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

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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 and provide farmers with better market access. On the other hand, mineral production may contribute to the marginalization of poor smallholders and increase food insecurity by encouraging land grabs, creating new pressures on environmentally sensitive areas and promoting structural labor market shifts. Although the link between mining and food security has been increasingly discussed by the qualitative literature, it has not been analyzed in a quantitative comparative way thus far. Combining geocoded survey data from three different sources (Demographic Health Survey, Afrobarometer and the Latin American Public Opinion Project) with novel information on the control rights of gold, diamond and copper mines in Sub-Saharan Africa and Latin America, this paper is the first attempt to systematically test the effect of mining activities on local populations' access to food. Thereby, it maintains that it is crucial to consider different governance structures, political contexts and gender-specific effects when analyzing the impact of extractive industries on food availability. Preliminary results from logistic models using municipalities and individual mines as levels of analysis show that mining operations decrease food security among women in a substantial way. At the same time, they show no significant or even a positive effect on men's access to food. As women are rarely employed within industrial mining and their traditional roles are closely intertwined with subsistence farming in many rural societies, they seem particularly vulnerable to mining-induced dispossession, environmental destruction and the boom and bust character of extractive industries. In addition, our instrumental variable probit estimations reveal that particularly multinational mining companies are linked to increased food insecurity, while domestic firms are not. Finally, the detrimental effect of mining activities on food security are largely confined to Sub-Saharan Africa.

Keywords: mining, food security, women, sub-Saharan Africa, South America

Introduction

Mining activities 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 the Mapela 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 security[1] are reported for coal mining in Bangladesh (Bedi 2014), 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.

[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" (FAO 1996). Thereby, a country is considered food secure if food is available, accessible, nutritious, and stable across the other three dimensions (FAO, 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).

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 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 and South America with survey data from Afrobarometer and the Latin American Public Opinion Project (LAPOP), we test the effect of mining activities on respondents' access to food both at the mine as well as at the municipal 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. In addition, women seem particularly vulnerable in extractive communities hosting multinational mining firms. Finally, we find no detrimental impact of mining on food security for South American states.

The Potential Impacts of Mining on Food Security

The potential impacts of industrial mining on local food security are highly ambiguous. There are various conceivable channels through which extractive activities may affect food accessibility within mining communities. 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). Through the development of local infrastructure, farmers may also profit from improved market access. Furthermore, populations within mining areas may benefit from increasing resource revenues flows 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 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). Since extractive industries are generally skill- and capital-intensive, their capacity to generate direct jobs is rather limited (Gamu et al., 2015: 168). The labor to capital ratio is comparably low in large-scale mining. Kotsadam & Tolonen (2016) show that only a limited number of the local male population find a job in the mining industry. However, 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 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 and Weber, 2017: 13-15; Marchand, 2012; Morris et al. 2012).

The theory of the enclave nature of natural resources, in contrast, assumes that there exist only few linkages to the local economy and supplies and services stem from outside the mining communities (Eftimie, Heller & Strongman 2009:12; Hirschman 1964; Pegg 2006). Ferguson (2005: 378), for instance, 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. This entails the problem of a decline of terms-of-trade and volatile prices (United Nations Economic Commission for Africa 2011:102–105).

In addition to employment-generating effects, extractive companies may contribute to local food security by providing transportation, power or water-based infrastructure (Adewuvi and Ovejide 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 revenue transfers and the implementation of basic services and social policies including water infrastructure, education and medical assistance (Hinojosa et al. 2012; Tordo et al. 2011; Wegenast and Krauser 2018).

Mining, however, may also be negatively linked to food security through various channels. 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). The socio-environmental impacts of mining commonly trigger profound changes in local livelihoods (Lu & Lora-Wainwright 2014). The extraction of minerals commonly requires the use or storage of hazardous substances including heavy metals or cyanide that may diffuse into the soil, pollute the air and water. Shrinking water supplies can be a threat for food security when large amounts of water are needed for mining operations (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).

The lack of waste management and dumps further aggravate the problematic land use situation (United Nations Economic Commission for Africa 2011:46). Aragón & Rud 2016 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. Hall (2011), for example, categorizes the global competition for land and its natural resources by mining firms as land for non-food production purposes. Focusing on Ghana's mining sector, Andrews (2018) shows that mining-related dispossessions curtails the sustainable livelihood of people in host communities.

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; eds. 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 becomes evident from the last section, a bundle of different and potentially offsetting mechanisms links mineral extraction to food security. The institutional context is likely to 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). Authors underline that women 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 and 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. Brain 2017; Jenkins 2014).

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. As 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 (2011:11), 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 (Jenkins 2014:333; Muchadenyika 2015:715). Especially small children who need regular attention and care by their mothers are adversely affected by these time constraints (Bryson 1981:42). Furthermore, women frequently come in contact with hazardous substances by trying to provide for their family, contributing to serious health conditions and "much grief for rural women who also have to cope with high levels of birth defects and child mortality" (Isla 2002:151).

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 firm, 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 (Lahiri-Dutt 2006). 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. 2006). 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 (c.f. Kotsadam and Tolonen 2016). Consequently, overall female unemployment is likely to increase within expanding mining regions (c.f. Kotsadam and 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 for women worldwide 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 (Christensen 2019; Haslam & Tanimoune 2016; Wegenast & Schneider 2017). Thereby, an important source of local grievances seems to be the lack of local employment opportunities. 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 and Medlock (2008), for example, show that national oil companies tend to favor excessive employment compared to international oil firms (see also El-Katiri, 2014, p. 29). Eller et al. (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). Recently, authors have shown that multinational mining companies are indeed associated with more unemployment compared to local firms (Elgersma 2018; Wegenast et al. 2019) and generate less local economic wealth (Wegenast et al. 2018).

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 Latin America Public Opinion Project (LAPOP) 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 Knutsen et al. (2017). Information on the number and ownership of mines was added in a second step, which is outlined below.

For our empirical analysis, we chose rounds 5 and 6 of Afrobarometer for their temporal coverage and prompted information. Both rounds ask 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.

To assess the degree of food insecurity in Latin American countries, we rely on the LAPOP dataset that provides public survey data for 34 countries in the Western Hemisphere. Each country survey is implemented based on a national probability design. We geocoded the three more recent waves (2012, 2014, 2016) of LAPOP as they include full information on the municipality name and – in contrast to older waves – are representative at the municipality level. In order to obtain information referring to the same geographic level, we overlaid the individual geographic units with global administrative units from Global Administrative Unit Layers (GAUL, EC-FAO Food Security Programme 2008). GAUL provide best available information on global administrative boundaries at country, province, and district level. We used the second order administrative boundary names for South America because they correspond to the municipalities provided in LAPOP.

Round 2012 is the only representative LAPOP round with an item that covers food security. Respondents were asked whether they or some other adult in the household ever eat only once a day or went without eating all day in the past three months. For several reasons related to LAPOP's data structure, we were not able to geocode this information on the individual level and thus calculated the municipal share of persons answering "yes" to this item.

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 and 12 South American countries between 1997 and 2015 (c.f. Wegenast & Schneider, 2017). It largely relies on information from Infomine (2013) and the U.S. Geo-logical 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 from the USGS and the mining companies' websites was retrieved to fill in missing information. Through this strategy, we were able to code the ownership structure of 538 in Africa and 349 mines in Latin America. Yearly observations from 1997 to 2015 depict the shares held by private domestic, state-owned domestic, private international, and state-owned international natural resource companies.

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 5 and 6 of Afrobarometer were surveyed in 2011–2013 and 2014–2015, respectively, we calculated mean control shares for each active mine for the corresponding periods: 2010–2013 and 2012–2015.[2] For our municipal-level analysis employing LAPOP data, we assigned each mine to its host municipality. As a result, we were able to obtain the number of mines controlled predominantly by international or domestic state companies per municipality.

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

[2] 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.

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 LAPOP data, we control for how much respondents trust local or municipal government on a scale from 0 to 7 averaged per municipality (*trust in local government*), the share of municipal population with completed secondary education (*secondary education*), the share of population having access to indoor plumping (as a proxy of *state capacity*) and owning a washing machine (*washing machine*), the number of times a respondent has been a victim of crime within the last 12 months (*crime*) and the percentage of population living in urban areas (*urban*).

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 each Afrobarometer survey round (2012–2015 for round 6). In estimating the geographically 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. E_i is the error term. As observations within the same country are unlikely to be independent, we use standard errors clustered around countries in all reported models. We also estimate both equations above separately for male and female respondents.

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 50 km buffer zone) 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.

**** FIGURE 1 ABOUT HERE ****

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. We use deposit types as an instrument. Thereby, we rely on a universal classification of host rocks according to which the formation of ores can be categorized into three main types: igneous, hydrothermal, and surficial.

These deposit types differ significantly in their degree of extraction difficulty. As surficial deposits are more easily extractable than igneous or hydrothermal formations, their exploitation is less skill and capital intensive (c.f. Robb, 2013; Zientek & Orris, 2005, p. 6). The extraction of gold, diamond, and copper originated from igneous and hydrothermal deposits require more know-how and more advanced technology. Thus, we assume that deposit type predicts the control rights observable in given mining sites: while domestic, state-owned companies tend to concentrate around areas exhibiting surficial deposits, multination firms – often counting on more technological know-how – are more frequently engaged in the exploitation of hydrothermal or igneous minerals. 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.[3] While endogenous to mineral control rights, deposit types are likely to be exogenous to food security (and the 2nd stage error term).

[3] The data can be retrieved from: https://mrdata.usgs.gov/major-deposits/ (accessed September 2, 2018).

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 or igneous deposits within each buffer zone as an instrument. The two endogenous variables are estimated in the 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.

For the municipal-level estimations using LAPOP data, we employ a cross-section linear regression method with the following components:

$$F_m = \beta_0 + \beta_1 * Interantional\ Mines_m + \beta_2 * Domestic\ State\ Mines_m + \beta_3 * X_d \ + \ \eta_c + \varepsilon_m \quad (3)$$

F_m indicates the percentage of the population facing food insecurity in the municipality m. The indicators International Mines ad Domestic State Mines total the number of differently controlled mines in district d. X_d incorporates a battery of control variables. H_c are country fixed effects and εd,t is the error term. In both equations the main coefficients of interest β_1 and β_2 estimate the association between mineral exploitation and municipal food security. Again, we employ standard errors clustered around countries. Figure 2 shows the location of internationally- and domestically-controlled mines along with the share of the population having had at least one day without eating in the past three months for Peruvian municipalities.

**** FIGURE 2 ABOUT HERE ****

Results and Robustness Checks

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 reduced food security 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 are increases respondents' risk of facing food insecurity.

**** TABLE 1 ABOUT HERE ****

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 for 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 substantiate these findings, we run iv-specifications as described above. Table 3 presents the findings for the second stage iv-probit estimations in which the sample is limited to mineral-extracting buffers. Instrumented by hydrothermal/igneous deposit types, multinational mining companies – compared to domestic state-controlled firms – have a positive and significant effect on food insecurity (model 1). A Wald test of exogeneity indicates that the null hypothesis of exogeneity can be rejected. Furthermore, the joint endogeneity test is satisfied. Proximity to state-controlled mines, in contrast, seems not to be associated with food insecurity (model 2).[4]

**** TABLE 2 ABOUT HERE ****
**** TABLE 3 ABOUT HERE ****

To test the consistency of our results, we performed different robustness checks. We re-estimated all models discussed above using round 5 of Afrobarometer. Furthermore, we used 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 of mines within each buffer zone. Instead of a 51% ownership threshold to define international and state-controlled companies, we also

[4] Results of the first stage of our iv-probit estimations are presented in Table A1 in the appendix.

employed a 66% threshold. Furthermore, we included mineral dummies to control for mineral-specific effects. Our main results proved robust to all these different specifications. Finally, we also extended the range of our buffer zones to 40km.[5] Thereby, the effect size of some coefficients became weaker while other coefficients turned out insignificant. 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 perceivable at a distance of 40km from a given extraction site.

Finally, we test whether our findings are also applicable to South American countries. Given that the 2012 wave of LAPOP asks whether someone or the respondents' household has experienced food shortage in the last three months, we are unable to disentangle the effects of mining on men and women. Nevertheless, we provide results for the overall impact of extractive activities on households' food security and test whether we also find significant different effects for multinational compared to domestic companies.[6]

Model 1 of Table 5 below shows that the average number of active mines per municipality has no significant effect on food security. Model 2 reproduces one key finding previously reported for African states: in South America, domestic mining firms are also associated with a reduced risk of food insecurity, while multinational companies tend to hamper access to food (although the coefficient for international firms is only statistically significant at the 10% level). An additional domestically-controlled mine within a municipality reduces its share of population having eaten only once a day or gone without eating all day in the previous three months by 3,6%. Taken together, our analysis suggests that the ownership-specific effects of mining on food availability found for sub-Saharan Africa are generalizable to other geographical areas.

**** TABLE 5 ABOUT HERE ****

Next Steps

In order to establish a closer causal link between mining and food security, our future research will combine information on mine openings with individual survey data from the Demographic

[5] Due to time constraints, the results of these robustness checks are still not integrated into this manuscript version. However, they are available upon request.

[6] As domestic state-controlled mining companies are rather rare in Latin America, we combined national private and state-owned firms into one category.

Health Survey (DHS) covering the nutritional status and eating habits of men, women and children. Relying on Coarsened Exact Matching techniques and mean differences tests, we are better able to draw causal inference through a quasi-experimental setting. We will match districts that experienced mine opening with controls showing no mineral production holding important covariates (socio-economic variables, access to water or forests, state capacity, hydrocarbon production) constant. Thereby, we will be able to compare difference between treated versus untreated districts regarding variables such as the weight-to-height-index and individual dietary practices (particularly food variety).

Conclusions

Does mining affect the food security of extractive communities? Our analysis underlines that, in order to answer this question, contextual factor must be taken seriously. In line with previous qualitative reports, we show that the impact of mining activities on access to food is gender-specific. Our logistic and instrumental variable probit estimations 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 firms are associated with decreased food security among women. 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 et al. 2018).

Our municipal level regression analysis using LAPOP survey data shows that these ownership-specific effects are also observable in South American states. Municipalities hosting domestic mining companies seem less affected by food insecurity. However, we do not find a strong negative impact of international firms on food security as in the sub-Saharan Africa context. Since, on average, political and economic institutions are stronger in most South American countries compared to African states, governments may be better able to regulate the activities of international investors prompting them, for example, to implement local content policies or better engage in social and environmentally responsible practices.

The research and policy implications of our findings are manifold. Our research suggests that future research should 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. We should further our understanding of the gendered or raced nature of mining-induced changes. This would allow us to craft and implement better policies to tackle socio-environmental injustices within mining communities.

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 and 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 et al. 2013).

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FIGURES AND TABLES

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

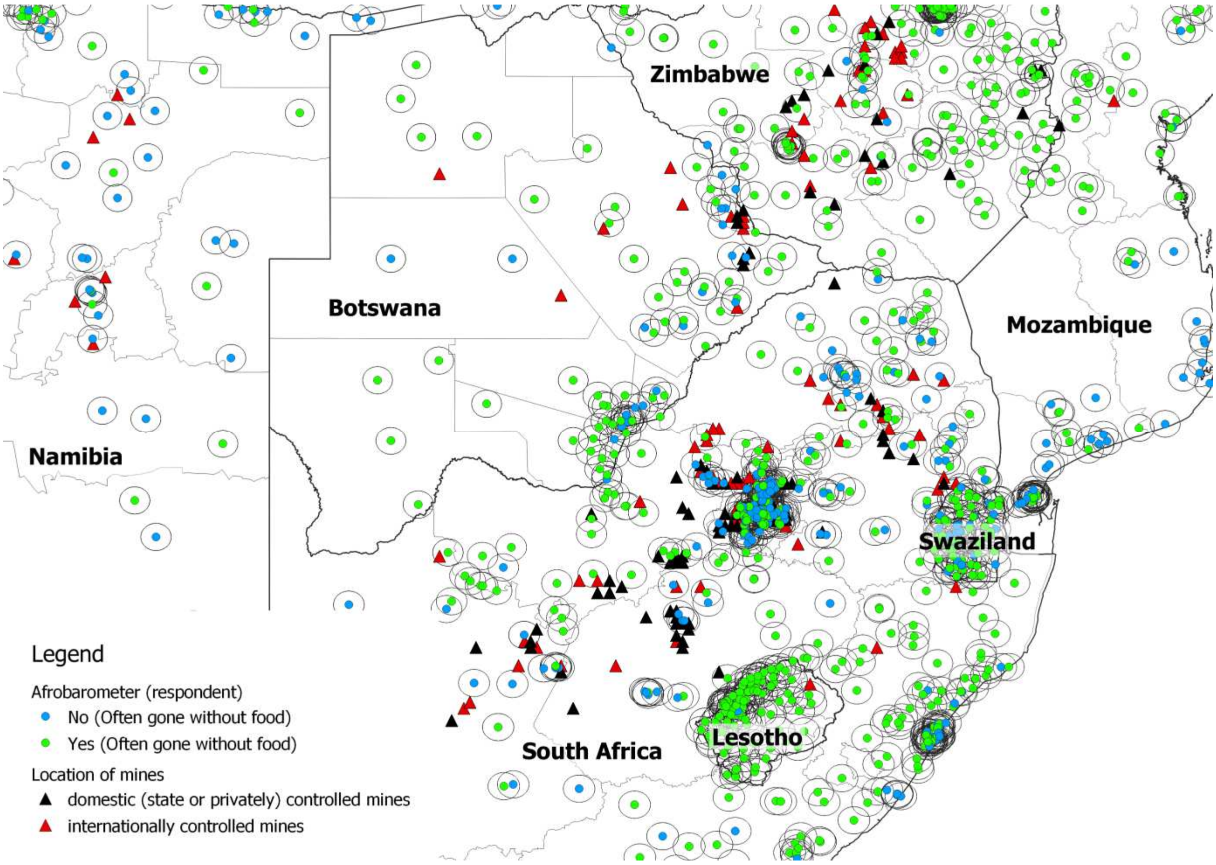

Figure 2: Mines and Access to Food in Peruvian municipalities

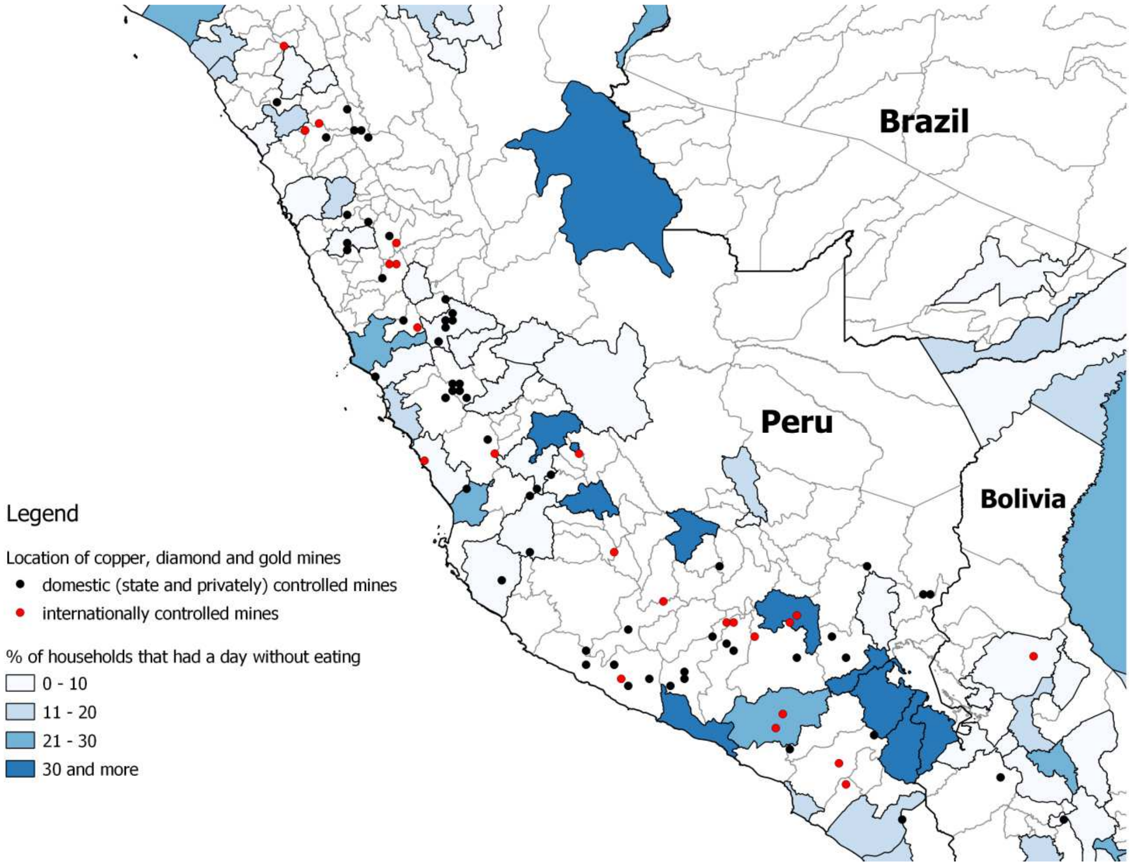

Table 1 : Gender-Specific Effect of Mining on Food Availability in SSA

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

Standard errors clustered around countries in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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)

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

Standard errors clustered around countries in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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).

Table 3: Ownership-Specific Effect of Mining on Food Availability in SSA, IV-Probit Estimations, 2nd Stage

VARIABLES	Food Insecurity	
	(1) Men & Women	(2) Men & Women
International Mines	0.08*	
	(0.04)	
State-Controlled Mines		-3.54
		(2.19)
Secondary Education	-0.47***	-0.53***
	(0.06)	(0.09)
Living Conditions	-0.45***	-0.46***
	(0.06)	(0.08)
Urban	0.13	-0.05
	(0.10)	(0.17)
Unemployed	0.30***	0.21*
	(0.06)	(0.10)
Crime	0.29***	0.25**
	(0.07)	(0.10)
Democracy	-0.07***	-0.13
	(0.06)	(0.09)
Discrimination	-0.01	0.07
	(0.08)	(0.11)
State Capacity	-0.23**	-0.17
	(0.09)	(0.07)
Local Corruption	0.14*	-0.03
	(0.06)	(0.13)
Constant	-0.52*	6.42
	(0.22)	(4.28)
Country Dummies	Yes	Yes
Observations	2777	2777

Note: All estimations IV-probit; only 2nd stage results shown. Exogenous instruments international and state-controlled mines in 1st stage are hydrothermal and igneous mineral deposits.
Absolute values of z-statistics in parentheses
* $z < 0.05$, ** $z < 0.01$, *** $z < 0.001$.

Table 4: Mining and Food Security in South America

VARIABLES	Food Insecurity	
	(1)	(2)
Mines	-0.001	
	(0.01)	
International Mines		0.02
		(0.01)
State-Controlled Mines		-0.04**
		(0.01)
Trust in Local Government	0.00	0.02
	(0.02)	(0.02)
Secondary Education	-0.07	-0.07
	(0.04)	(0.04)
Washing Machine	-0.12*	-0.12*
	(0.04)	(0.04)
State Capacity	-0.12*	-0.12*
	(0.04)	(0.04)
Crime	0.03	0.03
	(0.02)	(0.02)
Urban	-0.03	-0.03
	(0.03)	(0.03)
Constant	0.28*	0.29*
	(0.10)	(0.10)
Country Dummies	Yes	Yes
Observations	534	534

Standard errors clustered around countries in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

NOTE: OLS regressions with respondents' access to food ("did an adult in the household ever eat only once a day or went without eating all day in the past three months?") as dependent variable and mean number of internationally- or state-controlled mines per municipality as independent variable. Data comes from LAPOP round 2012.

APPENDIX

Figure A1: Number of Active Mines within 25km Buffers and Food Insecurity Among Men and Women

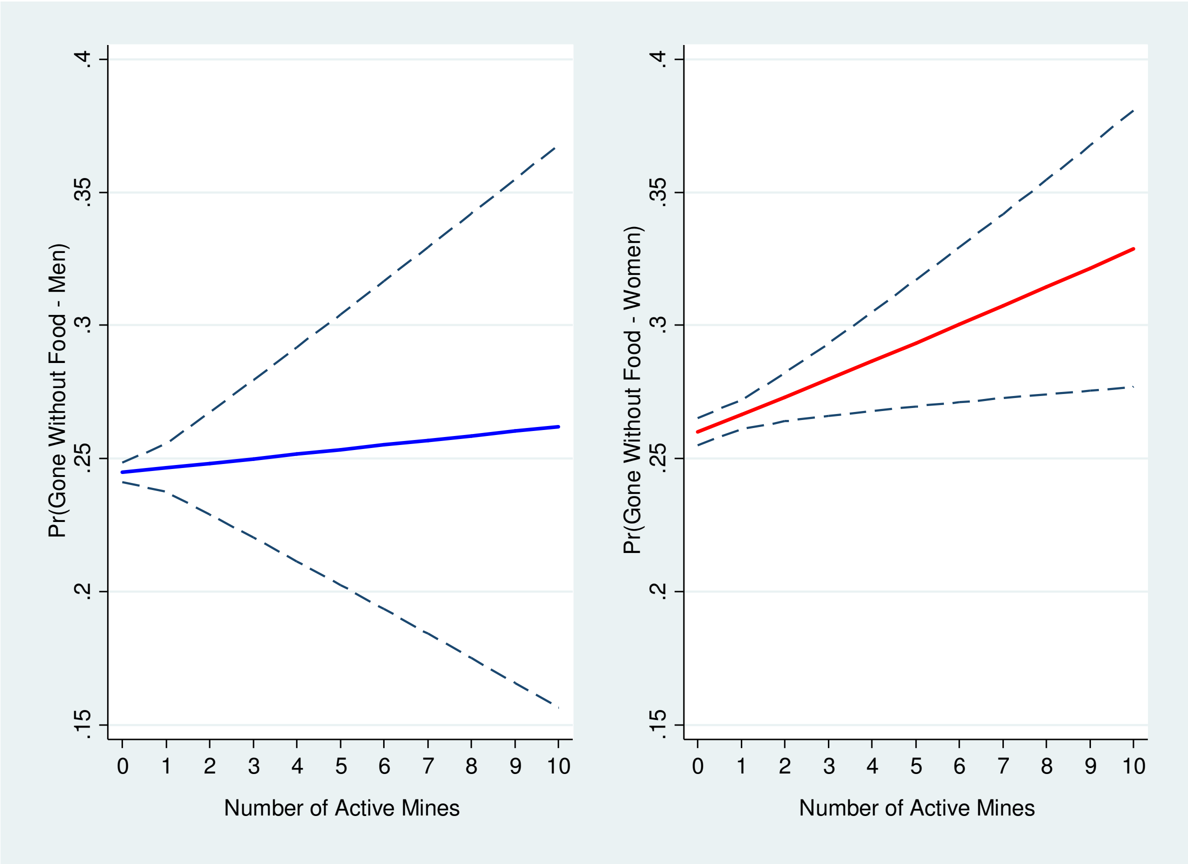

Table A1: Effect of Deposit Type on Mining Control Rights, IV-Probit Estimations, 1st Stage

VARIABLES		
	(1) International Mines	(2) State-Controlled Mines
Hydrothermal&Igneous	0.76***	-0.02*
	(0.04)	(0.01)
Secondary Education	0.09	-0.22
	(0.06)	(0.02)
Living Conditions	-0.11	-0.00
	(0.09)	(0.01)
Urban	0.17	0.05*
	(0.15)	(0.15)
Unemployed	-0.08	0.24
	(0.09)	(0.15)
Crime	0.26*	0.02
	(0.10)	(0.02)
Democracy	-0.04	0.02
	(0.09)	(0.14)
Discrimination	0.08	0.02
	(0.12)	(0.02)
State Capacity	-0.25*	0.02
	(0.12)	(0.02)
Local Corruption	-0.08	-0.04***
	(0.08)	(0.01)
Constant	0.42	1.96***
	(0.30)	(0.05)
Country Dummies	Yes	Yes
Observations	2777	2777

Notes: All estimations IV-probit; only 1st stage results for all exogenous instruments from two-step IV-probit shown. Absolute values of t-statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.