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Mining Matters: Natural Resource Extraction and Local Business Constraints

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Abstract

We estimate the impact of local mining activity on the business constraints experienced by 22,150 firms across eight resource-rich countries. We find that with the presence of active mines, the business environment in the immediate vicinity (<20 km) of a firm deteriorates but business constraints of more distant firms relax. The negative local impact of mining is concentrated among firms in tradeable sectors whose access to inputs and infrastructure becomes more constrained. This deterioration of the local business environment adversely affects firm growth and is in line with a natural resource curse at the sub-national level.

JEL-Codes: L160, L250, L720, O120, O130, Q300.

Keywords: mining, natural resources, business environment.

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1. Introduction

The last two decades have witnessed an extraordinary expansion in global mining activity. A surge in commodity demand from industrializing countries pushed up the price of metals, minerals and oil. This in turn led to substantial new mining investment, an increasing share of which is concentrated in emerging markets (Humphreys, 2010). This geographical shift reflects that many American and European mineral deposits have by now been depleted and that the long-distance transport of minerals by sea has become less costly. As a result, the world's largest mines can nowadays be found in Africa, Asia and Latin America.

The mining boom has also reinvigorated the debate about the impact of mining on economic activity and welfare. Some regard mines simply as stand-alone enclaves without any notable local impact (Hirschman, 1958). Others point to the potentially negative consequences of natural resource dependence such as real exchange rate appreciation, economic volatility, deindustrialization and corruption (see van der Ploeg (2011) for a comprehensive survey). Mines may also pollute and threaten the livelihoods of local food producers. They often require vast amounts of water, electricity, labor and infrastructure, for which they may compete with local manufacturers. Yet others stress the potential for *positive* spillovers to firms and households as mining operators may buy local inputs and hire local employees.[1] Local wealth can also increase if governments use taxable mining profits to invest in regional infrastructure or to make transfers to the local population.

Our paper informs this debate by estimating the impact of active mines on nearby firms across eight countries with large manufacturing and mining sectors: Brazil, Chile, China, Kazakhstan, Mexico, Mongolia, Russia and Ukraine. Our detailed data allow us to get around the endogeneity issues that plague country-level studies as well as the limitations to external validity of well-identified country-specific papers. Our empirical analysis is motivated by the "Dutch disease" model of Corden and Neary (1982) which sets out how a resource boom drives up wage costs for firms in the traded (manufacturing) sector as they compete for labor with firms in the resource and non-traded sectors. We hypothesize that mining companies and manufacturing firms also compete for other inelastically supplied inputs and public goods—such as transport infrastructure and electricity—and that this hurts tradeable-sector firms, which are price takers on world markets, in particular.

We test this hypothesis by combining two main data sets. First, we use detailed data on 22,150 firms from the EBRD-World Bank Business Environment and Enterprise Performance

[1] For example, Wright and Czelusta (2007) argue that "linkages and complementarities to the resource sector were vital in the broader story of American economic success".

Survey (BEEPS) and the World Bank Enterprise Survey. These data contain the responses of firm managers to questions on the severity of various constraints to the operation and growth of their business, including access to transport infrastructure, electricity, land, educated workers and finance. A growing literature uses such survey data to gauge whether access to various public goods affects firm performance.[2] Firms' perceptions of the relative importance of different external constraints on their activity can be useful to learn about which constraints affect economic activity the most (Carlin, Schaffer and Seabright, 2010). These constraint variables also measure competition for inputs directly as they reflect firms' intended rather than actual use of inputs. We therefore exploit variation across firms in the reported severity of external input constraints to assess how local mining activity, by congesting the quality and quantity of public input provision, affects the ability of local firms to grow.

Second, we use the proprietary SNL Metals & Mining data set, which contains comprehensive information on the geographical location, operating status and production data for individual mines. We identify the latitude and longitude of 3,793 mines producing 31 different metals and minerals in our country sample. Depending on the year, we observe the operating status of between 1,526 and 2,107 mines.

Merging these firm and mine data allows us to paint a precise and time-varying picture of the mines that open, operate and close around each firm. Since local mining activity is plausibly exogenous to the performance of individual firms—as it largely depends on local geology and world mineral prices—we can identify the impact of mining on local business constraints and firm performance. To the best of our knowledge, ours is the first paper to estimate this impact of mining activity on firm performance across a variety of countries.

Two core results emerge from our analysis, both consistent with a sub-national version of the seminal Corden and Neary (1982) model. First, in line with a "resource-movement effect", we uncover heterogeneous mining impacts in the immediate vicinity ($\leq$ 20 kilometers) of active mines that depend on whether a firm produces tradeable or non-tradeable goods. Only producers of tradeables that are close to active mines report tighter business constraints (as compared with similar firms that are not close to mines). These firms are especially hampered in their ability to access transport infrastructure and educated workers. Importantly, mining-induced business constraints hurt firm performance in terms of employment, asset size and sales. Our results indicate that moving a producer of tradeables from a region without mines

[2] See, for instance, Commander and Svejnar (2011) and Gorodnichenko and Schnitzer (2013). Appendix B contains the questions we use in this paper and www.enterprisesurveys.org provides additional background information. The surveys also provide a rich array of firm covariates, such as their industry, age, sales, employment, and ownership structure.

to a region with average mining intensity would reduce sales by 10 percent on average. In sharp contrast, up- or downstream firms in the natural resource sector itself and firms in the construction and non-traded sector actually *benefit* from local mining activity.

Second, in line with a sub-national "spending effect" we find that current mining activity improves the provision of public goods in a distance band of between 20 and 150 km around firms. This indicates that while mines can cause infrastructure bottlenecks in their immediate vicinity and crowd out other firms, they may improve the business environment on a wider geographical scale.

In robustness tests we vary the distance bands around firms; exclude young firms which may self-select into locations close to mines; exclude firms that have plants in multiple locations; examine coal mines separately; control for oil and gas fields; analyze panel data for a sub-set of firms; and measure mining activity using satellite imagery of night-time light intensity. None of this affects the main results. Moreover, a spatial randomization placebo test indicates that our findings are not spurious but depend on the exact location of the mines.

This paper contributes to a growing literature on the economic impact of natural resource abundance. Early contributions point to a negative cross-country correlation between resource exports and long-term economic growth (Sachs and Warner, 1997 and Auty, 2001). Various mechanisms have been proposed for why resource-rich countries appear unable to convert natural resources into productive assets. These include an appreciation of the real exchange rate which turns non-resource exports uncompetitive (the aforementioned Dutch disease); worsening institutions and governance (Besley and Persson, 2010; Dell, 2010); rent seeking (Mehlum, Moene and Torvik, 2006; Beck and Laeven, 2006) and increased conflict (Collier and Hoeffler, 2004; Miguel, Satyanath and Sergenti, 2004). The cross-country evidence remains mixed—reflecting thorny endogeneity issues—and the very existence of a resource curse continues to be heavily debated (van der Ploeg and Poelhekke, 2010; James, 2015).

To strengthen identification, recent papers exploit micro data to estimate the impact of natural resource discoveries on local living standards.[3] Aragón and Rud (2013) show how the Yanacocha gold mine in Peru improved incomes and consumption of nearby households. Their findings indicate that mining can have positive local equilibrium effects if backward

[3] See Cust and Poelhekke (2015) for a survey. Others estimate impacts on health and behavioral outcomes such as female empowerment and infant morbidity (Tolonen, 2015) and risky sexual behavior (Wilson, 2012). Sub-national data have also been used to reassess claims based on cross-country data, such as that natural resources cause armed conflict and violence (Dube and Vargas, 2013; Arezki, Bhattacharyya and Mamo, 2015; Berman, Couttenier, Rohner and Thoenig, 2015).

linkages are strong enough.[4] Loayza, Mier y Teran and Rigolini (2013) and Lippert (2014) also document positive impacts on living standards for Peru and Zambia, respectively. For the case of Ghana, Fafchamps, Koelle and Shilpi (2016) find that gold mining has led to agglomeration effects that benefit non-farm activities.[5] Consistent with these country studies, Von der Goltz and Barnwall (2014) show for a sample of developing countries that while mining boosts local wealth, it often comes at the cost of pollution and negative health impacts.

We contribute to this nascent literature in two ways. First, we shift the focus from households to firms in order to gain insights into the mechanisms through which mining affects local economic activity (and ultimately household incomes).[6] We not only observe firm-level outcomes (such as sales and employment) but also the mechanisms through which mining activity hampers some sectors but benefits others. Second, using harmonized micro data from a diverse set of countries with large mining and manufacturing sectors adds to the internal as well as external validity of our results.

Our paper also relates to a small parallel literature on local oil and gas booms in the United States. Michaels (2011) and Allcott and Keniston (2014) show that historical hydrocarbon booms benefited county-level economic growth through positive agglomeration effects, backward and forward linkages, and lower transport costs.[7] In contrast, Jacobson and Parker (2014) find that the US oil and gas boom of the 1970s led to negative long-term income effects. They suggest that contrary to booms in the more distant past (as studied by Michaels, 2011) the persistent negative effects of the 1970s boom offset any long-term positive agglomeration effects. We assess whether our results are sensitive to the presence of oil and gas production by extending our regressions with the number of oil and gas fields (if any) around each firm.

We also contribute to the literature on the relationship between the business environment and firm performance. This literature has moved from using country-level proxies for the

[4] Backward linkages exist if mines purchase local inputs like food, transportation services and raw materials. Forward linkages include the downstream processing of mineral ores such as smelting and refining.

[5] Aragón and Rud (2015) show the flipside of Ghanaian gold mining: increased pollution, lower agricultural productivity and more child malnutrition and respiratory diseases.

[6] Glaeser, Kerr and Kerr (2015) show how proximity to mining deposits led US cities to specialize in scaleable activities, such as steel production, at the cost of fewer start-ups. This negative impact on local entrepreneurship can become entrenched if entrepreneurial skills and attitudes are transmitted across generations (Chinitz, 1961).

[7] Caselli and Michaels (2013) show that revenue windfalls from Brazilian offshore oil wells (where backward and forward linkages are less likely) led to more municipal spending but not to improved living standards. Brollo, Nannicini, Perotti and Tabellini (2013) show that this may reflect an increase in windfall-induced corruption and a decline in the quality of local politicians. Likewise, Asher and Novosad (2016) show how mining booms in India result in the election of criminal politicians.

business environment (Kaufmann, 2002) to firm-level, survey-based indicators of business constraints. While various papers find negative correlations between such indicators and firm performance, endogeneity concerns linger.[8] Commander and Svejnar (2011) link firm performance in 26 transition countries to firms' own assessments of various aspects of the business environment. They conclude that once country fixed effects are included, firms' perceptions of business constraints add little explanatory power. Our contribution is to use exogenous shocks that stem from the opening of large-scale mines to help mitigate the endogeneity concerns that continue to plague this literature.

Lastly, a related literature investigates the negative externalities (congestion) and positive externalities (agglomeration) of geographically concentrated economic activity.[9] Congestion occurs when firms compete for a limited supply of infrastructure or other public goods.[10] Agglomeration effects emerge when spatially proximate firms benefit from deeper local labor markets, the better availability of services and intermediate goods, and knowledge spillovers (Marshall, 1920). In line with agglomeration benefits, Greenstone, Hornbeck and Moretti (2010) show that US firms close to new large plants experience positive productivity spillovers. We assess whether newly opened mines mainly lead to positive agglomeration or negative congestion effects for nearby firms.

The paper is organized as follows. Section 2 develops a simple theoretical model and derives our main hypotheses. Sections 3 and 4 then describe our data and empirical strategy, after which Section 5 presents our results. Section 6 concludes.

2. Theory and hypotheses

To build intuition on how a mining boom affects both local and more distant firms, we adapt a multiregional de-industrialization model (Allcott and Keniston, 2014). This theoretical framework is closely related to earlier Dutch disease models (Corden and Neary, 1982; Van

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[8] E.g. Johnson, McMillan and Woodruff (2002); Beck, Demirgüc-Kunt and Maksimovich (2005); Dollar, Hallward-Driemeier and Mengistae (2006) and Hallward-Driemeier, Wallstein and Xu (2006). Some papers use industry or city averages of business constraints as either regressors or instruments to reduce endogeneity concerns.

[9] See Combes and Gobillon (2015) for a survey of the agglomeration literature.

[10] A recent literature investigates the spatial impact of infrastructure on economic activity. Donaldson (2014) shows how new railways in colonial India integrated regions and boosted welfare gains from trade. In a similar vein, Bonfatti and Poelhekke (2015) show how purpose-built mining infrastructure across Africa determined long-term trading patterns between countries. In China, the construction of trunk roads and railways reinforced the concentration of economic activity and increased economic output (Faber, 2014 and Banerjee, Duflo and Qian, 2012). In the United States, Chandra and Thompson (2000) and Michaels (2008) exploit the construction of interstates to document agglomeration effects.

Wijnbergen, 1984). The distinctive feature of our model is that there are multiple regions across which labor is (imperfectly) mobile and that redistribution of natural resource rents may take place between regions.[11]

We model each region as a small open economy where each consumer supplies one unit of labor. Consumers work in one of three sectors: the manufacturing sector m, which produces goods that are tradeable internationally and across regions; services n, which are non-tradeable across regions; and the tradeable natural resource sector r. The prices of both manufacturing goods p_m and minerals p_r are set on world markets and therefore exogenous. Only the price of non-traded services p_{ni} is endogenous and varies by region *i*. Each sector s produces $X_{si} = A_{si} F_s\left(l_{si}\right)$ where A_{si} is productivity. A_{si} has a local component due to a sector's reliance on region-specific inputs such as agglomeration economies or natural resource deposits. F_s is a production function common to sector s with $F_s\left(0\right) = 0$, $F_s'\left(\cdot\right) > 0$ and $F_s''\left(\cdot\right) < 0$, and l_{si} is labor employed by sector s in region i.

Employment is perfectly substitutable across sectors and is mobile between regions such that total labor supply L_i is an increasing function of both wages and transfers received by workers: $L_i = L\left(w_i + b_i\right)$. With full employment we have:

$$l_{mi} + l_{ri} + l_{ni} = L\left(w_i + b_i\right) \tag{1}$$

Per capita transfers b are an increasing function of national resource rents $R = \sum_i \left(p_r X_{ri} - w_i l_{ri}\right)$ but ultimately depend on the country's welfare function and the exogenous weights attached to individuals in the extracting region. For example, if local consumers own the mining land (which resembles the institutional setting in the United States) then transfers in the form of royalty payments can be substantial. Conversely, if the state owns the mining rights (as is the case in most other countries) then fewer mining rents are redistributed to the producing region and rents are instead spread across regions.

Labor input *l* can also be interpreted as being used in combination with public good inputs, such as infrastructure, which are used in a fixed proportion to labor. We assume that such public goods are not mobile across regions, exogenously provided by a higher layer of government, and increasing in national natural resource rents *R*. A higher demand for *l* then

[11] We do not model firm heterogeneity or firm entry or exit as we cannot measure firm-level productivity.

translates into a higher demand for public goods as well. Crucially, the supply of such goods does not endogenously adjust to higher shadow prices for their use. For example, increased congestion on rail and roads will drive up delays and transportation costs, but it is up to the (national) government to invest more in these particular public goods (which are non-excludable *but* rivalrous in consumption). Congestion of public goods and competition for private goods will show up as higher self-reported business constraints when firms intend to use more of these inputs but cannot do so due to congestion or because the cost of using a given input rises. These costs can be monetary in the case of private goods and both monetary and time related (due to delays) in the case of public goods.

We assume that all minerals are directly or indirectly exported.[12] Aggregate income in region i then equals consumption of manufacturing goods and services from which consumers with Cobb-Douglas preferences derive utility U:

$$\left(w_i + b_i\right) L_i = p_m C_{mi} + p_{ni} C_{ni} \tag{2}$$

where C_{mi} includes imports from other regions and countries. Demand is given by:

$$p_{ni} C_{ni} = L_i \alpha \left(w_i + b_i\right) \tag{3}$$

$$p_m C_{mi} = L_i \left(1 - \alpha\right)\left(w_i + b_i\right) \tag{4}$$

The term b_i is the spending effect in the terminology of Corden and Neary (1982). If these transfers are zero, then an increase in the profitability of the natural resource sector will raise wages and non-traded prices proportionally. Transfers may be such that a natural resource boom in region i can introduce a spending effect in region $\not{i}$, for example in the state or province to which the region belongs.

The services and traded manufacturing goods market equilibria follow as:

$$C_{ni} = X_{ni} = A_{ni} F_n \left(l_{ni}\right) \tag{5}$$

$$C_{mi} = X_{mi} + IM_{mi} = A_{mi} F_m \left(l_{mi}\right) + IM_{mi} \tag{6}$$

[12] Downstream sectors may use minerals as inputs and subsequently export all downstream products.

where IM_m are net imports of manufactured goods. Finally, perfect sectoral labor mobility equalizes wages across sectors to their marginal product:

$$w_i = p_m A_{mi} F_m'(l_{mi}) = p_r A_{ri} F_r'(l_{ri}) = p_{ni} A_{ni} F_n'(l_{ni}) \quad (7)$$

We model a local resource boom as an exogenous shock to the natural resource sector in region i such that this sector becomes more productive. This can either be achieved through a rise in p_r , the world price of minerals, or through a rise in A_{ri}, which can be thought of as an improvement in extraction technology or the discovery of new deposits in region i.[13] In both cases local profits increase, which also increases transfers b_i.

The impact of the local resource boom $p_r A_{ri}$ will be fourfold. First, the demand for labor and public goods in the mineral sector rises and wages increase (equation 7). However, to the extent that labor supply L_i is not perfectly inelastic, immigration from other regions will dampen this increase in wages.[14] For perfectly elastic supply, the increase in labor demand in the mineral sector is completely met by supply from other regions.[15] Moreover, to the extent that supply chains are local, firms with strong upstream or downstream linkages to mines may benefit from an increased demand for intermediate inputs (Moretti, 2010).

Second, the boom in $p_r A_{ri}$ raises services prices p_{ni} and induces a real appreciation in region i. The production of non-traded services increases too. Higher wages (if labor demand is not fully met through immigration) are passed on to higher non-traded prices through a rise in local aggregate demand. Moreover, a rise in $p_r A_{ri}$ raises mineral rents and thereby regional

[13] New discoveries are assumed to be exogenous as exploration is spatially homogeneous within country-years in the sense that it is uncorrelated with pre-existing economic activity and other local characteristics.

[14] Since labor and public goods are used in fixed proportions, immigration will not dampen the wage increase unless more public goods are supplied as well. These may be financed by natural resource rents.

[15] An increase in $p_r A_r$ raises the marginal product of labor in the resource sector and thus wages in (7). It also decreases employment in the other two sectors (rewrite (7) for sector *m* (an equivalent for *n*) as $n_{mi} = F_m'^{-1}\left(\frac{p_r A_{ri}}{p_m A_{mi}} F_r'(l_{ri})\right)$). Labor reallocates from sectors *m* and *n* to sector *r*. However, through combining equations 1 and 7, the upward pressure on wages and subsequent reallocation is muted to the extent that total labor supply is elastic. Wages increase as long as total regional labor supply is not fully elastic.

transfers b_i. This also raises local aggregate demand and further drives up prices p_{ni} and services production X_{ni}.[16]

Third, if wages increase, profitability in the manufacturing sector declines because the traded sector is a price taker on world markets. From the marginal product of labor in the manufacturing sector it follows that l_{ri} and X_{ri} decrease, which is the resource-movement effect in Corden and Neary (1982). Manufacturing consequently contracts as firms compete with establishments in non-resource regions that did not suffer the same increase in input costs (Moretti, 2011).

Fourth, to the extent that labor is mobile between regions and rents are redistributed across regions, we should expect spillover effects. The immigration of labor into the boom region results in excess labor demand in origin regions and possibly a shrinking of services and manufacturing sectors in these regions. Unless labor is highly mobile, we expect this effect to attenuate with distance.

The increase in aggregate demand in the producing region spills over into higher demand for manufactured goods, which have to be supplied through imports from other regions or countries. In the former case, the demand for manufacturing goods in non-booming regions increases. This effect is particularly strong if no redistribution of rents takes place and local income increases by the full amount of rents. In our sample of countries, it is more likely that the increase in national mineral rents spreads to non-booming regions through transfers. Transfers thus introduce a spending effect in non-booming regions as well. From the perspective of the traded sector, the positive trade and spending effects are likely to be attenuated less by distance than the wage effect (which reflects regional competition for relatively immobile labor).

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[16] We assume that an exogenous fraction ω of national rents are spent in the producing region. Total local income from rents is equal to $\omega_i \sum_i p_r A_{ri} \left(F_r(\cdot) - F_r'(\cdot) l_{ri} \right)$, such that local rents are increasing in $p_r A_{ri}$. This relaxes the consumer budget constraint (3) and increases demand for non-traded goods, raising prices p_{ni}. Combining equations 3, 5 and 7 yields $p_{ni} A_{ni} F_n(l_{ni}) = L_i \alpha (w_i + b_i) = w_i \frac{F_n(l_{ni})}{F_n'(l_{ni})}$, and provides an expression for non-traded services production as a function of population and natural resource production: $L_i \alpha + \omega_i \alpha \sum_i \left(\frac{F_r(l_{ri})}{F_r'(l_{ri})} - l_{ri} \right) = \frac{F_n(l_{ni})}{F_n'(l_{ni})}$. Taking the derivative to $p_r A_{ri}$ and using the fact that F is concave, $\partial L_i / \partial p_r A_{ri} \geq 0$, and $\partial l_{ri} / \partial p_r A_{ri} \geq 0$ yields that an increase in $p_r A_{ri}$ raises both non-traded labor input and production. This results from an increase in wages and thus population L_i and through increased demand due to the transfer of rents. Finally, non-traded prices increase.

In all, this theoretical discussion suggests two main testable hypotheses with regard to the impact of mining on the business constraints faced by nearby firms:

1. Negative resource-movement effects in the vicinity of mines are associated with a deterioration of the business environment experienced by local firms. At a greater distance from mines, these negative effects are (more than) compensated by positive spending effects as the provision of public goods expands and the business environment improves.
2. In line with local resource-movement effects in the immediate vicinity of mines, firms in tradeable sectors experience tighter business constraints (in terms of access to labor and public goods such as infrastructure and institutions) than firms in non-tradeable sectors or in the natural resource sector. Positive spending effects benefit firms across all sectors.

3. Data

For our purposes we need data on the business constraints experienced by individual firms as well as detailed information on the presence of mines in the vicinity of each firm. We therefore merge our firm-level survey data from eight emerging markets—Brazil, Chile, China, Kazakhstan, Mexico, Mongolia, Russia and Ukraine—with the geographical coordinates of the near universe of minerals (including coal) and metal mines in these countries. All of these countries are geographically large, have a substantial mining sector and participated in one or more business environment surveys.[17]

3.1. Mining data

We download data from the leading provider of mining information, SNL's Metal & Mining (formerly Raw Materials Group). The data set contains for each mine annual information on the production levels for each mineral as well as the GPS coordinates of its center point. We also know the mine's operation status at each point in time. This allows us to distinguish between active (operating) and inactive mines. This status is typically driven by exogenous world prices: when prices rise, more mines (re-)open. We assemble this information for the 3,794 mines scattered across the eight countries. For a small subset of active mines we also know ore production, measured in millions of tons (metric megaton, Mt) of ore mined per

[17] The value of natural resource extraction at world prices as a share of GDP in 2008—not taking into account production costs—was 8 percent in Brazil; 25 percent in Chile; 15 percent in China; 56 percent in Kazakhstan; 12 percent in Mexico; 35 percent in Mongolia; 40 percent in Russia; and 17 percent in Ukraine (source: World Bank, Adjusted Net Savings Data).

annum.[18] Although a measure of ore produced (which includes both rocks and metals and minerals with varying grades) may be a better gauge of how many inputs the mine requires it is unfortunately only recorded for one in ten relevant mine-year observations. We therefore use the total production value of actual metal content by multiplying the production of each metal or mineral with its current world price.

We focus on mines rather than the extraction of oil and gas as hydrocarbon production typically has a different structure in terms of environmental, social and economic impacts (World Bank, 2002). For instance, oil and gas tend to occur in larger concentrations of wealth than metals and other minerals and this might lead to larger spending effects. Hydrocarbon production is also more capital intensive and may therefore affect labor demand to a lesser extent. Moreover, in our sample, oil and gas fields are very remote from almost all manufacturing activity. We return to the issue of hydrocarbon production in Section 5.5.

3.2. Firm data

To measure firms' business constraints we use various rounds of the EBRD-World Bank Business Environment and Performance Survey (BEEPS) and the equivalent World Bank Enterprise Surveys. Face-to-face interviews were held with 22,150 firms in 2,144 locations across our country sample to measure to what extent particular aspects of the business environment hold back firm performance. The surveys were administered on the basis of a common design and implementation guidelines.

Firms were selected using random sampling with three stratification levels to ensure representativeness across industry, firm size and region. The sample includes firms from all main industries (both manufacturing and services) and this allows us to use industry fixed effects in our regression framework. While mines are not part of the surveys, upstream and downstream natural resource firms are included. The first four columns of Appendix Table A4 summarize the number of observations by year and country (all regressions include country-year fixed effects). We have data for the fiscal years 2005, 2007, 2009 and 2011.

As part of the survey, owners or top managers evaluated aspects of the local business environment and public infrastructure in terms of how much they constrain the firm's operations. For instance, one question asks: *"Is electricity "No obstacle", a "Minor*

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[18] Mines typically produce ore that contains several minerals with varying grades. Appendix Table A3 provides a frequency table of the minerals in our data set. All minerals and metals are point-source resources: unlike diffuse natural resources such as coffee and tobacco, they are produced in geographically concentrated locations. Limited information on reserves is also available but we focus on actual mining activity as unmined subsoil assets should not affect firm performance directly.

obstacle", a "Moderate obstacle", a "Major obstacle" or a "Very severe obstacle" to the current operations of your establishment?". Similar information was elicited on the following business constraints: inadequately educated workforce; access to finance; transportation infrastructure; practices of competitors in the informal sector; access to land; crime, theft and disorder; business licenses and permits; political instability; corruption; and courts. Crucially, these questions allow us to measure competition for inputs directly because they reflect a firm's intended use of inputs as opposed to their actual use. Moreover, we do not have to rely on price data which often do not exist for non-market public goods. Because the scaling of the answer categories differs across survey rounds (either a five- or a four-point Likert scale) we rescale all measures to a 0-100 scale using the conversion formula (value – minimum value)/(maximum value – minimum value).

For each firm we construct *Average business constraints,* which measures the average of the above-mentioned 12 constraint categories. Like the underlying components, this average ranges between 0 and 100. Appendix A contains a histogram of the distribution of this variable. In addition, we create the measures *Input constraints* (access to land, access to an educated workforce, and access to finance); local *Infrastructure constraints* (electricity and transport); and *Institutional constraints* (crime, informal competitors, access to business licences, corruption, political instability and court quality). These three measures again range between 0 and 100. The average constraint intensity is 30.2 but there is wide variation across firms; the standard deviation is 27.3. The most binding constraints are those related to access to inputs (34.7), followed by infrastructure constraints (29.5) and institutional constraints (23.4).

We also create firm-level covariates. These include the firm *Age* in number of years and dummies to identify *Small firms*, *Medium-sized firms* and *Large firms*; *International exporters* (firms whose main market is abroad); *Foreign firms* (foreigners own 10 percent or more of all equity); and *State firms* (state entities own at least 10 per cent of the firm's equity). We create the following industry dummies: *Manufacturing*; *Construction*; *Retail and wholesale*; *Real estate, renting and business services;* and *Others*.[19] For each firm we know the name and geographical coordinates of its location (city or town). We exclude firms in capital cities.

Lastly, the enterprise surveys not only measure the business constraints that firms experience on a daily basis but, for a subset of survey rounds, also their performance. We create log *Employment*, log *Assets* and log annual *Sales* as firm-level outcome measures.

[19] Once we separate firms into traded, non-traded, construction and natural resource related sectors, we replace sector dummies with dummies for these categories.

Table A1 in the Appendix provides an overview of all variable definitions while Table A2 provides summary statistics.

3.3. Combining the mining and firm data

A final step in our data construction is to merge—at the local level—information on individual firms with information on the mines that surround them. We identify all mines within a radius of 20 km (12.4 miles) and within a distance band of between 21 and 150 km (13.0 and 93.2 miles, respectively) around each firm. Figure 1 provides a data snapshot for two sample countries, Ukraine and Kazakhstan. The top panel shows the location of firms and mines and indicates that geographical coverage is comprehensive. Firms are not concentrated in only a few cities nor are mines clustered in just a few regions. Zooming in to the squares in the bottom panel reveals substantial variation in distances between firms and mines. There are both firms with and without mines in their immediate vicinity (within a 20 km radius). Throughout our analysis, we nevertheless include a dummy for whether a sub-national administrative region has any mines or not. All results are also robust to including region-year-sector fixed effects so that we compare firms with and without local mines in the same year, in the same sector and *in the same geographical region within a country*.

[Insert Figure 1 here]

We are agnostic about the spatial range within which mines affect firms and therefore start by exploring spatial rings used in the literature.[20] We assess distance circles of radius 10, 20, 50, 100, 150, 300 and 450 km. Exploratory regressions (in Appendix Table A5) show positive effects on firms' constraints up to 20 km, after which the sign switches to negative effects up to 150 km. After 150 km the effects become very small. We therefore group mines into three distance bands: up to 20 km, 21-150 km and 151-450 km and find that only the first two

[20] Kotsadam and Tolonen (2013) and Tolonen (2015) show that the impact of African gold mines on labor markets is strongest within a radius of 15 to 20 km. Cust (2015) finds that labor market impacts are concentrated within a 15 km radius around Indonesian mines. Aragón and Rud (2015) use a 20 km radius to study agricultural productivity near African gold mines while Goltz and Barnwall (2014) take a 5 km cutoff based on prior evidence on the spatial extent of pollution. Aragón and Rud (2013) analyze longer-distance impacts (100 km) of the Peruvian mine they study. Finally, Glaeser, Kerr and Kerr (2015) examine distances of up to 500 km between historical coal deposits and US cities. Papers that focus on district-level impacts due to fiscal channels typically also use longer distances (Loayza et al., 2013 and Allcott and Keniston, 2014).

bands show significant and economically meaningful results.[21] All our results are robust to redefining these two distance bands by reducing or expanding them by 10 percent.

Using our merged data, we then create variables that proxy for the extensive and intensive margin of mining activity in each of these two distance bands. At the extensive margin, we create dummy variables that indicate whether a firm has at least one active mine in its direct or its broader vicinity (*Any active mine*). In our sample, 24 percent of all firms have at least one mine within a 20 km radius while 77 percent have at least one mine within a 21-150 km radius. At the intensive margin, we measure the number of mines around firms (*№ active mines*). On average, each firm has 0.6 active mines within a 20 km radius but there is wide variation: this variable ranges between 0 and 19 mines. Within a 21-150 km distance band, the number of active mines is on average 7.6 and again ranges widely between zero and 152 mines. We also create similar variables that measure inactive mines and mines with an unknown operating status and use these as control variables in our analysis.

Lastly, we measure the value of total production of nearby and more distant mines. Because the volume of ore produced—and its mineral content—is only recorded for a subset of mines and has limited accuracy, we use information on the median mine size by country-mineral cell and multiply this with the annual world price of the mineral. In the calculation of median mine-size by metal-country cell, we exclude the size of the mine itself (if known) so that its size is effectively instrumented by the expected size of all other mines in the same country that produce the same mineral. Identification then relies not on the status of mines but on the exogenous type of mineral mined and its time-varying world price. Minerals that tend to be extracted in small mines (such as lead), or those that have low world prices, should affect firm performance less than metals and minerals mined in large mines (such as copper) or that command high prices.[22]

4. Empirical strategy

We consider the following empirical model to estimate the impact of mining on firms' business constraints within a certain distance band:

[21] The same pattern emerges when including sector interactions in Panel B of Table A5. Comparing column (2) with (8) and (9) in both panels of Table A5 also shows that the results of the number of mines within 20 km on (traded) firms do not depend on inclusion of the outer band(s). Although there is some positive spatial correlation between the number of mines across the distance rings, this does not cause severe multicollinearity.

[22] While a typical lead mine produces 1 Mt of ore per year, the average copper mine produces only 14.5 Mt of ore.

$$Y_{fsct} = \beta M_{fsc,t-2} + \gamma X_{fsct} + d_{sct} + \varepsilon_{fsct} \tag{8}$$

where Y_{fsct} indicates for firm *f* in sector *s* in country *c* in year *t* either the local *Average business constraints* it experienced on a scale of 0 to 100 or, more specifically, its *Input constraints, Infrastructure constraints* or *Institutional constraints.* $M_{fsc,t-2}$ contains a number of two-year lagged indicators of local mining activity within a 0-20 or 21-150 km spatial band around firm *f.*[23] X_{fsct} is a matrix of covariates related to firm age, size and ownership.

We saturate the model with country-year-sector fixed effects—d_{sct}—to wipe out (un)observable variation at this aggregation level and to rule out that our results are driven by industry-specific demand shocks or country-specific production structures. These fixed effects also take care of any (unintended) differences in survey implementation across countries, years and sectors. In addition, we include (within-country) regional dummies that are '1' if the region has at least one mine of any operating status; '0' otherwise. These control for inherent geographical and other (for example, business climate) differences between resource-rich and resource-poor regions within one and the same country.[24] Robust standard errors are clustered by country-year-sector and in Table 8 we show that our results are robust to various alternative clustering levels. We are interested in the OLS estimate of β, which we interpret as the impact of local mining intensity on firms' business constraints.[25]

Our data allow us to test whether the impact of mines on firm constraints differs across sectors. As discussed in Section 2, theory suggests that the impact of local mining may be positive for non-tradeable sectors and construction but negative for firms in tradeable sectors. We therefore also estimate:

$$Y_{fsct} = \beta M_{fsc,t-2} \times N_s + N_s + \gamma X_{fsct} + d_{sct} + \varepsilon_{fsct} \tag{9}$$

[23] While it may take time for mining to affect local firms, impacts and employment generation may already be substantial during the investment phase (Tolonen, 2015). Appendix Table A6 shows that our results are robust to changing the time lag to zero, one or three years. Because we do not know for each mine how long it has been active or closed (due to incomplete recording of the history before the year 2000) we do not attempt to separate short-run from medium or long-run effects.

[24] A total of 84 per cent of all firms in our data set are in a mining region. All our results go through when we limit our sample to these firms.

[25] Alternatively, one can estimate (8) with ordered logit to reflect that our constraints measure is the average of rescaled business constraints. However, after rescaling and averaging, the resulting business-constraints measure takes 327 different values, which makes logit results less straightforward to interpret. All our results are nevertheless robust to ordered logit estimation or to using a Tobit model with a lower (upper) limit of 0 (100).

where N_s is one of four dummies that identify whether a firm is in a *Tradeable* sector, the *Construction* sector, a *Non-traded* sector or the *Natural resource* sector. We discuss this sector classification in more detail in Section 5.2.

Our identification exploits that the local presence of mining deposits is plausibly exogenous and reflects random "geological anomalies" (Eggert, 2001; Black, McKinnish and Sanders, 2005). The only assumption we need is that spatial exploration intensity within country-years is homogeneous in the sense that it is uncorrelated with pre-existing business constraints and other local characteristics and instead only depends on national institutions such as expropriation risk (Bohn and Deacon, 2000). We can then treat the local presence of mines as a quasi-experimental setting that allows us to identify the general equilibrium effects of exogenous geologic endowments on local businesses. To the extent that exploration intensity is driven by institutional quality, openness to FDI or environmental regulation, such effects will be taken care of by our country-year-sector fixed effects.

5. Results

5.1. Baseline results

Table 1 reports our baseline results on the impact of mining on local business constraints. In each regression, the dependent variable is the average of the business constraints as perceived by a firm. We present different functional forms of our main independent variables: the number of active mines in the 0-20 km and 21-150 km spatial bands around each firm. In the first four columns we use a count variable—the number of active mines—to measure local mining activity. In the fourth column, we impute the operational status (active or inactive) on the basis of night-time light emissions in the direct vicinity (1 km radius) of the mine.[26] In column 5 we take the log of the number of mines plus one to allow for possible concavity in mining impacts.

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[26] Source: Earth Observation Group. Night-time light intensity (luminosity) as captured by satellite imagery is increasingly used to measure economic activity at the most disaggregated geographical level (Henderson, Storeygard and Weil, 2011). To impute the missing operating status for mines, we run a probit regression of mine operating status on the luminosity within a 1 km radius of the mine interacted with an open-pit (versus underground) dummy, and country-year fixed effects. The coefficient on lights is positive and highly significant for both types of mines with coefficients of 0.015 and 0.008, respectively, and this difference is significant. Open-pit mines therefore emit almost twice as much night-time light. We then use this model to predict missing operating statuses and assume that a mine is operating if the predicted probability is above the median. This affects 119 (2,520) observations in the 0-20 (21-150) km band.

In line with our discussion in Section 2, we find that mining activity near firms increases the business constraints experienced by these firms. In contrast, mining activity relaxes constraints at a longer distance: between 21 and 150 km we find mostly positive mining impacts.[27] These findings hold regardless of the functional form of our mining variables and regardless of whether we saturate the model with country-year fixed effects (column 1), country-year-sector fixed effects (all other columns), exclude our standard set of firm covariates (column 3) or impute missing mining statuses (column 4). Column 5 shows that concavity in the mining impact does not change the baseline impacts. In column 6 we measure mining activity by the sum of night-time light emitted within a 1 km radius around mines. It is reassuring that this alternative way to calculate mining activity yields qualitatively very similar impacts.[28] We therefore measure mining activity by the count of mines throughout the remainder of the paper.

In column 7 the mining count variables are expressed as the log of the number of active minus where zero values are set to missing. We now also add two dummy variables that separate out localities with and without any mining activity. This effectively splits the earlier effect into impacts along the extensive and intensive margin. The economic and statistical significance of our earlier results hardly changes. That is, even when we control for the fact that locations with mining activity may be different from locations without mining, we find that—conditional on mines being present—more mining activity leads to tighter business constraints nearby and fewer constraints further away.

Lastly, in column 8 our main independent variables are total mining input of nearby and more distant mines. As discussed before, we use information on the median mine size by country-mineral cell and multiply this with the annual world price of the mineral. Variation now comes from the number of mines near firms and the exogenous world price of the metals and minerals they produce. We replicate both the strong negative effects in the 0-20 distance band and the strong positive effects in the wider 21-150 band.[29]

In sum, Table 1 shows that mining activity is robustly associated with a deterioration of the business environment in the immediate vicinity of firms but with an improvement at a larger distance. Conditioning on the presence of any mines, we find that this effect is stronger when there are more mines and when mines are larger in terms of total ore output. These

[27] The unreported covariate coefficients show that larger firms are more and foreign-owned firms less constrained on average. Firm age does not matter much.
[28] The marginal effect of a one standard deviation increase in mines' night-time light is 0.5 percentage points.
[29] The sample size is reduced here since we cannot estimate the mine size when output information is missing for other mines that produce the same metal or mineral in the same country.

results are in line with negative local resource-movement effects and positive regional-spending effects. A one standard deviation increase in nearby mining increases the average business constraint by 0.6 percentage points (compared with an average of 30.2) while more distant mining activity reduces constraints by 3.4 percentage points. The effect of mining on the local business environment hence appears modest for the *average* firm. However, theory predicts that the sign of the impact will depend on the sector of the firm. In Section 5.2 we therefore split the average effect by sector while in Section 5.3 we estimate the real effects of increased business constraints and find that these are substantial.

[Insert Table 1 here]

5.2. The impact of mining on tradeable versus non-tradeable sectors

Our second hypothesis states that local mining activity affects tradeable and non-tradeable sectors in different ways. In order to test this prior, we need to decide whether firms belong to a tradeable or a non-tradeable sector. This split is not entirely straightforward as many goods can both be consumed locally and traded (inter)nationally. For example, a leather tannery may sell exclusively to a local downstream clothing manufacturer or may (also) sell internationally. To deal with this issue, we apply two methods to classify sectors and show that our results are robust to either method.

First, we follow Mian and Sufi (2014) and classify the retail sector, restaurants, hotels and services of motor vehicles as non-tradeable (*NT*). Construction is classified separately (*C*), while non-metallic mineral products plus basic metals are labelled as natural resource sectors (*R).* All other sectors are then considered tradeables (*T*). In a slightly different version of this baseline classification, we further restrict tradeables to include only those sectors that export on average at least 5 percent of output (either directly or indirectly through intermediaries). In a third version, we exclude retail from non-tradeables and combine all excluded sectors in a separate *Other* category.

Second, we define tradeables and non-tradeables according to their geographical concentration, following Ellison and Glaeser (1997). The idea is that producers of traded goods do not have to locate themselves close to consumers and can therefore agglomerate, while producers of non-traded goods spread across space to serve nearby consumers. A measure of agglomeration is then informative of the degree of tradeability. We construct an index that is a measure of excess concentration with respect to a random distribution of sectors across space. Let G be a measure of geographic concentration, where s_{si} is the share of industry s's employment in region i and x_i the share of aggregate employment in region i:

$$G_s = \sum_i (s_{si} - x_i)^2$$

Furthermore, let H be the Herfindahl-Hirschmann index of industry concentration, where z_{sj} is establishment j's employment share by industry s:

$$H_s = \sum_j {z_{sj}}^2$$

G and H can now be combined into the following Ellison-Glaeser agglomeration index:

$$\gamma_s = \frac{G_s - (1 - \sum_i {x_i}^2)H_s}{(1 - \sum_i {x_i}^2)(1 - H_s)}$$

As H_s approaches zero (at high levels of aggregation, when the number of plants is large, or for an increasing number of equally sized establishments) γ_s approaches $G_s/(1 - \sum_i {x_i}^2)$ and is a rescaled measure of raw concentration. The index is unbounded on both sides, but $E(\gamma_s)=0$ when no agglomerative spillovers or natural advantages exist. Positive values suggest more concentration than a random distribution would predict, while negative values suggest that establishments locate themselves relatively diffusely. We calculate γ_s for each country-sector-year to allow for different development stages of each country over time, which may translate into changing agglomeration patterns. As in Mian and Sufi (2014), we classify sectors as non-traded if they are within the first decile (most dispersed) of the country-sector γ_s distribution.

Appendix Table A7 lists the number of firms by classification method. Firms in construction and natural resources never change sector by definition. At the margin, different methodologies cause firms to switch between tradeable and non-tradeable status, but the differences in terms of sample size by classification do not change a lot. The average index value of the Ellison-Glaeser index is close to zero (-0.018) for tradeable sectors, but much more negative (-1.183) for the non-tradeable sectors, indicating more dispersion.

In Table 2 we first use our baseline classification based on Mian and Sufi (2014). Using this split, columns 1 to 3 show that only traded firms, which take world or national output prices as a given, suffer from nearby mining activity while natural resource and non-traded firms benefit. These opposite impacts are consistent with the predictions of the standard

Corden and Neary (1982) model as well as our model of Section 2. A one standard deviation increase in the number of active mines within a radius of 20 km leads to a 1.1 percentage point increase in the average business constraints for firms in tradeable sectors. This result holds independent of whether we include firm controls (column 2) or impute mining status with night-time lights (column 3). Each additional active mine within 20 km of a tradeable-sector firm increases business constraints by an additional 0.6 percentage points. In contrast, an increase in local mining activity reduces business constraints by 2.1 percentage points for firms in non-tradeable sectors and by 0.4 percentage points for natural resource firms (see column 1 in Table 5, where we report the marginal effects).

At a longer distance, *all* firm types benefit from local mining activity although this effect is imprecisely estimated for firms in the non-traded sectors. A one standard deviation increase in mining activity in the 21-150 km band leads to a decline in business constraints of 3.8, 4.6 and 5.0 percentage points for firms in the traded, construction and natural resource sectors, respectively.

Robustness checks in Appendix Table A8 indicate that the findings based on the Mian and Sufi (2014) classification are robust to applying other classification methods. In particular, the effect of mines in the direct vicinity of tradeable-sector firms is reassuringly similar across all specifications. In the rest of our analysis, we therefore use our baseline classification.

In column 4 of Table 2 we measure local mining activity as the night-time light emitted within 1 km around mines. The results are very similar to the earlier regressions based on counting the number of mines: a one standard deviation increase in mining leads to an 0.8 percentage point increase in business constraints. Appendix Table A9 shows that this result, as well as our previous findings, also holds when we control for general local economic activity as measured by night-time light emitted in a 20 km radius around firms.

In column 5 we exclude the 10 percent largest and youngest companies. Excluding younger firms reduces the risk that firms have moved to or from newly established mines thus undermining our assumption that mining activity is exogenous. Excluding the largest firms disregards firms that are least sensitive to the local business environment. When we exclude these two types of firms, our results continue to hold. The negative effect of local mining on the business constraints of natural resource companies now disappears. This reflects that some of the largest and youngest firms in our data set are mining-related companies as well as newly established upstream and downstream companies. Removing these firms makes it difficult to precisely estimate the impact of mining on the business environment as perceived by these firms. Note also that if some traded firms moved away due to the opening of mines, we would underestimate the negative effect on traded-sector firms.

In column 6 we exclude firms that operate as multi-plant establishments and that have their headquarters in another region than where the interview took place. Our findings continue to hold here as well. Next, in column 7 we replace our country-year-sector fixed effects with region-year-sector fixed effects. We now compare firms with and without local mines *in the same year, in the same sector and in the same geographical region within a country*. Our main results go through in this very restrictive specification.[30]

Lastly, in columns 8a and 8b we split the mine count near firms according to whether mines are inside (8a) or outside (8b) the administrative region in which the firm is located. Column 9 then provides an F-test for the equality of the estimated coefficients. This shows that within the 21-150 km band, there is not much difference between the impact of intra-region and extra-region mines: their presence reduces business constraints in both cases. As expected, this impact is more precisely estimated for mines that are not only nearby but also within the same administrative region.

Within the 20 km circle, we find two important effects. First, traded firms are not only negatively affected by nearby mines in their own region but even more so by nearby mines that are just across the administrative border. This indicates that the negative impact of mining on the producers of tradeable goods does not simply reflect worsening institutions at the local administrative level. Second, the sign of the impact on non-traded firms depends on whether the mines are within or outside the administrative region. Nearby mines *inside* the same administrative region benefit non-trading firms (probably reflecting positive spending effects at the administrative level) whereas nearby mines just *outside* the administrative boundary hurt non-traded firms (just like they hurt nearby traded firms).

[Insert Table 2 here]

Next, we unpack the average business constraint variable in order to understand *how* local mining affects firms in different sectors. To get at the underlying mechanisms we create three sub-indices of business constraints related to inputs (access to land, an adequately educated workforce and finance), infrastructure (electricity and transport) and institutions (crime,

[30] As regions we use the highest administrative level in each country: states in Brazil and Mexico (*estado*), regions in Chile (*región*), mainland provinces in China, oblasts in Kazakhstan and Ukraine, provinces in Mongolia and federal subjects in Russia.

competition from the informal sector, ease of obtaining an operating license, corruption, political instability, court quality). Each of these indices is an unweighted average of the underlying constraints and ranges between 0 and 100.

The results in Table 3 indicate that firms in traded sectors suffer from mines in their immediate vicinity due to increased difficulties in accessing inputs (column 1, in particular qualified employees) and infrastructure (column 2, in particular transport). To a lesser extent they also complain more about institutional constraints such as those related to crime (column 3). Perhaps not surprisingly, both firms in the construction and in the natural resource sector suffer significantly less from a constrained access to inputs when they are near mines.

The beneficial effects of mining at a slightly larger distance manifest themselves mainly in the form of fewer problems in accessing inputs, especially land and a suitable workforce. To a lesser extent more distant firms also complain less about competition from the informal sector. The fact that we do not find strong effects with regard to infrastructure provision (column 2) suggests that governments in our country sample do not use natural resource revenues to invest heavily in regional public infrastructure. Only the natural resource sector itself reports fewer infrastructure constraints, which may point towards purpose-built infrastructure rather than open access transportation links. This contrasts with the findings of Michaels (2011) who shows that public goods provision prolonged the positive effects of a local resource boom in the United States during the last century.

[Insert Table 3 here]

5.3. Real effects

An important empirical question is whether the impact of mining on local business constraints also translates into measurable effects on firm performance in terms of employment, assets and sales. To analyze this issue, we follow Commander and Svejnar (2011, henceforth CS) who examine the impact of local business constraints on firm performance using BEEPS data for 26 European transition countries. They find that country fixed effects absorb nearly all the variation in business constraints across firms within countries and hence conclude that country-level institutions (and other characteristics) are responsible for holding back firms.

We first replicate their findings based on our sample, which includes a larger number of BEEPS/Enterprise Survey rounds and a smaller but more diverse set of countries. It is therefore worthwhile to examine if this additional variation leads to different results. Contrary to CS, we use a 2SLS approach where in the first stage we instrument business constraints with local mining activity (and the interaction terms of mining activity with economic sector dummies). In the second stage we then treat firm-level average business constraints as the endogenous variable that explains firm performance. This approach deals with possible endogeneity that arises when firms report higher constraints due to an increased demand for their products in booming mining regions. It also reduces concerns related to measurement error and cultural biases in self-reported statistics. The sample size is much reduced when we include assets and sales, because few firms report these numbers and because the 2005 survey wave did not include questions about assets or sales in China, Kazakhstan, Russia and Ukraine.

Table 4 summarizes our results. Column 1 reports our first-stage regression, which also includes interaction terms between local mining activity and the four main economic sectors. The specification contains country-year-sector fixed effects as well as our standard firm-level covariates. We exclude firm size as it is likely to be a "bad control" that is affected by mining activity itself and can thus introduce selection bias.

As before, we find that mining activity in a 21-150 km band around firms reduces average business constraints for all firms whereas mining in the immediate vicinity (<20 km) hurts firms in tradeable sectors but benefits those in non-tradeable sectors. Local mining activity is overall a strong predictor of average business constraints. This is confirmed by the robust first stage F-test on the excluded instruments, which is consistently and comfortably above the rule-of-thumb of 10. Our instruments (mining activity and the sectoral interaction terms) appear valid according to a Hansen's J-test for overidentifying restrictions.

In the second stage, we regress the log of employment, total assets or sales on the average of reported constraints (columns 2-3-4).[31] As before, we include firm covariates related to ownership and age and we saturate the model with country-year-sector dummies (similar to the OLS regressions of CS that include country-year fixed effects). Including this rich set of controls and fixed effects allows us to examine whether constraints as predicted by local mining activity matter when controlling for national institutions.

The results show that predicted business constraints reduce employment, assets and sales. The effects are economically quite large. A one standard deviation increase in local mining activity reduces employment by 2.2 per cent, assets by 6.3 per cent and sales by 2.6 per cent

[31] Employment is the sum of permanent full-time employees plus the number of part-time or temporary employees at the end of the last fiscal year. Assets are the replacement value of machinery, vehicles and equipment in the last fiscal year in US dollars. Sales are annual sales in the last fiscal year in US dollars. All our results are robust to using the book value instead of the replacement value of assets.

for a producer of tradeables.[32] In contrast, there are sizeable positive impacts of mining on both assets and sales of firms producing non-tradeables and firms in the natural resource sector. Table 5 provides a summary of all marginal effects.

[Insert Tables 4 and 5 here]

Table A10 in the Appendix shows a number of alternative IV specifications. Throughout the table we replace country-year-sector fixed effects with sector fixed effects. This yields more precisely estimated second-stage results. We think, however, that it is important to use country-year-sector fixed effects in our baseline specification in Table 4 to adequately control for country-specific unobserved effects, such as institutions and macroeconomic fluctuations. While this somewhat reduces the statistical significance of the main estimates (in line with CS) we nevertheless continue to find relatively precisely estimated negative real impacts.

In columns 5 and 6 we use firm-size dummies. A comparison with the preceding two columns shows that adding these potentially "bad controls" reduces the coefficients. This suggests that controlling for firm size may introduce some positive selection bias and lead to an underestimation of the effect of business constraints on real firm outcomes.

5.4. Robustness: Panel data

While our main firm data set consists of repeated but independently sampled rounds of cross-sectional survey data, a subset of firms was interviewed at least twice (in separate survey rounds) in Chile, Kazakhstan, Mexico, Russia and Ukraine. We can use this small panel to observe the same firms at different points in time and compare how firms that experienced an increase in local mining activity differ from firms that did not. Importantly, this difference-in-differences framework allows us to include firm fixed effects to control more tightly for time invariant firm and locality characteristics.

Table 6 shows the results. Controlling for firm fixed effects, we continue to find an impact of mining on firms' business constraints (columns 1 and 2). The sample is much smaller (798 observations versus 20,857) and covers only 29 country-year-sectors versus 44 when using the repeated cross-sections. Nevertheless, we now find a much larger effect: a one standard

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[32] These negative real impacts also indicate that an increase in self-reported business constraints does not simply reflect a booming local economy in which firms struggle to meet demand. If this drove our results in Tables 1 and 2, then we should find that lower reported business constraints lead to positive instead of negative real effects. In other words, instrumenting firm-level constraints reduces concerns about endogeneity of firms' demand for inputs in the sense that more productive firms need more inputs and thus feel more constrained.

deviation increase in mining activity is associated with a 6.3 percentage point increase in constraints for the average firm (column 1). Column 2 confirms our earlier finding that this negative impact is driven by firms in the tradeable sector, in line with local resource movement effects. The spending effects in the wider area are less clear cut, reflecting the smaller sample size in these panel regressions. Columns 3 to 5 present a similar IV framework as in Table 4 (we use the specification in column 2 as the first stage). We find similar negative impacts on firm growth although, again, the estimates are less precise due to the smaller panel data set.

[Insert Table 6 here]

5.5. Robustness: Controlling for oil and gas fields

One may be concerned that our results are confounded by mining localities that also produce oil and gas. Oil and gas tend to occur in higher concentrations of wealth than metals and other minerals, which may lead to larger local spending effects. On the other hand, production tends to be more capital intensive and this may imply smaller effects on local labor demand.

To assess whether our results are sensitive to the local presence of large-scale hydrocarbon production, we extend our regressions with the number of oil and gas fields within distance bands of each firm. We use data from Horn (2003) who reports both the geographic coordinates and the size of 874 giant onshore and offshore oil and gas fields (with a minimum pre-extraction size of 500 million barrels of oil equivalent).[33]

In Table 7 we report our baseline regressions while adding the number of active oil and gas fields (column 1), total oil and gas reserves (column 2) or the remaining oil and gas reserves (column 3). In each case we include these variables both measured within a 20 km distance of the firm and for a 21-150 km spatial distance ring. Controlling for giant oil and gas fields does not alter our main result that nearby mining activity constrains firms in tradeable sectors but helps firms in the non-tradeable sector as well as firms downstream and upstream of natural resource companies. We also find that the presence of oil and gas fields decreases reported business constraints. However, closer inspection of the data reveals that only few firms have any oil and gas fields nearby (Table A11). While there is on average 0.5 mines within 20 km of a firm, there is only 0.01 oil and gas fields within that distance. In fact, no firms in Brazil, Chile, Kazakhstan, Mexico or Mongolia have any fields within 20 km.

[33] Oil, condensate and gas are summed using a factor of 1/.006 to convert gas trillion cubic feet to oil equivalent million barrels.

This suggests that most fields are located in remote regions and that the negative effect is driven by very few observations.

[Insert Table 7 here]

5.6. Robustness: Clustering standard errors

Our data is a repeated cross-section of country-sectors. In such cases, Bertrand, Duflo and Mullainathan (2004) recommend clustering at the country level when estimating country-level interventions. Yet, in our case the treatment happens at the firm level and is heterogeneous within countries. It is therefore not obvious that autocorrelation is an issue. Arbitrary spatial correlation is more likely and this is taken care of by clustering at the country-year-sector level (without assuming a particular distance decay function). In Table 8, we show that our main baseline results—here replicated in column 1—are robust to alternative clustering methods.

In column 2, we replace the country-year-sector fixed effects with region-year-sector fixed effects where (within-country) regions are either mining rich or poor. We now also cluster the standard errors at this level and show that our results are robust. In column 3, we cluster at the country-year level while correcting the confidence bands for the small number of clusters by using a wild bootstrap (Cameron, Gelbach and Miller, 2008). Our results for the 0-20 km band remain precise but we lose precision in the wider distance band. Next, in column 4 we cluster standard errors by the highest administrative level in each country. Alternatively, in columns 5 and 6, we cluster at regions defined by grids of 2.5 by 2.5 degrees (which equals 275 by 275 km at the equator) and 5 by 5 degrees (550 by 550 km), respectively. The grids are defined within country borders. In all three cases, our results remain precisely estimated and the effect of mines on non-traded firms in the 21-150 distance band now becomes marginally significant.

Finally, we cluster at the country level in column 7, again using the wild bootstrap procedure to take the small number of clusters into account. We then use this regression as a first stage in a replication of our IV results. The second-stage results in columns 8 to 10 indicate that our earlier findings (Table 4, columns 2 to 4) are robust to this quite drastic change in clustering.

[Insert Table 8 here]

5.7. Placebo test: Spatial randomization of mines

One may worry that our results do not only reflect the location of mines but also unobservable characteristics that correlate with the presence of mines in certain areas. To show that our findings hinge on the actual location of active mines, we perform a spatial randomization test. Following Tolonen (2015) we construct 1,000 alternative datasets where we move the location of each mine by a random distance of up to 50 km in any direction while keeping all other mine (and firm) characteristics constant. The number of active mines that falls within the distance bands of each firm changes as a result. Using these artificially modified data, we rerun our baseline specification of column 2 in Table 1 a thousand times and plot the distribution of the estimated coefficients for both distance bands.

Figure 2 depicts the distribution of coefficients for the number of mines within 20 km of firms (left) and for the number of mines between 21 and 150 km (right). The red vertical lines indicate the baseline coefficients using the true observed data. In both cases the distribution of coefficients attenuates towards zero. Because the displacement is large relative to the smallest distance band, the effect is close to zero on average in the left graph. In contrast, the displacement is smaller relative to the 21-150 km distance ring. Many randomly displaced mines therefore still lie within the true distance band and we continue to find a negative average effect. As expected, however, this placebo effect is much closer to zero.

[Insert Figure 2 here]

6. Conclusions

We estimate the local impact of mining activity on the business constraints of over 20,000 firms in eight resource-rich countries. We exploit spatial variation in local mining activity within these countries to facilitate causal inference in both a cross-sectional and a panel setting. To the best of our knowledge, ours is the first paper to estimate this impact of mining activity on firm performance across a variety of countries. Our results are clearly at odds with views that consider mines as “enclaves” without any tangible links to local economies. Instead we find that the presence of active mines deteriorates the business environment of firms in close proximity (<20 km) to a mine but relaxes business constraints for more distant firms. The negative local impacts are concentrated exclusively among firms in tradeable sectors. In line with mining-related congestion effects and infrastructure bottlenecks, the ability of these firms to access inputs, skilled labor and infrastructure is hampered. This mining-induced deterioration of the local business environment also stunts the growth of these firms: they generate less employment, sell fewer goods and own fewer assets. In sharp contrast, firms in the services sector and in upstream and downstream natural resource sectors benefit from local mining.

In line with the Dutch disease model of Corden and Neary (1982), our results provide evidence for negative-resource movement effects in the immediate vicinity of mines (a “local curse”) as well as positive spending effects in a wider geographical area (a “regional blessing”). We believe that these findings can contribute to a better understanding of why studies of the local impact of mining often find positive effects on household income, while many aggregate studies find adverse effects on national income growth. Our results suggest that only traded sector manufacturing firms suffer from mining, and only at a localized level, while the non-traded and construction sectors benefit. Because most firms are traded we find that the net average effect is negative at the local level. Moreover, the spending effect may increase demand for all sectors in the wider economy.

From a policy perspective our results indicate that, on average and across countries, mining activity can have a positive impact on local economies. To minimize localized negative effects on the business environment, policy-makers should think about ways to let local producers share extraction-related infrastructure. This may reduce the infrastructure bottlenecks and congestion effects that we observe in the data. Improving transport, electricity, water and other enabling infrastructure may not only help firms in tradeable sectors but also further stimulate local services sectors and clusters of downstream and upstream industries that are related to mines. To maximize positive spillovers, policy-makers can also help firms to become fit to supply local mining-related supply chains. These measures can help meet the preconditions for a resource boom to trigger agglomeration and positive long-term impacts.

Finally, the geographical and sector distribution of the economy at the time of natural resource discoveries also matters for whether resource booms have aggregate negative growth effects or not. Moreover, to what extent any negative effects persist depends on whether the contraction of tradeable sectors during the boom will be reversed once a boom ends. Tradeable sectors may remain depressed for a protracted period if during the boom local residents have specialized in resource-related skills that are not easily transferable to other sectors. Policy has a clear role to play here as well.

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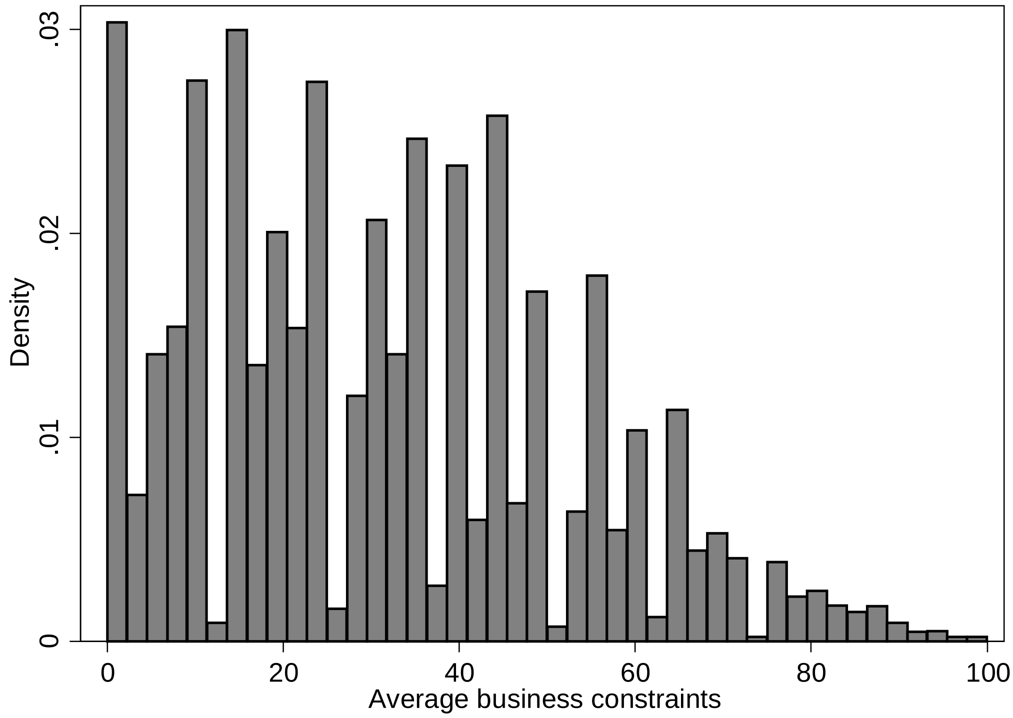
Appendix A. Histogram of *Average business constraints*



Appendix B. Survey questions

We use the following BEEPS V survey questions to measure firm-level business constraints. In each case the following answer categories were offered: *No obstacle*, *Minor obstacle*, *Moderate obstacle*, *Major obstacle*, *Very severe obstacle*, *Don't know*, *Does not apply*. For earlier survey rounds and for the World Bank Enterprise Surveys we use equivalent questions.

Question C.30a: Using the response options on the card, to what degree is ***electricity*** an obstacle to the current operations of this establishment?

Question D.30a: Using the response options on the card, to what degree is ***transport*** an obstacle to the current operations of this establishment?

Question E.30: Using the response options on the card, to what degree are ***practices of competitors in the informal sector*** an obstacle to the current operations of this establishment?

Question G.30a: Using the response options on the card, to what degree is ***access to land*** an obstacle to the current operations of this establishment?

Question I.30: Using the response options on the card, to what degree is ***crime, theft and disorder*** an obstacle to the current operations of this establishment?

Question K.30: Using the response options on the card, to what degree is ***access to finance*** an obstacle to the current operations of this establishment?

Question J.30c: Using the response options on the card, to what degree are ***business licencing and permits*** an obstacle to the current operations of this establishment?

Question J.30e: Using the response options on the card, to what degree is ***political instability*** an obstacle to the current operations of this establishment?

Question J.30f: Using the response options on the card, to what degree is ***corruption*** an obstacle to the current operations of this establishment?

Question H.30: Using the response options on the card, to what degree are ***courts*** an obstacle to the current operations of this establishment?

Question L.30b: Using the response options on the card, to what degree is an ***inadequately educated workforce*** an obstacle to the current operations of this establishment?