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Large-scale mining and local development: Evidence from Mongolia[?]

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Abstract

We investigate the local economic impacts of a large-scale copper-gold mine in Mongolia. Employing household data from 2008 to 2016, we find positive economic effects of the mine and its corporate social responsibility (CSR) activities. A ten percent increase in mining activities resulted in 2.2 and 2.3 percent increases in income and food consumption, respectively. Mining activities enabled households to increase their medical expenditures, while sickness did not increase significantly. In contrast, education expenditures reduced while educational attainments improved in mining areas. Both expenditure patterns indicate that large-scale extractive industries can generate positive welfare outcomes for residents, and CSR activities further enhance the mining sector's traditional benefits.

JEL-Classification: L72, O12, O13, Q32, R11

Keywords: Mining, Natural Resources, Regional Economy, and Economic Development

[?]I thank Syed Hasan, Martin Berka, Derrin Davis, Rukmani Gounder, Robert Breunig, Kompal Sinha, Dean

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Abstract

We investigate the local economic impacts of a large-scale copper-gold mine in Mongolia. Employing household data from 2008 to 2016, we find positive economic effects of the mine and its corporate social responsibility (CSR) activities. A ten percent increase in mining activities resulted in 2.2 and 2.3 percent increases in income and food consumption, respectively. Mining activities enabled households to increase their medical expenditures, while sickness did not increase significantly. In contrast, education expenditures reduced while educational attainments improved in mining areas. Both expenditure patterns indicate that large-scale extractive industries can generate positive welfare outcomes for residents, and CSR activities further enhance the mining sector's traditional benefits.

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Natural resource extraction appears to have both bene cial and adverse impacts on local communities in advanced economies. The oil extraction a ected the employment, educational attainment, and per capita income positively in oil-rich counties of the southern US (Michaels, 2011). A decade of natural gas development in the south-central US created jobs and increased earnings per job (Weber, 2014; Allcott and Keniston, 2017). Mining regions in Australia had lower income inequality than the non-mining and non-metropolitan areas as new mining jobs increased employment in other sectors through local multiplier e ects (Fleming and Measham, 2015). Similarly, energy extraction in Western Canada created jobs in construction, retail, and service sectors during boom periods (Marchand, 2012). Conversely, mining suppressed income growth, and the number of high school drop-outs increased in coal-dependent counties of the US (James and Aadland, 2011; Douglas and Walker, 2017).

Evidence from resource-rich developing countries is also mixed. For example, copper mines in Zambia, where scal links are weak, created solid backward linkages to local markets, resulting in positive impacts on household expenditure, housing conditions, and the ownership of consumer durables (Lippert, 2014). The real incomes of residents around a large-scale gold mine in Peru rose because of the mine's backward linkages to local markets (Aragon and Rud, 2013). Also, mining districts in Peru had higher consumption per capita and lower poverty rates than the non-mining communities, but consumption inequality was higher within mining districts (Loayza and Rigolini, 2016).

The consumption of households living near artisanal gold mining sites in Burkino Faso increased signi cantly during the gold boom period (Bazillier and Girard, 2020). Localities near oil elds in Brazilian municipalities experienced a higher level of per capita income (Gradstein and Klemp, 2020). Similarly, oil and gas production in district government areas in Indonesia tlo6.937 -21.923 Td [(si)-3

productivity and increased rural poverty (Aragón and Rud, 2015). Because of o cials' rent-seeking behavior in Brazil's oil-rich municipalities, living standards did not improve despite oil companies' increased investment in infrastructure, education, and health facilities (Caselli and Michaels, 2013). Ahlerup et al. (2020) also found that educational attainments of adults who lived near gold mines during their adolescence were signi cantly lower in most countries across Africa due to the higher incidence of child labor in the mining sector. Therefore, mining activities do not necessarily lead to positive development outcomes for nearby communities.

In addition to the outcomes mentioned above, mining depletes non-renewable resources, grabs farmland and pastureland, redirects rivers and streams, and leaves irreversible environmental footprints. The historically widespread con icts between indigenous people, local communities, and mining companies resulted in the recent shift in mining companies' uptake of corporate social and environmental responsibility (Jenkins, 2004). Mining corporations usually seek to mitigate the adverse externality e ects through their corporate social responsibility (CSR) activities, including monetary and in-kind donation, community development programs, and nancial compensation (Reinhardt et al., 2008).

The community relationship between mining companies and local stakeholders, which is sometimes not smooth, plays an essential role in shaping the development outcomes (Jenkins, 2004). When negotiation and consensus between mining companies and local communities are reached, both parties win: mining operations continue without disruption, and local people in the proximity of mining bene t from CSR initiatives (Otto, 2010). However, besides the traditional bene ts, whether CSR activities and investment resulting from mining activities a ect household consumption patterns and decisions is unclear.

Our study is the rst to use CSR spending as a proxy for mining activities. We empirically examine the causal relationship between early-stage, large-scale mine development and household welfare in a developing country. Speci cally, we investigate the impact of an exogenous shock - resource discovery and a signi cant in ow of foreign direct investment - on households' welfare in a mining region. Previous studies such as Caselli and Michaels (2013); Aragón and Rud (2015); Mamo et al. (2019); Gradstein and Klemp (2020) have used windfall revenues, mining production,

local taxes, procurement, and proximity to oil fields to examine the impact of natural resource extraction. We employ CSR spending as it captures the overall impact of mining activities and the effect of CSR activities on household consumption decisions.

We undertake both macroeconomic and microeconomic analyses to draw a complete picture of the mining sector's impact at the local level. First, we employ a three-variable Vector Autoregressive (VAR) model to examine the mining sector's contribution to the provincial economy. We then use a difference-in-differences (DD) model in a quasi-experimental setting, with data from four recent Mongolia Household Socio-Economic Survey (HSES) rounds. Our analysis focuses on household consumption patterns to examine the local welfare effects of mining activities.

We find that a 10 percent increase in CSR spending resulted in 2.2, 2.3, and 1.9 percent increases in income, food consumption, and non-food consumption, respectively. Therefore, the mining activities positively impact households' incomes and consumption in a region currently typified by limited economic and social opportunities and infrastructure. A detailed analysis of consumption, including expenditures on food, health, education, energy, clothing, and transportation, further supports the idea that mining activities benefit the local population.

The rest of the paper proceeds as follows. Section 2 provides background to the study. Section 3 discusses the empirical strategy and data. Section 4 presents the main results and discusses the associated policy implications. Section 5 concludes the paper.

2. Background

2.1. Mongolia and its dependence on minerals

In 2012, CNN reporter Amanpour asked, \What is the world's fastest-growing economy? If Mongolia did not pop into your mind, you are probably not alone."[2] Mongolia is a lower-middle-income nation with a small, open economy, which relies on minerals, including coal, copper, iron ore, and zinc. The extractive industries received more than 75 percent of foreign direct investment (FDI) during 2011-2016 (NSO, 2019). In 2016, the highest value exports were copper ore ($1.61b),

[2] See https://cnn.it/3aPZ8b2.

gold ($1.53b), and coal briquettes ($987m).[3] The mining sector comprised 18 percent of GDP, 63 percent of total exports, and 19 percent of government budget revenue in 2016. Also, the mining sector employed three percent of the country's workforce in 2016 (NSO, 2019). This and other country analysis (e.g., Baatarzorig et al., 2018) indicates the economy's reliance on the resources sector.

Economic growth in Mongolia topped 17 percent in 2011 as FDI poured in with the expectation of substantial returns from mineral development. Average economic growth was 7.5 percent per

their local administrative expenses. However, the central government funds national-level public projects (Vanchin, 2018).

2.2. Impacts of mining: sub-national differences

We first examine the mining sector's impact at the sub-national level before undertaking our main analysis at the household level. Following the definition of Auty (1993) for a resource-rich country, we categorize nine provinces as resource-rich, mining provinces as at least eight percent of their annual provincial GDP comes from the mining sector for the period 2010-2018.[6] The remaining 12 are classified as non-mining provinces. Appendix A.1 presents the list of provinces with the categorization.[7] We examine the sub-national effects, reflecting the importance of mining sector production to provincial economies, through the following three-variable vector autoregressive

GDP, and government revenue, to a one standard deviation shock in the mining sector production. Panel (a) relates to the mining provinces. The top graph shows the response of the mining sector production to its one standard deviation shock. The mining sector production increases by 0.45 percent in the same year, then declines up to year four, increases up to year six, and reaches long-term stability after year eight in response to this shock. GDP increases by a little more than 0.1 percent in year one, grows in the second year and then the response is insigni cant to the mining sector production shock in the next graph. Although the mining sector production shock increases the provincial government revenue up to year four, the e ect is not signi cantly di erent from zero. Overall, a shock in the mining sector production has positive e ects on GDP and government revenue in the mining provinces in the short-run.

[Figure 1]

Panel (b) in Figure 1 shows the IRF for the non-mining provinces. In the top graph, the mining sector production increases by 0.8 percent to its one standard deviation shock in the same year, remains negative after year two until year four and becomes insigni cant after that. The response is higher in non-mining provinces compared to the mining provinces due to the unstable and volatile nature of the mining sector in non-mining provinces. However, provincial GDP and government revenue drop by less than 0.02 percent and more than 0.1 percent, respectively, in year one and stay around zero. Overall, mining sector production does not signi cantly a ect GDP and government revenue in non-mining provinces. Taken together, the VAR model results indicate that the mining provinces predominantly realize the bene ts from mining activities.

2.3. Oyu Tolgoi mine and its CSR activities

Large-scale mines in Mongolia are strategically critical mineral deposits that will either impact national security and economic and social development or have the resource reserves and the

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a signi cant asymmetry on the system (Sims, 1980; Enders, 2010). Our ordering of variables from contemporaneously

capacity to produce more than ve percent of the country's annual GDP (Parliament of Mongolia, 2006). Southgobi, the host of a recently discovered copper-gold deposit in Mongolia, is a large-scale mining province examined in this study.[9] Copper, which accounted for over 30 percent of total export value during 2001-2016, is the country's most important mineral. With 31.3m tonnes of copper reserves and 3.3b tonnes of mineable copper ore reserves, Oyu Tolgoi is one of the ve largest copper deposits in the world (Oyu Tolgoi, 2018). Oyu Tolgoi's production in mid-2013 increased the volume of copper concentrate exports of Mongolia, from an average of 0.5m tonnes during 1995-2013 to 1.4m tonnes in 2014 (Figure 2). The mine's annual production is projected at 0.43m tonnes of copper and 0.42m ounces of gold for the next 20 years (Rio Tinto, 2019). Oyu Tolgoi's mineral reserves and the scale of the investment for its development are unprecedented in

The two aspects of CSR, protecting and improving, are particularly important in the context of mine-impacted communities in resource-rich developing countries. To

Bayankhongor, Uvurkhangai, Dundgobi, and Dornogobi, otherwise similar to Southgobi, that do not have mines identical to Oyu Tolgoi (diagonal line shaded area in Figure 3).[12]

[Figure 3]

3. Methodology and data

3.1. Empirical approach

We examine our research question in a quasi-experimental setting. Employing the ordinary least square (OLS) can produce biased or inconsistent estimates in the presence of endogeneity that may arise due to the omission of relevant variables in the model (Wooldridge, 2015). The di erence-in-di erences (DD) model can tackle the endogeneity problem arising from omitting relevant variables (Parmeter and Pope, 2013). As a result, we use the DD model in our analysis. Our empirical speci cation closely followed the DD model used by Aragon and Rud (2013) and takes the following form:

$$y_{ist} = + _t + _s + (\ln M_t \quad D_s) + X_{ist} + "_{ist}; \qquad (2)$$

where, y_{ist} is the (natural logarithm of) monthly income per capita (or consumption or speci c categories of consumption in separate analyses) of household $(i = 1; : : : n)$ in province s $(s = 1; : : : s)$ and year t; X_{ist} is a set of control variables (described in subsection 3.2), $_t$ is the year xed e ects and $_s$

provides information about the e ect of mining activity on the incomes of households living in Southgobi province. In our model, we expect the CSR investments to impact the households

$5m per calendar year to the \Gobi Oyu" development support fund (DSF) to support community development.[15]

Figure 4 shows that the CSR spending of Oyu Tolgoi was low during 2008-09 and increased slightly during 2010-11. It rose signi cantly during 2012-13 and then sharply fell in 2014 before growing again during 2014-2016. The services and infrastructure that the mining companies built with the CSR fund complement public services and amenities provided by the central or local government. Hence, compared to resource-poor provinces, mineral-rich provinces receive additional social investment due to mine development. Figure 4 indicates that people in the mining region are likely to bene t from CSR spending after 2010.

[Figure 4]

3.2.2. Household data

We use data from the HSES in the study. The HSES is a nationally representative cross-

(NSO, 2019). The e ect of mining activity on incomes, food consumption, and various non-food consumption components is the primary focus of this paper. Each of the variables relates to household welfare, and we consider them as the dependent variables in equation (2) in sequential analysis. The categorization of non-food expenditures were conducted following previous studies (e.g., Banks et al., 1997; Blundell et al., 2007; Hasan, 2016). The main categories of expenditures analyzed in this study are medical, education, energy, clothing, services, and transportation.

Table 1 reports the summary statistics for the dependent variables (values are CPI-adjusted at the 2010 level) for treatment and control households by the survey year. We observe a steady increase in monthly income per capita for both groups in all years, except for the treatment group

both model results would indicate whether any control modi es the impact signi cantly, which consequently would show whether the estimates of remain stable with additional controls. All the models in this analysis were estimated using sample weights, with standard errors clustered at the primary sampling unit level. Following the convention, all tests were conducted at the ve percent signi cance level. Results that are not presented here are available from the author upon request.

4.1. Main results

Table 4 reports the e ects of mining on income, food consumption, and non-food expenditure per capita. The DD estimate is positive and signi cant in column 1, suggesting that mining activity increased real incomes. As expected, the year xed e ects show the signi cant growth in the control households' incomes during the period 2012-2016. The results remain stable when we include other control variables in the model. The DD coe cient estimate in column 2 from our preferred estimate indicates that a 10 percent increase in CSR spending increases households' real incomes by 2.2 percent in Southgobi.

[Table 4]

The coe cients of the control variables in column 2 are mostly meaningful and statistically signi cant. For example, in line with previous studies like Bertrand et al. (2004); Juhn and McCue (2017

that a 10 percent increase in CSR would increase non-food consumption by 1.9 percent. The direction and signi cance of other control variables are similar to those in columns 2 and 4. The model explains 43 percent of the variations in non-food consumption.

Interestingly, our elasticity estimate for non-food expenditure is lower than food consumption. While non-food expenditure elasticity is usually higher than that for food, the opposite may occur for low-income countries where the budget share for food may increase as income rises (Almas, 2012). In particular, Hasan (2016) found that households in Bangladesh, a low-income country, initially increased their budget share for food when their incomes rose. Bhalotra and Att eld (1998) also found that low-income households in rural Pakistan spent nearly all of their additional income

also funded hepatitis screening and vaccination for health workers in 2012 and supplied ambulances and equipment to some town hospitals in 2013 (Oyu Tolgoi, 2018). All these allowed people in Southgobi to save money on some activities, thus lowering their health expenditures. Furthermore, the initiatives strengthened the capacity, quality, and accessibility of health services in Southgobi, allowing people to spend more on health by removing the supply constraint on medical services[23].

However, increased health care expenditure may mean that local people living nearby the mine experience frequent or severe illnesses than their counterparts. Studies on other countries sometimes reported such an outcome. For example, incidence of anemia among women and stunting in children was higher for those who live in the proximity of mines that release lead contamination than those who lived far (von der Goltz and Barnwal, 2019). We employ the linear probability model, probit, and logit models to examine the e ect of mining on the individuals' likelihood of feeling unwell. The results indicate that, during the same period, sickness did not increase signi cantly in Southgobi (see Table A.2). Since there is no evidence that mining is causing adverse health impacts on local communities in Southgobi in Mongolia, we associate the positive health expenditure elasticity with

region, similar to health services, supported educational services that might reduce households' spending on education. Recently, 292 students from Southgobi province received scholarships from Oyu Tolgoi to study medical science, education, agriculture, construction engineering, and environmental management (Oyu Tolgoi, 2018).

Additionally, 184 health care workers were trained on medical waste management and rst aid equipment from 2010, while 26 doctors in 13 towns received scholarships to attend training in 2013. The \Gobi Oyu" DSF built two kindergartens, which accommodated 400 children in 2016 (Oyu Tolgoi, 2018). Thus the lower educational spending in Southgobi could be due to the better job prospective of potential students created by the mining activity.

On the other hand, low expenditure on education can engender from the lower educational attainment in Southgobi due to higher employment opportunity in the region, as was seen in some earlier studies (e.g., Douglas and Walker, 2017; Ahlerup et al., 2020). We employ the OLS and Ordered logit model to explain the household heads' educational attainment years to examine the issue. The results indicate that, during the same period, the increase in educational attainment in Southgobi was signi cantly higher than the same in other provinces of the country (see Table A.3). Thus, we can reject the low-enrollment issue and conclude that mining activity positively impacted educational outcomes for Southgobi residents while allowing them to spend less than their counterparts due to their increased access to free educational activities.[24]

Next, we analyze energy expenditures that include electricity and other types of energy in columns 5 and 6 of Table 5. Households in Southgobi increased their energy expenditures more compared to the control households. Energy expenditures in our preferred speci cation rise by 1.2 percent due to a 10 percent increase in mining activity (Column 6). The higher energy expenditures may result from the increased electricity availability in the mining region, spDou-383(d018a)-3 in lein le in278(ermitt(en)28(t)-393(electricit)27(y)-049(supl(y)-049(to)-190(the)-049cmen)27(rnal)-393(electrio)-190gridl

more goods and services are locally available due to the mining boosted local economy (Papageorgiou and Thisse, 1985). The outcome is con rmed because the DD coe cient becomes negative and statistically signi cant even when we include income in the model.

Overall, the results reported in Tables 4-6 provide evidence that the large-scale mine in South-gobi had a signi cant positive impact on the incomes and welfare of local households.

4.2. Robustness checks

We perform additional checks to see whether our measures of welfare are robust. First, we look at two other variables that can also capture the impact of mining activity on household income and consumption { local taxes paid by the mining company to the local government and wages paid to employees. Thus, in modeling income and consumption, we used the mining company's wages paid to the employees as a proxy to mining activities and repeat Tables 4-6. The results indicate that mining wages also have a positive and signi cant impact on the welfare of households in the mining region (Tables A.4-A.6). Although the magnitudes of coe cients are smaller as they do not capture CSR activities' impact, they are qualitatively similar to our main results. Our investigation with local taxes as a proxy to mining activities also indicate that mining activities have a positive and signi cant e ect on household welfare (Tables A.7-A.9).

The increases in incomes resulting from mining activities drive the signi cant changes that we observe in consumption. We focus on the di erent categories of consumption to better understand the local welfare outcomes of mining activities. As household income and consumption are highly correlated, adding income as a control variable in the DD model will capture part of the e ects of CSR spending. Thus, we examine how income a ects the DD model outcomes for each category of consumption. In line with our expectations, income signi cantly a ects food and non-food consumption and expenditures on health, energy, clothing, services, and transportation. However, it has a signi cant and negative e ect on education expenditures, re ecting the fact that higher income is associated with mining activity. The DD estimates are mostly signi cant even when we include income in the model, indicating that mining activities may positively a ect welfare beyond the conventional income channel, e.g., through the CSR activities.

Our results are robust to the inclusion of CSR spending by another mining company, Mongolian Mining Corporation, that actively supports community development in Southgobi. The Mongolian Mining Corporation mainly builds infrastructure development, implements community development programs, provides grants and sponsorships, and undertakes local procurement in sub-province, Tsogt-Tsetsii. On the other hand, Oyu Tolgoi's CSR activities' outreach is beyond the sub-province where it operates. The results are available from the author upon request.

We also examine whether the choice of variables in per capita terms a ects our results. We explore this because there are economies of scale in household consumption, while demographic factors may also a ect consumption level. Income and consumption analyses widely utilize equivalence scales to address those issues (Bishop et al., 2014). We use two well-known equivalence scales { the square root of family size (SRFS) and modi ed OECD equivalence scale (Aaberge and Melby, 1998; Schwarze, 2003). The former takes the square root of the number of family members to adjust the household size. The latter assigns one to the rst adult and adds 0.5 for an additional adult and 0.3 for an extra child in the household. The models using the equivalized variables, the SFRS and modi ed OECD scale, produce qualitatively similar results as our results, indicating the robustness of our main ndings.

4.3. Validity of the common trend assumption

The validity of our di erence-in-di erences model depends on the parallel trend assumption, as we discussed previously. We examine the common trend assumption visually. Figure 5 plots the monthly real per capita incomes and food, and non-food consumption, separately for the households located in Southgobi province and those living in the neighboring areas. Panel (a) in the gure shows that until 2012 real incomes for both the groups follow a similar trend. However, they diverge after 2012, with the income increasing substantially for households living in Southgobi. The same pattern holds for food consumption in Panel (b). The pattern is less clear for the non-food consumption in Panel (c). We, therefore, undertake an econometrics analysis to examine the validity of the common trend assumption.

[Figure 5]

We conduct a placebo test using a conventional DD model with the interaction of dummy variables as it is not plausible to conduct a placebo test with equation (2). Since we would not expect to see signi cant di erences in the incomes and consumption of treatment and control households before the large-scale mine commenced operations, using the year 2002 as the event year would serve as a useful \placebo test". In that model, we also include households from the 2002 round of HSES survey, the only available survey that collected household-level information before 2008.[26] We expect that the interactions between the years and the treatment dummy D would be positive and signi cant, except for 2002, as there was no large-scale mining activity before 2008.

Table 7 presents the results of the Placebo test. The estimate of the dummy variable `Southgobi' in column 1 shows that the per capita incomes of households in Southgobi were higher in 2008, although the di erence was not statistically signi cant. The real incomes of the control group increased over time, as indicated by the year xed e ects. The di erence in incomes between the control and treatment group was not signi cantly di erent in 2002, as shown by the interaction of Southgobi and 2002. As expected, the e ects were positive and signi cant for 2012, 2014, and 2016. We expect such a nding as mining activity, including CSR spending, peaked in 2012-2013 and continued to rise in subsequent years. The control variables' size and signi cance in column 2 remain similar to what we observed in our previous models. The same pattern holds for both food, and non-food consumption reported in columns 4 and 6, respectively. Thus, the overall placebo test results validate the identifying assumption of the DD model.

[Table 7]

4.4. Policy implications

Overall, we observe the local bene ts of mining activities. Such activity directly increased household incomes, allowing people to increase spending on food and non-food items. Mining also enabled increased access to health and education services. Increased spending on food and medical services will bene t the population in the long-run as a higher level of nutrition, and better access

[26] Speci cally, we run the following model: $y_{ist} = + _t + _s + \sum_t _t(_t \quad D) + X_{ist} + "_i$, where, in addition to the previous notations, D is a dummy taking the value of 1 if a household is from Southgobi, and 0 otherwise.

to health services enable people to live longer, healthier, and have a more productive life. Improved education services will improve this outcome further. Households spend less on education due to the CSR spending on learning activities, but, as they enjoy free educational activities, educational attainments were higher. Thus, in addition to income, CSR spending played a vital role in realizing improved welfare for Southgobi households.

Thus, local cooperation agreements between local administrative bodies and mining companies can bene t communities that can otherwise be a ected negatively by large-scale resource extraction. Policies that support local employment, purchases, and CSR spending enhance opportunities and livelihoods for the local population. Therefore, resource-rich developing countries should design the laws and regulations that enforce large-scale mines to contribute equitably to local socio-economic development. It is also essential that governments and local administrative bodies have clear guidelines and rules for establishing the local-level cooperation agreements for mining companies. A clear set of guidelines will enhance residents' voices in negotiation with mining companies and strengthen the cooperation agreements' accountability and transparency.

Our study also highlights the importance of looking beyond income draws a better picture of mining activity's impact on household welfare. The reason is that income may not capture some welfare-enhancing amenities created by CSR activities or spending by the local government.

It is important to note two potential issues with our study. First, we investigated the impacts of a large-scale and foreign-invested mine, such as Oyu Tolgoi, which may have better outreach to local communities than mines smaller in size with limited nancial capabilities. The majority of mining companies in Mongolia still have not established cooperation agreements with local administrative bodies as required by the minerals law due to the government's lack of clear guidance and weak law enforcement. Thus our ndings may not directly apply to locally owned small mines as they may not have the urge and capacity to invest in CSR activities. Second, this study only focused on the short-run gains from mining as we only examined the e ects occurring in the early development and operational periods of mining. Although we can infer that the short-run improvement in health, education, and nutrition will provide long-run bene ts, future research should examine the ex-post gains, focusing on the intermediate/outcome welfare indicators.

5. Conclusion

We investigate the impact of a large-scale, capital-intensive mine on households' incomes and consumption in a mining region. Using a VAR model and the sub-national level data, we nd that the mining sector positively impacted the local economy. We then use di erence-in-di erences models with several rounds of recent household survey data from Mongolia and nd robust evidence that large-scale mining activity bene ted the local population. Compared to the households in the neighboring provinces, the incomes, food, and non-food consumption of households in the mining province increased disproportionately. The CSR activities undertaken by the large-scale mining company eased the supply constraints of the health care services, which enabled households to purchase medical services and increase their medical expenditures. Besides, support for secondary and tertiary education, facilitated by the mining company, enhanced educational outcomes while the expenditure on those groups reduced signi cantly for the households in the mining region. The paper's main contribution is to show that large-scale extractive industries can generate positive welfare outcomes for residents, and CSR activities further enhance the mining sector's traditional bene ts. While analyzing the impact of mining activity on household welfare, we also demonstrate that consumption can draw a better picture than income because the latter may not e ectively

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6. Figures

Figure 1: Impulse response functions for provinces

Source: NSO, 2019
Figure 2: Exports volume of copper concentrate, 2006-2016

Figure 3: Map of Mongolia

Source: OT, 2008-2016
Figure 4: CSR spending, 2008-2016, annual

Source: NSO, 2002-2016
Figure 5: Monthly income, food and non-food consumption, 2002-2016

7. Tables

Table 1: Summary statistics of dependent variables

	2008		2012		2014		2016	
Variable	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
Per capita income	130	94	223	164	292	191	274	222
	(129)	(91)	(172)	(143)	(262)	(150)	(179)	(159)
Per capita food consumption	44	45	70	59	87	65	71	53
	(33)	(27)	(53)	(41)	(52)	(38)	(42)	(33)
Per capita non-food consumption	106	61	157	87	187	122	146	121
	(131)	(76)	(179)	(95)	(188)	(112)	(116)	(105)
Per capita medical expenditures	2	1	3	3	11	3	6	5
	(3)	(4)	(7)	(7)	(101)	(8)	(14)	(16)
Per capita education expenditures	7	6	6	5	4	6	4	6
	(16)	(12)	(15)	(12)	(13)	(13)	(11)	(17)
Per capita energy expenditures	3	4	5	6	7	7	9	9
	(3)	(5)	(5)	(6)	(6)	(7)	(6)	(7)
Per capita clothing expenditures	14	10	26	18	30	23	24	21
	(13)	(8)	(23)	(13)	(24)	(17)	(20)	(17)
Per capita services expenditures	3	1	3	1	3	1	3	2
	(5)	(2)	(7)	(2)	(13)	(2)	(4)	(5)
Per capita transportation expenditures	18	10	25	11	25	14	22	15
	(37)	(19)	(29)	(14)	(33)	(20)	(26)	(22)
Number of households	304	1,597	312	1,819	622	2,493	624	2,582

Note: Means are reported in thousand Tugrik (MNT): The exchange rate for the end of survey period (December) ranged from US $

Table 2: Di erence between treatment and control households

Variable name	2008	2012	2014	2016
ln(Per capita income)	0.166	0.991		

Table 3: Summary statistics of control variables

	2008		2012		2014		2016	
Variable	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
CSR spending	495.51	0.00	12,199.07	0.00	4,393.61	0.00	15,159.27	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household head's age	46.50	44.51	46.30	44.98	44.78	45.80	43.35	46.26
	(15.06)	(14.39)	(15.57)	(14.51)	(15.00)	(14.26)	(14.63)	(15.05)
Household head is married	0.63	0.69	0.47	0.67	0.51	0.63	0.47	0.59
	(0.48)	(0.46)	(0.50)	(0.47)	(0.50)	(0.48)	(0.50)	(0.49)
Household head is male	0.74	0.82	0.71	0.80	0.73	0.77	0.71	0.75
	(0.44)	(0.39)	(0.45)	(0.40)	(0.44)	(0.42)	(0.45)	(0.43)
Years of education	11.11	10.86	11.66	11.80	12.14	12.30	12.43	11.76
	(3.61)	(3.76)	(4.24)	(4.22)	(4.61)	(4.41)	(3.53)	(3.91)
Proportion of working members	0.63	0.49	0.44	0.42	0.39	0.40	0.42	0.36
	(0.28)	(0.28)	(0.33)	(0.29)	(0.32)	(0.30)	(0.33)	(0.31)
Lives in apartment/house	0.07	0.11	0.08	0.07	0.06	0.10	0.10	0.11
	(0.26)	(0.31)	(0.27)	(0.26)	(0.24)	(0.29)	(0.30)	(0.32)
Lives in rural area	0.61	0.70	0.62	0.74	0.61	0.61	0.62	0.63
	(0.49)	(0.46)	(0.49)	(0.44)	(0.49)	(0.49)	(0.49)	(0.48)
Number of households	304	1,597	312	1,819	622	2,493	624	2,582

Note: CSR spending is in million MNT. Education is the highest number of years for any member of the household. Dummy variables indicating rural/urban status and living conditions show their sample proportions. Standard deviations are reported in the parentheses.

Table 4: E ect of mining on income, food and non-food consumption

	ln(income)		ln(food)		ln(non-food)	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
ln(CSR spending) mining	0.194	0.218	0.208	0.227	0.166	0.187
	(0.067)	(0.056)	(0.062)	(0.050)	(0.063)	(0.053)
Year=2012	0.775	0.843	0.619	0.687	0.728	0.792
	(0.101)	(0.085)	(0.097)	(0.080)	(0.093)	(0.081)
Year=2014	0.932	1.086	0.750	0.903	0.913	1.057
	(0.096)	(0.076)	(0.091)	(0.072)	(0.089)	(0.072)
Year=2016	1.309	1.303	0.938	0.940	1.211	1.203
	(0.099)	(0.086)	(0.092)	(0.080)	(0.091)	(0.081)
Household head's age		0.045		0.040		0.040
		(0.002)		(0.002)		(0.002)
Household head is married		-3.343		-3.128		-3.115
		(0.107)		(0.099)		(0.099)
Household head is male		0.744		0.720		0.662
		(0.125)		(0.116)		(0.116)
Proportion of working members		2.056		1.837		1.965
		(0.119)		(0.109)		(0.113)
Lives in apartment/house		0.452		0.335		0.438
		(0.05 -13.5r05 -6.e500.099)				(0.116)

Table 5: E ect of mining on medical, education and energy expenditures

	ln(medical)		ln(education)		ln(energy)	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
ln(CSR spending) mining	0.124	0.145	-0.037	-0.076	0.109	0.118
	(0.045)	(0.039)	(0.029)	(0.024)	(0.047)	(0.042)
Year=2012	0.553	0.561	0.053	0.016	0.687	0.692
	(0.064)	(0.059)	(0.048)	(0.041)	(0.083)	(0.077)
Year=2014	0.766	0.815	-0.057	-0.126	0.905	0.965
	(0.063)	(0.055)	(0.043)	(0.040)	(0.074)	(0.065)
Year=2016	1.087	1.029	-0.079	-0.136	1.266	1.182
	(0.063)	(0.059)	(0.045)	(0.042)	(0.078)	(0.073)
Household head's age		0.039		-0.033		0.034
		(0.001)		(0.001)		(0.002)
Household head is married		-1.953		0.549		-2.451
		(0.066)		(0.039)		(0.084)
Household head is male		0.321		-0.679		0.438
		(0.079)		(0.049)		(0.099)
Proportion of working members		0.953		-0.722		1.124
		(0.079)		(0.049)		(0.092)
Lives in apartment/house		0.331		0.008		0.133
		(0.063)		(0.052)		(0.071)
Lives in rural area		-0.247		-0.012		-0.415
		(0.042)		(0.030)		(0.052)
Province xed e ects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.05	0.43	0.00	0.23	0.04	0.41
Number of households	10,353	10,353	10,353	10,353	10,353	10,353

Note: 1. All dependent variables are on monthly per capita basis and in real terms.
2. Education is controlled in the model but not reported.
3. Including age^2 does not a ect the results.
4. Standards errors, clustered at the 744 primary sampling units, are recorded in the parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: E ect of mining on other expenditures

	ln(clothing)		ln(services)		ln(transportation)	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
ln(CSR spending) mining	0.132	0.150	0.157	0.171	0.043	0.059
	(0.051)	(0.043)	(0.047)	(0.045)	(0.055)	(0.050)
Year=2012	0.655	0.723	-0.507	-0.464	0.874	0.945
	(0.075)	(0.068)	(0.077)	(0.078)	(0.084)	(0.083)
Year=2014	0.779	0.919	0.490	0.569	1.021	1.161
	(0.073)	(0.061)	(0.069)	(0.067)	(0.080)	(0.076)
Year=2016	0.986	1.008	0.736	0.772	1.294	1.343
	(0.073)	(0.067)	(0.079)	(0.074)	(0.086)	(0.085)
Household head's age		0.028		0.005		0.017
		(0.002)		(0.002)		(0.002)
Household head is married		-2.505		-0.921		-2.111
		(0.082)		(0.071)		(0.086)
Household head is male		0.500		0.103		0.582
		(0.095)		(0.078)		(0.101)
Proportion of working members		1.842		1.301		1.943
		(0.096)		(0.099)		(0.111)
Lives in apartment/house		0.375		0.312		0.347
		(0.072)		(0.089)		(0.082)
Lives in rural area -2.111						

Table 5: E ect of mining on medical, education and energy expenditures

	ln(medical)		ln(education)		ln(energy)	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
ln(CSR spending) mining	0.124	0.145	-0.037	-0.076	0.109	0.118
	(0.045)	(0.039)	(0.029)	(0.024)	(0.047)	(0.042)
Year=2012	0.553	0.561	0.053	0.016	0.687	0.692
	(0.064)	(0.059)	(0.048)	(0.041)	(0.083)	(0.077)
Year=2014	0.766	0.815	-0.057	-0.126	0.905	0.965
	(0.063)	(0.055)	(0.043)	(0.040)	(0.074)	(0.065)
Year=2016	1.087	1.029	-0.079	-0.136	1.266	1.182
	(0.063)	(0.059)	(0.045)	(0.042)	(0.078)	(0.073)
Household head's age		0.039		-0.033		0.034
		(0.001)		(0.001)		(0.002)
Household head is married		-1.953		0.549		-2.451
		(0.066)		(0.039)		(0.084)
Household head is male		0.321		-0.679		0.438
		(0.079)		(0.049)		(0.099)
Proportion of working members		0.953		-0.722		1.124
		(0.079)		(0.049)		(0.092)
Lives in apartment/house		0.331		0.008		0.133
		(0.063)		(0.052)		(0.071)
Lives in rural area		-0.247		-0.012		-0.415
		(0.042)		(0.030)		(0.052)
Province xed e ects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.05	0.43	0.00	0.23	0.04	0.41
Number of households	10,353	10,353	10,353	10,353	10,353	10,353

Note: 1. All dependent variables are on monthly per capita basis and in real terms.
2. Education is controlled in the model but not reported.
3. Including age^2 does not a ect the results.
4. Standards errors, clustered at the 744 primary sampling units, are recorded in the parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.