvement in subsistence farming, women within mining communities are particularly vulnerable (c.f. Jenkins 2014; Brain 2017).

Given the mining-induced displacements and the environmental pressures on agricultural land described above, women within extractive communities may lose their main source of livelihood. Furthermore, when companies negotiate access to land, compensation or benefits, women are often not consulted. Since mostly men are land title holders, women do not receive compensation for the loss of valuable arable land, access to water bodies and fire wood (Oxfam International 2017:4). As noted by (Downing 2002:11), women are indeed more vulnerable to impoverishment following mining-induced displacement and resettlement as they “rely heavily on their surrounding environment, and alterations to the surrounding ecology are likely to overwhelm individual and community adaptive responses”. Women’s ability to fetch clean water and nourish their family may be undermined by mining-induced contamination or water scarcity, resulting in additional pressure and time burdens (Isla 2002:151; Jenkins 2014:333; Muchadenyika 2015:715).

Different than men, women may also not benefit from potential employment effects stemming from extractive industries. While a certain share of the local male population may be directly employed by mining firms, women’s direct involvement in industrial mining is very low (Bose 2004:410; Eftimie *et al.* 2009:10) and limited to ancillary and administrative positions (Hinton, Hinton & Veiga 2016). Following the expansion of mining, women’s occupational activities tend to shift from subsistence farming and raising livestock to domestic work or rather precarious jobs in the service sector (Hinton *et al.* 2016). Given the high share of female agricultural workers in poor rural societies, only a portion of women who abandon farming is absorbed by new economic sectors. Consequently, overall female unemployment is likely to increase within expanding mining regions (c.f. Kotsadam & Tolonen 2016). Women’s vulnerability is furthered by the boom and bust character of extractive industries: once mining is no longer lucrative and the non-tradable sector shrinks, women often are unable to resume former agricultural activities.

Considering that agriculture is a main livelihood source of women in rural areas and that mining is largely incapable of increasing female labor force participation, women’s income and access to food may be considerably hampered by mining openings. Thus, we hypothesize that, *compared to men, women are more likely to face mining-induced food insecurity* (H1).

Apart from gender, the impact of industrial mining activities on food security may also be conditioned by mineral control rights. As has been shown in previous research, particularly multinational oil or mining companies seem to trigger local social conflicts (Haslam & Ary Tanimoune 2016; Wegenast & Schneider 2017; Christensen 2019) Thereby, an important source of local grievances seems to be the lack of local employment opportunities (c.f. Davis & Franks 2014). Multinational resource extracting firms generally rely on an international

network of skills, technology and machines, thereby operating independently from the local endowment context. While importing skilled- and semi-skilled labor, local recruitment by international companies often concentrates around low-skill and low-paid work, limiting potential know-how and wage spillovers.

In contrast, state-controlled, domestic mining or oil companies are more likely to hire local labor. Hartley & Medlock, III. (2008), for example, show that national oil companies tend to favor excessive employment compared to international oil firms (see also El-Katiri 2014:29). Eller, Hartley & Medlock (2011:638) demonstrate that public ownership of the oil sector “tends to result in a larger workforce than necessary to meet purely commercial objectives.” Case studies confirm that regional unemployment increases after the privatization of the mining sector (c.f. Mususa 2010).

In addition to possibly generating more direct employment opportunities, domestic resource extraction firms are more likely to encourage local procurement of goods and services. Adewuyi & Oyejide (2012), for example, show that multinational oil companies operating in Africa exchange less information compared to their local counterparts since they can rely on information flows within their internal multinational operations. Furthermore, different authors have demonstrated that the presence of local partners in the ownership structure of multinational corporations promotes technology transfer and skills upgrading and encourages local linkages (Fessehaie 2012; Morris *et al.* 2012; Amendolagine *et al.* 2013). Recent studies in fact find that multinational mining companies are associated with more unemployment compared to local firms (Elgersma *et al.* 2019; Wegenast *et al.* 2019).

Considering the potentially greater job creation and multiplier effects of local companies, we contend that *domestic, state-owned mining firms are more likely to guarantee food security within mineral extraction regions than international companies* (H2).

Empirical Strategy and Data

Dependent Variables

For our analysis, we rely on three main data sources: the Afrobarometer, the Demographic Health Survey (DHS) and our novel data on the control rights of copper, diamond and gold mines. The Afrobarometer is one of the most comprehensive data sources on the socioeconomic development of more than 30 African countries. The national samples comprise either 1,200 or 2,400 face-to-face interviews with randomly selected respondents. To assure representativeness, the Afrobarometer uses a stratified, multi-stage area probability design. Stratification is based on the main subnational unit of government (state,

province, or region) and urban and rural location. The smallest geographic unit for which reliable population data is available constitutes the primary sample unit (PSU) in which eight survey respondents are combined into one cluster.

Relying on the subnational geocoded data provided by Afrobarometer, we joined point coordinates from our mine-level dataset with the geo-location of Afrobarometer respondents through spatial proximity using the software QGIS. For this, we first calculated 25 km buffer zones around the centroids of the survey clusters following and expanding the procedure applied by Kotsadam & Isaksson (2016), Kotsadam & Tolonen (2016) or Knutsen *et al.* (2017).² Information on the number and ownership of mines was added in a second step, which is outlined below.

For our empirical analysis, we chose round 6 of Afrobarometer as it is the most recent survey and, compared to other rounds – covers the highest number of countries (36) and respondents (53,935).³ Most importantly, it asks the frequency by which respondents have gone without enough food to eat in the past year. We code *food insecurity* as a binary variable taking the value “1” when individuals report having gone without food to eat “several times” and “many times” in the last year.⁴

In addition to assessing mining activities’ effect on food availability in general, we are also interested in how extractive industries may impact on the diversity of food consumption as an indicator of nutritional security. For this purpose, we make use of detailed DHS information on what type of foods the youngest children born in the two years preceding the respective survey wave have consumed in the previous 24 hours.⁵

Following recommendations from FAO, we construct an additive index indicating the number of food groups consumed (Kennedy, Ballard & Dop 2011). For our analysis, the variable *food diversity* has a potential score range of zero to six as we combined several food items into following food groups: cereals, white roots and tubers (1), vitamin A rich vegetables and dark green leafy vegetable (2), vitamin A rich fruits, other fruits and fruit juice (3), animal protein

² To tackle possible endogeneity between mine’s location and corruption, Knutsen *et al.* (2017) distinguish between mines’ operational status (active or not open yet). While this is certainly a pertinent causal identification strategy, we do not rely on this approach for one main reason: as our data collection was motivated primarily on assessing mines’ ownership patterns, it is more limited in temporal scope and number of mines. Differentiating between state- and internationally-controlled mines, have too few mine openings between 1997-2015 and not enough statistical power to perform a difference-in-difference analysis. We are confident, however, that our instrumental variable strategy addresses potential endogeneity issues between mine location and food security. Considering mine closure, as in Kotsadam & Tolonen (2016), is also not particularly suitable for our research question as – in contrast to employment levels – regional food insecurity may persist for a long time after mine closure (e.g. due to displacement or environmental degradation).

³ Table A1 in the Online Appendix provides a list of countries included in our models.

⁴ For a complete list of variable definitions, coding rules, and data sources see Table A2 in the Online Appendix. For descriptive statistics of all variables, please refer to tables A3 and A4.

⁵ As this data is not provided for men and only very sparsely available for women, we have to rely on DHS children’s data. While we would have wanted to include data on the diet diversity of older children as well, we believe that the diet of the youngest child is a good proxy for the family’s food consumption.

such as organ meat, flesh meat, eggs, fish and seafood (4), legumes, beans, seeds and nuts (5) as well as milk and dairy products (6). Although respondents might have differing dietary habits due to cultural settings and local availability of specific food items, the food diversity score allows making comparisons over countries as it is composed of food groups instead of food items (Sibhatu, Krishna & Qaim 2015).

Independent Variable of Interest

Our dataset on mineral deposits contains mine-level information on the control rights structure of copper, gold, and diamond mines within 38 sub-Saharan countries between 1997 and 2015 (c.f. Wegenast & Schneider 2017). It largely relies on information from Infomine (2013) and the U.S. Geological Survey (USGS). The first database provides details on the location, production status of extraction sites as well as the shares controlled by the respective operating companies. Data retrieved from the mining companies' websites was used to fill in missing information. Through this strategy, we were able to code the ownership structure of 538 mines in Africa for the period 1997-2015.

Every mine is dummy coded as internationally- or publicly-owned if either international or domestic state companies hold at least 51 percent of the shares respectively. Alternatively, we also make extensive robustness checks using a 66 percent majority threshold. Our main independent variable of interest captures the number of mines that are predominantly controlled by international investors or the state. Making use of the latitude and longitude coordinates collected during the coding phase, we calculated the number of internationally- or publicly-controlled mines in 25km buffer zones around Afrobarometer respondents.

Since rounds 6 of Afrobarometer was conducted in 2014–2015, we calculated mean control shares for each active mine for the period 2012–2015.⁶ We decided to rely on a 25km range around respondents for several reasons. Dispossession of agricultural land – one key channel potentially explaining our findings – is likely to occur in the mining area itself or in the very close vicinity. For example, (Mtero 2017) shows that for a platinum mine in South Africa, villages within a 10km radius are likely to either co-habitat with the mine or to be relocated. In Ghana's gold province, the average distance of neighboring villages to a mine is 5km (Moomen, Dewan & Corner 2016). In addition, we believe that 25km is still a reasonable distance for the (mostly) male population in adjacent cities to commute to the mines. Finally, smaller buffer zones would considerably reduce the match between respondents and mines with a consequential drop in statistical power. Note, however, that we also provide

⁶ We also test the robustness of our results when employing average ownership shares of active mines using 5- and 6-year periods (instead of the reported 4-year periods), and obtain substantively unchanged results.

robustness checks for 40km buffer zones.⁷ Table A5 in the online appendix provides the respective number of individuals surveyed by Afrobarometer round 6 living within a distance of 25 and 40 km from internationally- and publicly-controlled active mines for all covered countries over the period 2011–2015.

Control Variables

When assessing how the proximity to mining activities impacts respondents' food security, we mainly control for individuals' socioeconomic status, including whether they have attained at least secondary education (*education*), are currently unemployed (*unemployed*), regard themselves as economically better off compared to the rest of the country (*living conditions*), or belong to an ethnic group that experiences discrimination (*discrimination*). We also include neighborhood characteristics and proxies for institutional quality in our models. *Crime* is a dummy variable indicating whether respondents feel unsafe walking in their neighborhood, and *urban* denotes respondents living in an urban area. *Democracy* measures the perceived level of democracy within the respondents' country. We also account for local state capacity by including a dummy variable in which respondents report having access to electricity (*state capacity*). Finally, we add the variable *local corruption*, which takes the value "1" when respondents indicate that most or all local government councilors are corrupt and "0" otherwise.

Regarding our models using DHS data, we control for the share of district's population that has completed secondary education (*secondary education*), that is employed in the agricultural sector (*agricultural employees*) and that has access to piped water as a proxy for state capacity (*piped water*). Finally, we control for a district's level of economic activity by an indicator of nightlight emissions obtained from the PRIO-GRID 2.0 dataset (c.f. Tollefsen, Strand & Buhaug 2012). Nightlight emissions are considered accurate predictors of economic wealth estimates at the grid level (Weidmann & Schutte 2017).

Estimation Technique

As previously noted, we construct 25km-buffer zones around each respondent and calculate the location and average ownership structure of all active mines for the four years previous to the employed Afrobarometer survey round (2012–2015). In estimating the geographically

⁷ We explicitly decided not to use the distance of each respondent to the closest mine as our main independent variable of interest since we would not be able to consider cases in which a respondent is surrounded by two or more mines.

disaggregated effects of mines on Afrobarometer respondents' food security status, we fit the following logistic regression below:

$$F_i = \beta_0 + \beta_1 * Mines_i + \beta_2 * X_i + \eta_c + \varepsilon_i \quad (1)$$

$$F_i = \beta_0 + \beta_1 * International\ Mines_i + \beta_2 * Domestic\ State\ Mines_i + \beta_3 * X_i + \eta_c + \varepsilon_i \quad (2)$$

F_i reports the food security status of individual i . International Mines and Domestic State Mines each indicate the total number of mining facilities operated by the relevant company type in 25km-buffers around individual i . X_i denotes a vector of control variables referring to individual i . With η_c we additionally control for country fixed effects. ε_i is the error term. As observations within the same country are unlikely to be independent, we use standard errors clustered around countries in the models above.

Our main estimation strategy for the effect of mining on diet diversity on the district level is the following fixed-effects model:

$$DD_{d,t} = \beta_0 + \beta_1 * International\ Mines_{d,t} + \beta_2 * Domestic\ State\ Mines_{d,t} + \beta_3 * X_{d,t} + \alpha_{c,y} + \varepsilon_i \quad (3)$$

$DD_{d,t}$ reports the food diversity index within district d at year t . International Mines and Domestic State Mines each indicate the total number of mining facilities operated by the relevant company. $X_{d,t}$ denotes a vector of control variables referring to district d at year t . α_d is the district-specific error component and $\varepsilon_{d,t}$ is the idiosyncratic error term.

Figure 1 illustrates the research design employed. Drawing on round 6 from Afrobarometer, it shows the location of mines predominantly operated by domestic or international companies and the location of respondents aggregated into enumeration areas (with corresponding buffer zones) for selected African countries. In addition, the map depicts whether the majority of respondents within each enumeration area report to have faced food insecurity within the last 12 months or not.

One concern when estimating equation (2) is that the ownership structure of mining companies operating in a given area may be endogenous to our dependent variable. Theoretically, one could think that domestic, state-controlled mining firms choose better developed areas with more infrastructure and higher levels of human capital for their activities. To counter this possible reversed causality problem, we employ an instrumental variable approach. Finding strong and valid instruments is not an easy endeavor. Relying on a universal classification of host rocks according to which the formation of ores can be

categorized into three main types (igneous, hydrothermal, surficial), we use deposit types as an instrument.

Deposit types differ considerably in their degree of extraction difficulty. Surficial deposits are commonly exploited through opencast mining, an exploration form that is cheaper and technologically simpler than digging tunnels and shafts as well as having to continuously pump out ground water. As surficial deposits are more easily extractable than igneous or hydrothermal formations, their exploitation is less skill and capital intensive (Zientek & Orris 2005:6; c.f. Robb 2013). The extraction of gold, diamond, and copper originated from igneous and hydrothermal deposits require more know-how and more advanced technology. Based on these major differences, we assume that deposit type predicts the control rights observable in a given mining site: while multinational firms – often counting on more technological know-how – are more frequently engaged in the exploitation of hydrothermal or igneous minerals, domestic companies tend to avoid areas exhibiting these types of deposit.

To match our mines with their respective deposit type, we connect each site to its closest deposit, using data on global major mineral deposits from the USGS.⁸ While endogenous to mineral control rights, deposit types are likely to be exogenous to food security (and the 2nd stage error term). According to Jenny (1941), the soil formation process is a function of climate, organisms, topography, rock type or parental material and time. The type of mineral deposit does not seem to affect soil fertility (and thereby food production) in any substantial way. Merely certain types of igneous rocks such as granite or quartz – commonly known as serpentine rocks – may be associated with less cultivatable areas including barrens and uplands in certain regions (Campbell 1961:710). This type of “serpentine barrens”, however, are rather rare in sub-Saharan Africa and limited to particular regions in South Africa or Zimbabwe (c.f. Alexander 2007:179).

In our sample, merely 15% of the soil within buffer zones showing actual mineral production is characterized by igneous deposits. Moreover, copper, gold or diamond mining is highly unlikely under igneous serpentine rock formations in Africa. In any case, to make sure that the exclusion restriction is not violated, we use the number of hydrothermal deposits within each 25km buffer zone as our instrument.⁹ We are unaware of any plausible channel by which hydrothermal deposit types may systematically affect food production.

To estimate the effect of mining control rights on our binary dependent variable (food security), we employ a two-step iv-probit model using the number of hydrothermal deposits within each buffer zone as an instrument. The two endogenous variables are estimated in the

⁸ The data can be retrieved from: <https://mrdata.usgs.gov/major-deposits/> (accessed September 2, 2018).

⁹ In our sample, around 60% of the deposits within mineral-producing buffer zones (25km) can be classified as hydrothermal, approximately 25% are surficial and 15% igneous deposits.

first stage by an OLS regression, while the second stage uses a probit approach to predict the probability of a respondent reporting to have gone without enough food to eat within the last 12 months. Note that, given the nature of our instrument, the sample for our iv-specifications is restricted to mining areas. In addition, we rely on a 2SLS estimation framework in order to better assess the diagnostics determining the strength of our instrument.¹⁰

Results and Robustness Checks

Mining and Food Security: Findings from Cross-Sectional Analysis Using Afrobarometer Data

Table 1 below shows that there seems to be no overall significant effect of mining on food security in sub-Saharan Africa (model 1). However, once we consider respondents' gender or the control rights of mining companies, a more nuanced picture can be drawn: while mining does not seem to aggravate men's access to food (model 2), it significantly increases food insecurity among women (model 3). The effect size appears moderate: each additional active mine within a 25km buffer zone increases women's risk of reporting to have frequently suffered from food shortage within the last 12 months by approximately 3,4%. Considering the potential offsetting mechanisms linking mineral production to food availability described in the theoretical section and the multiple causes of food insecurity, this effect seems to be substantial though. Figure A1 in the appendix present marginal effect plots of models 1 and 2. The control variables are largely in line with our expectations: while higher levels of education, better economic living conditions, more democracy and higher state capacity (as proxied by access to electricity) are all associated with less food insecurity, being unemployed, belonging to a discriminated groups, or living in an unsafe and corrupt area increases respondents' risk of facing food insecurity.

Control rights seem to condition the effect of mining on food scarcity. Table 2 reveals that domestic, state-controlled mining companies in fact reduces food insecurity among both men and women. Each additional state-controlled mine within a buffer reduces the probability of men and women frequently facing food scarcity by 19% and 25% respectively. In contrast, multinational mining companies seem to increase women's food security considerably.

To test the consistency of our results, we performed different robustness checks. We re-estimated our main models using 5- and 6-years averages of active mines prior to the respective survey year (instead of the reported 4-year-periods) when calculating the number

¹⁰ As there is no appropriate rules-of-thumb for the F statistic to determine the strength of an instrument when the structural model is nonlinear, we use the diagnostics developed for 2SLS estimations. This is possible since – in probit iv specifications using STATA's "ivprobit" command – the reduced form for the endogenous explanatory variable is linear (c.f. Wooldridge 2010).

of mines within each buffer zone (see Tables A6 and A7 in the online appendix). Instead of a 51% ownership threshold to define international and state-controlled companies, we also employed a 66% threshold (see Table A8). Our main results proved robust to all these different specifications. Finally, we also extended the range of our buffer zones to 40km. As can be noted in Table A9, the effect size of some coefficients became weaker while other coefficients turned out insignificant. As previously assumed, it seems that the impact of mining on food security is rather limited to a certain region around the mine. Particular detrimental mining-related effects such as dispossession or increased living costs are unlikely to be notable at a distance of 40km from a given extraction site. Potential beneficial employment and income effects may also be restricted to the direct vicinity of a mine.

The results reported above suggest that particularly foreign mining companies may increase food insecurity among mining communities. To substantiate this finding, we directly compare the effect of international- versus publicly-controlled companies by limiting the sample to mineral-extracting buffer zones. Moreover, as the concession of mine's control rights may be endogenous to food availability, we run iv-specifications. Model 1 of Table 3 corroborates the findings reported above: compared to domestic state-owned companies, international mining firms increases respondents' risk of facing food insecurity. Models 2 and 3 present the results for the second stage iv-probit estimations. Instrumented by hydrothermal deposit types, multinational mining companies have a positive and significant effect on food insecurity (model 2). The Cragg–Donald Wald test for weak identification reveals that the null hypothesis of weak instruments can be rejected (see model 4).¹¹

The results of the first stage iv-probit estimations, reported in Table A10 in the appendix, are in line with our prior expectations: while multinational mining companies are more prone to mine under hydrothermal deposits, domestic state-controlled firms seem to rather avoid operating under this type of deposit. Model 3 reveals that proximity to state-controlled mines seems not to be associated with food insecurity. Note, however, that while our instrument seems adequate for predicting the effect of multinational mining firms on food insecurity, it is rather weak to predict the impact of publicly-controlled firms as shown by the F-statistics in model 5. At the same time, a Wald test of exogeneity reveals that the null hypothesis of exogeneity cannot be rejected, suggesting that there is no necessity for instrumentalizing the impact of domestic, state-owned firms and that the result reported in model 1 is unlikely to suffer from endogeneity.

Mining and Food Diversity: Findings from TSCS Analysis Using DHS Data

¹¹ Also, the first-stage F statistic of the 2SLS model is above the rule-of-thumb value of ten, suggesting that the instrument is not weak.

Besides affecting the access to food of extractive communities, mining may also impact on the nutritional diversity of local populations. Particularly due to the described pressures on agricultural land, mining activities may crowd out subsistence and smallholder farming, hindering rural populations from producing their own food. This may have effects on their diets. According to some authors, production for home consumption may positively affect households' availability of vegetables and increase the intake of micronutrient (Hendriks 2003; Aliber & Hart 2009) or act as a safety net against food price shocks (Janvry & Sadoulet 2011)

To test the effect of mining on nutritional diversity, we rely on a food diversity index for children using DHS data as described in the last section. Results from fixed- as well as random-effects models reported in Table 4 below show that mineral extraction indeed seems to affect people's diet diversity but primarily in districts hosting international mining investments. Across all models, only internationally-controlled mines reduce the diversity of food consumed by the local population. An additional internationally-controlled mine reduces the food diversity score by 0.12 points adjusting for time trends (model 3). Thus, our findings suggest that multinational mining firms limit access to food in both quantitative (total food consumption) and qualitative (variety of food consumption) terms.

Conclusions

Does mining affect the food and nutritional security of extractive communities? Our analysis underlines that, in order to answer this question, contextual factor must be taken into account. In line with previous qualitative reports, we show that the impact of mining activities on access to food is gender-specific. Our logistic regressions for single respondents in sub-Saharan Africa demonstrate that while men's food availability is not affected by extractive operations, women living close to mines face a significant higher risk of food shortage. While men are partially employed by nearby industrial mines, women are rarely hired (c.f. Kotsadam & Tolonen 2016; Elgersma *et al.* 2019). Moreover, as we have argued, women are more vulnerable to the detrimental effects of mining (including land dispossession, pollution of agricultural land or grazing fields, and water shortage) since they are largely responsible for subsistence farming and food production in most poor rural societies.

In addition, our analysis indicates that particularly multinational mining companies promote food insecurity among women. While both men and women living in the vicinity of a domestic, state-controlled mine report increased access to food, international mining investments are associated with decreased female food security. This finding may be

primarily explained by an income-effect: compared to multinational extraction firms, domestic, state-owned companies may create more direct and indirect jobs. In fact, recent quantitative studies show that international mining companies generate less local employment opportunities (Elgersma *et al.* 2019; Wegenast *et al.* 2019) and less local economic wellbeing (Wegenast, Khanna & Schneider 2018). Our instrumental variable models indicate that this ownership-specific effect of mineral extraction on food availability is unlikely to be driven by reversed causality.

Besides affecting the access to food of local populations, extractive industries also seem to impact on their diet diversity. In line with our previous results, this effect is only observable for international mining investment though. Our fixed-effects estimates show that the diversity of food consumed by children decreases with each additional internationally-controlled mine within a district. At the same time, we find no significant effect for domestic mining companies.

While our study has found consistent evidence for a gender- and ownership-specific effect of mining on food security and nutritional diversity, future research needs to probe more deeply into the mechanisms underlying the mining-food nexus. It seems plausible to assume that women living around industrial mining areas are particularly vulnerable to suffer from food insecurity as they are commonly not employed by large-scale mining companies and may be hindered from pursuing subsistence farming. However, further comparative as well as in-depth case studies analyzing more detailed data (e.g. on individuals' occupational status or mining-induced displacements and pollution) are needed to elucidate why the nutritional impact of mining investments is gender-specific. By the same token, we need a more thorough assessment of the reasons why international mining investments are associated with lower food and nutritional security, while domestic companies seem to reduce food access problems among local rural populations.

The research and policy implications of our findings are manifold. The core message of our paper is that we need to better disentangle the societal effects of extractive industries, putting greater emphasis on the livelihood of particular vulnerable groups such as women in poor rural areas. At the same time, we need to consider how governments regulate the access to country's natural resources. This would allow us to craft and implement better policies to tackle socio-environmental injustices stemming from large-scale mining investments.

When rights to mineral extraction are granted to companies on community lands following the principles of communities' Social License to Operate (SLO) or Free, Prior and Informed Consent (FPIC), women should be more involved in the consultation process. As has been argued, women are still rarely consulted when access to land, compensation or benefits are

negotiated. Considering the pervasive effect of malnutrition on women and especially on their children, effective measures to counter gender-specific food insecurity in extractive regions are urgently needed.

There are effective ways of raising women's voices within traditional rural societies that have the potential to increase women's bargaining power. Joint land certification to household heads and spouses, for example, may increase home-grown food and investments in health or nutrition (Mishra & Sam 2016; Muchomba 2017). The strengthening of democratically-elected customary institutions such as ward councilors or customary land secretariats may also facilitate women's empowerment as they may weaken the exclusive power of traditional leaders such as chiefs and headmen that often exercise complete and sole authority over land allocation decisions (Bennett, Ainslie & Davis 2013).

Our study also challenges the widely held belief that the privatization of countries' mining sector and the attraction of primary foreign direct investment will inevitably generate economic gains in developing economies and ameliorate local livelihoods (e.g. by promoting efficiency gains). Under structural adjustment programs, the privatization of extractive industries was a core requirement for the provision of financial assistance by external donors in the 1990s. To tackle the dismal economic situation of most African countries, an older World Bank report argued in favor of a partial or complete privatization of state mining firms and noted that "[f]uture growth will depend on attracting high-risk capital from foreign mining companies" (Strongman 1994:1).

However, privatization of Africa's mining sector has often failed to bring about the socio-economic gains advocated by its proponents and did not necessarily contribute to community welfare (Hilson 2004; Rolfe & Woodward 2004; Campbell 2010). In fact, our study suggests that future research needs to shed more light on the complex interplay between mineral property rights regimes, local institutions, social fabrics and vulnerable indigenous communities.

References

- ActionAid, 2016, 'Precious Metals II: A Systemic Inequality' 2016, viewed 3 February 2019, from www.actionaid.org/sites/files/actionaid/precious_metals_ii_lr.pdf.
- Adewuyi, A.O. & Oyejide, T.A., 2012, 'Determinants of backward linkages of oil and gas industry in the Nigerian economy', *Resources Policy*(37), 452–460, viewed 9 April 2019.
- Alexander, E.B., 2007, *Serpentine geoecology of western North America: Geology, soils, and vegetation*, Oxford University Press, New York, from <http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=16758>.
- Aliber, M. & Hart, T.G.B., 2009, 'Should subsistence agriculture be supported as a strategy to address rural food insecurity?', *Agrekon* 48(4), 434–458, viewed 15 April 2019.
- Amendolagine, V., Boly, A., Coniglio, N.D., Prota, F. & Seric, A., 2013, 'FDI and Local Linkages in Developing Countries: Evidence from Sub-Saharan Africa', *World Development* 50, 41–56, viewed 15 April 2019.
- Andrews, N., 2018, 'Land versus livelihoods: Community perspectives on dispossession and marginalization in Ghana's mining sector', *Resources Policy* 58, 240–249, viewed 20 January 2019.
- Aragón, F. & Rud, J.P., 2013, 'Natural Resources and Local Communities: Evidence from a Peruvian Gold Mine', *American Economic Journal: Economic Policy* 5(2), 1–25, viewed 22 October 2018.
- Aragón, F.M. & Rud, J.P., 2016, 'Polluting Industries and Agricultural Productivity: Evidence from Mining in Ghana', *The Economic Journal* 126(597), 1980–2011, viewed 31 October 2018.
- Bedi, H.P., 2015, 'Right to food, right to mine? Competing human rights claims in Bangladesh', *Geoforum* 59, 248–257, viewed 15 April 2019.
- Bennett, J., Ainslie, A. & Davis, J., 2013, 'Contested institutions? Traditional leaders and land access and control in communal areas of Eastern Cape Province, South Africa', *Land Use Policy* 32, 27–38, viewed 15 April 2019.
- Bose, S., 2004, 'Positioning Women within the Environmental Justice Framework: A Case from the Mining Sector', *Gender, Technology and Development* 8(3), 407–412, viewed 24 January 2019.
- Brain, K.A., 2017, 'The impacts of mining on livelihoods in the Andes: A critical overview', *The Extractive Industries and Society* 4(2), 410–418, viewed 20 January 2019.
- Bryson, J., 1981, 'Women and Agriculture in sub-Saharan Africa: Implications for Development (an Exploratory Study)', *The Journal of Development Studies* 17(3), 29–46, viewed 20 January 2019.
- Bunte, J.B., Desai, H., Gbala, K., Parks, B. & Miller Runfola, D., 2018, *Natural resource sector FDI, government policy, and economic growth: Quasi-experimental evidence from Liberia*, International Growth Centre (IGC), viewed 18 October 2018.
- Campbell, A.B., 1961, *Geology and Mineral Deposits of the St. Regis-Superior Area Mineral County, Montana*, Geological Survey Bulletin 1082, United States Government Printing Office, I. Washington, viewed 16 April 2019.
- Campbell, B., 2010, 'Revisiting the Reform Process of African Mining Regimes', *Canadian Journal of Development Studies / Revue canadienne d'études du développement* 30(1-2), 197–217, viewed 11 May 2019.
- Christensen, D., 2019, 'Concession Stands: How Mining Investments Incite Protest in Africa', *International Organization* 73(1), 65–101, viewed 15 April 2019.

- Chuhan-Pole, Dabalen, Land, Chuhan-Pole, P., Dabalen, A.L. & Land, B.C., *et al.* (eds.), 2017, *Mining in Africa: Are local communities better off?*, World Bank Group, Washington, DC, USA, viewed 21 January 2019.
- Clapp, J., 2017, 'Food self-sufficiency: Making sense of it, and when it makes sense', *Food Policy* 66, 88–96, viewed 15 April 2019.
- Cust, J. & Rusli, R.D., 2014, *The Economic Spillovers from Resource Extraction: A Partial Resource Blessing at the Subnational Level?*, EGC Report 2014/02, viewed 15 April 2019.
- Davis, R. & Franks, D., 2014, *Costs of Company-Community Conflict in the Extractive Sector*, Corporate Social Responsibility Initiative 66, Harvard Kennedy School, Cambridge, MA, viewed 15 April 2019.
- Downing, T.E., 2002, *Avoiding New Poverty: Mining-Induced Displacement and Resettlement*, Mining, Minerals and Sustainable Development 58, International Institute for Environment and Development (IIED); World Business Council for Sustainable Development (WBCSD), viewed 29 January 2019.
- Eftimie, A., Heller, K. & Strongman, J.E., 2009, *Gender Dimensions of the Extractive Industries: Mining for Equity*, Extractive Industries and Development Series 8, World Bank Group, viewed 24 January 2019.
- Elgersma, I.H., Krauser, M., Schneider, G. & Wegenast, T., 2019, *A Gendered Resource Curse? Mineral Ownership, Female Unemployment and Domestic Violence in Latin America and Sub-Saharan Africa*, Manuscript, University of Konstanz.
- El-Katiri, L., 2014, 'The guardian state and its economic development model', *The journal of development studies* : JDS 50(1), 22–34.
- Eller, S.L., Hartley, P.R. & Medlock, K.B., 2011, 'Empirical evidence on the operational efficiency of National Oil Companies', *Empirical Economics* 40(3), 623–643, viewed 15 April 2019.
- Ferguson, J., 2005, 'Seeing Like an Oil Company: Space, Security, and Global Capital in Neoliberal Africa', *American Anthropologist* 107(3), 377–382.
- Fessehaie, J., 2012, 'What determines the breadth and depth of Zambia's backward linkages to copper mining? The role of public policy and value chain dynamics', *Resources Policy* 37(4), 443–451.
- Food and Agriculture Organization of the United Nations (FAO), 1996, *Rome Declaration and Plan of Action*, viewed 16 April 2019, from <http://www.fao.org/3/w3613e/w3613e00.htm>.
- Food and Agriculture Organization of the United Nations (FAO), 2008, *An Introduction to the Basic Concepts of Food Security*, Author, viewed 15 April 2019.
- Frelat, R., Lopez-Ridaura, S., Giller, K.E., Herrero, M., Douxchamps, S. & Andersson Djurfeldt, A., *et al.*, 2016, 'Drivers of household food availability in sub-Saharan Africa based on big data from small farms', *Proceedings of the National Academy of Sciences of the United States of America* 113(2), 458–463, viewed 28 January 2019.
- Gamu, J., Le Billon, P. & Spiegel, S., 2015, 'Extractive industries and poverty: A review of recent findings and linkage mechanisms', *The Extractive Industries and Society* 2(1), 162–176, viewed 4 November 2017.
- Geenen, S., 2014, 'Dispossession, displacement and resistance: Artisanal miners in a gold concession in South-Kivu, Democratic Republic of Congo', *Resources Policy* 40, 90–99.
- Hanlin, R. & Hanlin, C., 2012, 'The view from below: 'lock-in' and local procurement in the African gold mining sector', *Resources Policy* 37(4), 468–474, viewed 24 January 2019.

- Hart, T. & Aliber, M., 2012, *Inequalities in agricultural support for women in South Africa*, Human Sciences Research Council Policy Brief, viewed 15 April 2019, from www.hsrc.ac.za/uploads/pageContent/5325/InequalitiesLR.pdf.
- Hartley, P. & Medlock, K.B., III., 2008, 'A model of the operation and development of a National Oil Company', *Energy Economics* 30, 2459–2485, viewed 15 April 2019.
- Haslam, P.A. & Ary Tanimoune, N., 2016, 'The Determinants of Social Conflict in the Latin American Mining Sector: New Evidence with Quantitative Data', *World Development* 78, 401–419.
- Hendriks, S.L., 2003, 'The potential for nutritional benefits from increased agricultural production in rural Kwazulu-Natal', *South African Journal of Agricultural Extension*(32), 28–44, viewed 15 April 2019.
- Hilson, G.M., 2004, 'Structural Adjustment in Ghana: Assessing the Impacts of Mining-Sector Reform', *Africa Today* 51(2), 53–77, viewed 11 May 2019.
- Hinojosa, L., Bebbington, A. & Barrientos, A., 2012, 'Social policy and state revenues in mineral-rich contexts', in K. Hujo (ed.), *Mineral rents and the financing of social policy: Opportunities and challenges*, pp. 91–121, Palgrave Macmillan, Basingstoke.
- Hinton, J.J., Hinton, B.E. & Veiga, M.M., 2016, 'Women in artisanal and small scale mining in Africa', in K. Lahiri-Dutt and M. Macintyre (eds.), *Women miners in developing countries: Pit women and others*, pp. 209–226, Routledge, Abingdon, Oxon.
- Howieson, J., Calmy, H., Ballard, N., Skinner, P., WO'Hara, G. & Skinner, L., et al., 2017, 'Bread from stones: Post-mining land use change from phosphate mining to farmland', *The Extractive Industries and Society* 4(2), 290–299.
- Infomine, 2013, *Mine sites: Major mining operations around the world*.
- Isla, A., 2002, 'Water and Livelihood in the Era of Globalization', *Canadian Woman Studies* 21/22(1), 148–154, viewed 24 January 2019.
- Janvry, A. de & Sadoulet, E., 2011, 'Subsistence farming as a safety net for food-price shocks', *Development in Practice* 21(4-5), 472–480, viewed 15 April 2019.
- Jenkins, K., 2014, 'Women, mining and development: An emerging research agenda', *The Extractive Industries and Society* 1(2), 329–339, viewed 24 January 2019.
- Jenny, H., 1941, *Factors of Soil Formation*., McGraw-Hill, New York.
- Kennedy, G., Ballard, T. & Dop, M.C., 2011, *Guidelines for measuring household and individual dietary diversity*, Food and Agriculture Organization of the United Nations, [Rome], viewed 11 March 2019.
- Knutsen, C.H., Wig, T., Hammersmark Olsen, E. & Kotsadam, A., 2017, 'Mining and Local Corruption in Africa', *American Journal of Political Science* 61(2), viewed 30 August 2018.
- Kotsadam, A. & Isaksson, A.-S., 2016, *Chinese aid and local corruption*, Working Paper 33, AidData, viewed 3 June 2019.
- Kotsadam, A. & Tolonen, A., 2016, 'African Mining, Gender, and Local Employment', *World Development* 83, 325–339, viewed 22 October 2018.
- Lu, J. & Lora-Wainwright, A., 2014, 'Historicizing Sustainable Livelihoods: A Pathways Approach to Lead Mining in Rural Central China', *World Development* 62, 189–200, viewed 28 January 2019.
- Marchand, J., 2012, 'Local labor market impacts of energy boom-bust-boom in Western Canada', *Journal of Urban Economics* 71(1), 165–174.
- Marchand, J. & Weber, J., 2018, 'Local Labor Markets and Natural Resources: A Synthesis of the Literature', *Journal of Economic Surveys* 32(2), 469–490.

- Mills, S., Tuglavina, Simmons, D. & Claus, R., 2017, 'Food security and mining in Nunatsiavut', *Northern Public Affairs* 2017, 39–41, viewed 15 April 2019.
- Mishra, K. & Sam, A.G., 2016, 'Does Women's Land Ownership Promote Their Empowerment? Empirical Evidence from Nepal', *World Development* 78, 360–371.
- Moomen, A.-W., Dewan, A. & Corner, R., 2016, 'Landscape assessment for sustainable resettlement of potentially displaced communities in Ghana's emerging northwest gold province', *Journal of Cleaner Production* 133, 701–711, viewed 15 April 2019.
- Morris, M., Kaplinsky, R. & Kaplan, D., 2012, "One thing leads to another"—Commodities, linkages and industrial development', *Resources Policy* 37(4), 408–416.
- Mosley, P., 2018, *Fiscal Policy and the Natural Resource Curse: How to escape from the poverty trap*, CRC Press, [Place of publication not identified].
- Mtero, F., 2017, 'Rural livelihoods, large-scale mining and agrarian change in Mapela, Limpopo, South Africa', *Resources Policy* 53, 190–200, viewed 15 April 2019.
- Muchadenyika, D., 2015, 'Women struggles and large-scale diamond mining in Marange, Zimbabwe', *The Extractive Industries and Society* 2(4), 714–721, viewed 20 January 2019.
- Muchomba, F.M., 2017, 'Women's Land Tenure Security and Household Human Capital: Evidence from Ethiopia's Land Certification', *World Development* 98, 310–324.
- Mususa, P., 2010, "Getting by": life on the Copperbelt after the privatisation of the Zambia Consolidated Copper Mines', *Social Dynamics* 36(2), 380–394.
- Mwitwa, J., German, L., Muimba-Kankolongo, A. & Puntodewo, A., 2012, 'Governance and sustainability challenges in landscapes shaped by mining: Mining-forestry linkages and impacts in the Copper Belt of Zambia and the DR Congo', *Forest Policy and Economics* 25, 19–30, viewed 24 January 2019.
- Nguyen, N., Boruff, B. & Tonts, M., 2018, 'Fool's Gold: Understanding Social, Economic and Environmental Impacts from Gold Mining in Quang Nam Province, Vietnam', *Sustainability* 10(5), 1355, viewed 25 October 2018.
- Ogunlela, Y.I. & Mukhtar, A.A., 2009, 'Gender Issues in Agriculture and Rural Development in Nigeria: The Role of Women', *Humanity & Social Sciences Journal* 4(1), 19–30, viewed 15 April 2019.
- Oxfam International, 2017, *Position Paper on Gender Justice and the Extractive Industries*, viewed 20 January 2019.
- Pegg, S., 2006, 'Mining and poverty reduction: Transforming rhetoric into reality', *Journal of Cleaner Production* 14(3-4), 376–387, viewed 25 October 2018.
- Petkova, V., Lockie, S., Rolfe, J. & Ivanova, G., 2009, 'Mining Developments and Social Impacts on Communities: Bowen Basin Case Studies', *Rural Society* 19(3), 211–228.
- Pijpers, R., 2014, 'Crops and carats: Exploring the interconnectedness of mining and agriculture in Sub-Saharan Africa', *Futures* 62, 32–39, viewed 5 January 2019.
- Robb, L., 2013, *Introduction to Ore-Forming Processes*, 1st edn., John Wiley & Sons, New York, NY.
- Rolfe, R.J. & Woodward, D.P., 2004, 'Attracting Foreign Investment Through Privatization', *Journal of African Business* 5(1), 5–27, viewed 11 May 2019.
- Sibhatu, K.T., Krishna, V.V. & Qaim, M., 2015, 'Production diversity and dietary diversity in smallholder farm households', *Proceedings of the National Academy of Sciences of the United States of America* 112(34), 10657–10662, viewed 11 March 2019.
- SOFA Team & Doss, C., 2011, *The Role of Women in Agriculture*, ESA Working Paper 11-02, Food and Agriculture Organization of the United Nations (FAO), viewed 16 April 2019.

- Strongman, J., 1994, *Strategies to attract new investment for African mining*, World Bank Group, Washington D.C., viewed 11 May 2019.
- The Zambian Analyst, 2013, 'The Impact of Multi-National Mining Investments on Food Security in Zambia', *The Zambian Analyst*, 16 October, from <http://paulshalala.blogspot.com/2013/10/the-impact-of-multi-national-mining.html>.
- Tollefsen, A.F., Strand, H. & Buhaug, H., 2012, 'PRIO-GRID: A unified spatial data structure', *Journal of Peace Research* 49(2), 363–374, viewed 2 November 2017.
- Tordo, S., Tracy, B.S. & Arfaa, N., 2012, *Natural Oil Companies and Value Creation*, World Bank, s.l., viewed 6 October 2018.
- United Nations Economic Commission for Africa (UNECA), 2011, *Minerals and Africa's Development: The International Study Group Report on Africa's Mineral Regimes*, Author, Addis Ababa, Ethiopia, viewed 21 January 2019.
- Vela-Almeida, D., Kuijk, F., Wyseure, G. & Kosoy, N., 2016, 'Lessons from Yanacocha: assessing mining impacts on hydrological systems and water distribution in the Cajamarca region, Peru', *Water International* 41(3), 426–446, viewed 20 January 2019.
- Weber-Fahr, M., Strongman, J.E., Kunanayagam, R., McMahon, G. & Sheldon, C., 2002, 'Mining', in J. Klugman (ed.), *A sourcebook for poverty reduction strategies*, pp. 440–461, World Bank, Washington D.C., viewed 24 January 2019.
- Wegenast, T. & Krauser, M., 2018, *Educational Resource Curse? A Disaggregated Analysis of Oil Ownership and Human Capital Formation*, Manuscript, University of Konstanz.
- Wegenast, T. & Schneider, G., 2017, 'Ownership matters: Natural resources property rights and social conflict in Sub-Saharan Africa', *Political Geography* 61, 110–122, viewed 1 November 2017.
- Wegenast, T., Strüver, G., Krauser, M. & Giesen, J., 2019, 'At Africa's Expense? Disaggregating the Social Impact of Chinese Mining Operations', *World Development*(forthcoming).
- Weidmann, N.B. & Schutte, S., 2017, 'Using night light emissions for the prediction of local wealth', *Journal of Peace Research* 54(2), 125–140, viewed 1 November 2017.
- Weng, L., Boedhihartono, A.K., Dirks, P.H.G.M., Dixon, J., Lubis, M.I. & Sayer, J.A., 2013, 'Mineral industries, growth corridors and agricultural development in Africa', *Global Food Security* 2(3), 195–202, viewed 20 January 2019.
- Wooldridge, J.M., 2010, *Econometric analysis of cross section and panel data*, 2nd edn., MIT Press, Cambridge, Mass.
- Zientek, M.L. & Orris, G.J., 2005, *Geology and nonfuel mineral deposits of the United States. U.S. Geological Survey*, Open-File Report 2005-1294A, viewed 16 April 2019.

FIGURES AND TABLES

Figure 1: Mine Control Rights and Food Security in sub-Saharan Africa

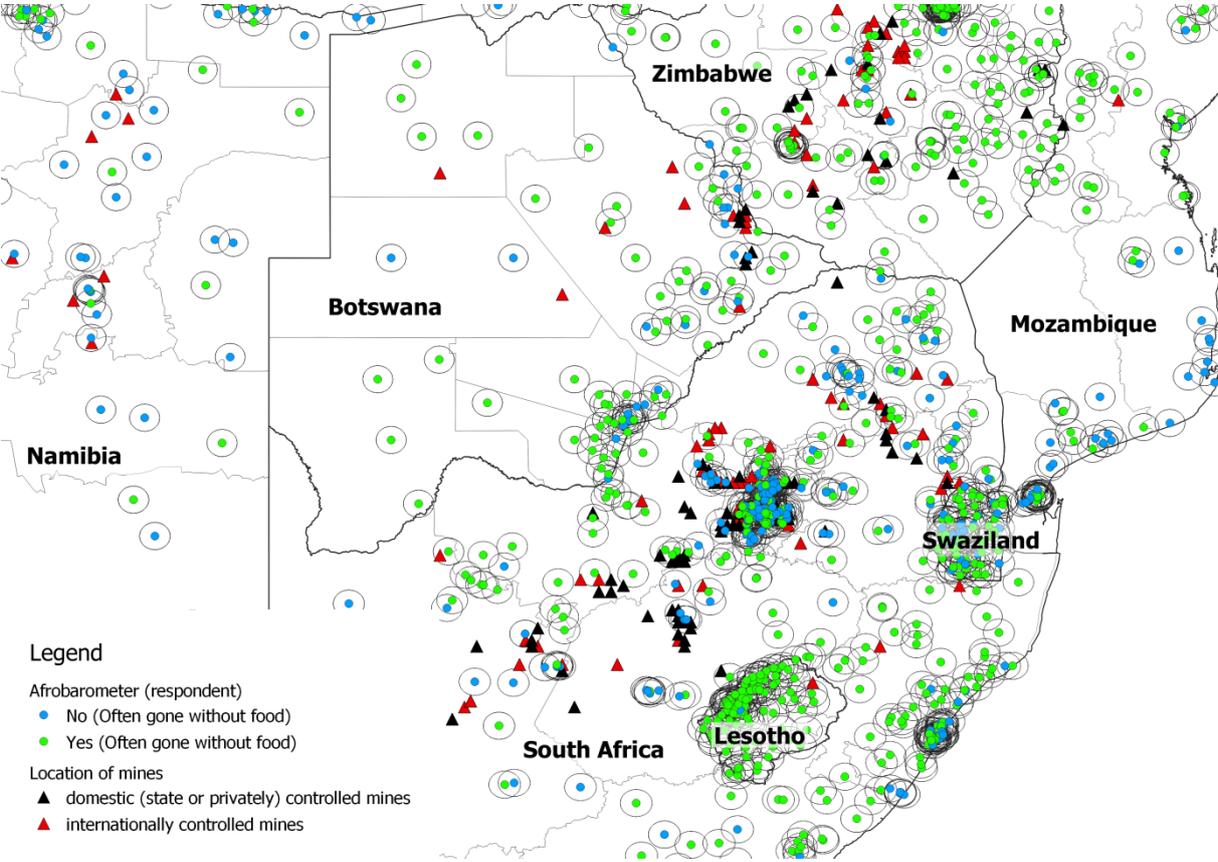


Table 1 : Gender-Specific Effect of Mining on Food Insecurity in SSA

VARIABLES	Food Insecurity		
	(1) Men & Women	(2) Men	(3) Women
Mines	0.02 (0.02)	0.01 (0.03)	0.03** (0.01)
Secondary Education	-0.60*** (0.08)	-0.55*** (0.07)	-0.67*** (0.11)
Living Conditions	-0.76*** (0.08)	-0.77*** (0.08)	-0.76*** (0.09)
Urban	0.06 (0.08)	0.05 (0.08)	0.08 (0.09)
Unemployed	0.31*** (0.06)	0.35*** (0.06)	0.26** (0.08)
Crime	0.53*** (0.05)	0.54*** (0.06)	0.53*** (0.05)
Democracy	-0.29*** (0.05)	-0.29*** (0.05)	-0.28*** (0.07)
Discrimination	0.26*** (0.08)	0.28** (0.10)	0.25** (0.08)
State Capacity	-0.39*** (0.07)	-0.37*** (0.07)	-0.42*** (0.07)
Local Corruption	0.09* (0.04)	0.11* (0.05)	0.06 (0.04)
Constant	-2.05*** (0.12)	-2.17*** (0.12)	-1.91*** (0.15)
Country Dummies	Yes	Yes	Yes
Observations	33080	17469	15610

Note: Logistic regressions with respondents' access to food ("have you often or very often gone without food in the last 12 months") as dependent variable and mean number of active mines during the last four years as independent variable. Unit of analysis is 25km-buffer zone around respondents. Data comes from Afrobarometer round 6 (2016). Standard errors clustered around countries in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Ownership-Specific Effect of Mining on Food Availability in SSA

VARIABLES	Food Insecurity		
	(1) Men & Women	(2) Men	(3) Women
International Mines	0.04 (0.02)	0.02 (0.04)	0.05** (0.02)
Domestic State-Controlled Mines	-0.25*** (0.06)	-0.21*** (0.06)	-0.29*** (0.07)
Secondary Education	-0.60*** (0.08)	-0.55*** (0.07)	-0.67*** (0.11)
Living Conditions	-0.76*** (0.08)	-0.77*** (0.08)	-0.76*** (0.09)
Urban	0.06 (0.08)	0.05 (0.08)	0.08 (0.09)
Unemployed	0.31*** (0.06)	0.35*** (0.06)	0.26** (0.08)
Crime	0.53*** (0.05)	0.54*** (0.06)	0.53*** (0.05)
Democracy	-0.29*** (0.05)	-0.29*** (0.05)	-0.28*** (0.07)
Discrimination	0.26*** (0.08)	0.28** (0.10)	0.25** (0.08)
State Capacity	-0.39*** (0.07)	-0.37*** (0.07)	-0.42*** (0.07)
Local Corruption	0.08* (0.04)	0.11* (0.05)	0.06 (0.05)
Constant	-2.05*** (0.12)	-2.17*** (0.12)	-1.92*** (0.15)
Country Dummies	Yes	Yes	Yes
Observations	33080	17469	15610

Note: Logistic regressions with respondents' access to food ("have you often or very often gone without food in the last 12 months") as dependent variable and mean number of internationally- or state-controlled mines during the last four years as independent variable. Unit of analysis is 25km-buffer zone around respondents. Data comes from Afrobarometer round 6 (2016). Standard errors clustered around countries in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Ownership-Specific Effect of Mining on Food Insecurity, Instrumental Variable Estimations, 2nd Stage

VARIABLES	Food Insecurity				
	Logit	IV Probit		2SLS	
	(1) Men & Women	(2) Men & Women	(3) Men & Women	(4) Men & Women	(5) Men & Women
International Mines	0.06*** (0.01)	0.08* (0.04)		0.02* (0.01)	
State-Controlled Mines	-0.09 (0.08)		-3.54 (2.19)		-1.03 (0.74)
Secondary Education	-0.84*** (0.12)	-0.47*** (0.06)	-0.53*** (0.09)	-0.13*** (0.02)	-0.14*** (0.03)
Living Conditions	-0.81*** (0.16)	-0.45*** (0.06)	-0.46*** (0.08)	-0.11*** (0.02)	-0.11*** (0.02)
Urban	0.22 (0.15)	0.13 (0.10)	-0.05 (0.17)	0.03 (0.03)	-0.02 (0.06)
Unemployed	0.54* (0.26)	0.30*** (0.06)	0.21* (0.10)	0.08*** (0.02)	0.05 (0.03)
Crime	0.55*** (0.12)	0.29*** (0.07)	0.25** (0.10)	0.07*** (0.02)	0.06* (0.03)
Democracy	-0.16 (0.10)	-0.07 (0.06)	-0.13 (0.09)	-0.02 (0.02)	-0.04 (0.02)
Discrimination	0.00 (0.09)	-0.01 (0.08)	0.07 (0.11)	-0.00 (0.02)	0.02 (0.03)
State Capacity	-0.43** (0.15)	-0.23** (0.08)	-0.17 (0.11)	-0.07** (0.02)	-0.05 (0.04)
Local Corruption	0.29* (0.12)	0.14* (0.06)	-0.03 (0.13)	0.04* (0.02)	-0.01 (0.04)
Constant	-1.00*** (0.21)	-0.64*** (0.14)	0.22 (0.53)	0.28*** (0.04)	0.53** (0.18)
Cragg-Donald F-stat				328.045	5.864
Stock-Yogo				16.38/5.53	16.38/5.53
Country Dummies	Yes	Yes	Yes	Yes	Yes
Observations	2368	2777	2777	2777	2777

Note: Model 1 reports logit estimations, Models 2 and 3 IV-probit (“ivprobit” STATA-command); Models 4 and 5 two-stage least square models (“ivreg2” STATA-command). Only results from 2nd stage estimations are shown). Exogenous instrument for international and state-controlled mines in 1st stage are hydrothermal mineral deposits. Critical values for Stock-Yogo test: 10% and 25%. Absolute values of z-statistics in parentheses * $z < 0.05$, ** $z < 0.01$, *** $z < 0.001$.

Table 4: Mineral Extraction and Food Diversity in SSA (DHS Data)

VARIABLES	Food Diversity Index			
	FE	RE	FE	RE
	(1)	(2)	(3)	(4)
Total nr. of mines	-0.06 (0.03)	-0.03 (0.03)		
Nr. of international mines (51%)			-0.12** (0.04)	-0.05* (0.02)
Nr. of public national mines (51%)			0.09 (0.10)	0.12 (0.14)
Secondary education	0.18 (0.11)	0.40** (0.14)	0.18 (0.11)	0.40** (0.14)
Self-employed in agriculture	0.41*** (0.11)	0.32* (0.14)	0.41*** (0.11)	0.32* (0.14)
Water inside	0.90*** (0.21)	1.24*** (0.32)	0.92*** (0.21)	1.24*** (0.33)
Wealth (nightlight emission)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Constant	3.09*** (0.07)	3.32*** (0.14)	3.10*** (0.07)	3.33*** (0.14)
Country Dummies	-	Yes	-	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	5055	5055	5055	5055
R^2	0.078	0.275	0.079	0.156

Note: Models 1 and 3 are fixed effects estimations with standard errors in parentheses; Modes 2 and 4 are random effects estimations with standard errors clustered around districts in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$