



# Mining matters: Natural resource extraction and firm-level constraints

Ralph De Haas <sup>a,\*</sup>, Steven Poelhekke <sup>b,2</sup>

<sup>a</sup> European Bank for Reconstruction and Development (EBRD), One Exchange Square, London EC2A 2JN, United Kingdom.

<sup>b</sup> Vrije Universiteit Amsterdam and De Nederlandsche Bank, Vrije Universiteit Amsterdam, Faculty of Economics and Business Administration, De Boelelaan 1105, 1081, HV, Amsterdam, The Netherlands

## ARTICLE INFO

### Article history:

Received 4 July 2017

Received in revised form 15 January 2019

Accepted 16 January 2019

Available online 19 January 2019

### Research data related to this submission:

<https://data.mendeley.com/datasets/x4btx35vjf/draft?fa=40c3a396-9610-4a79-b44b-98a95c4fe3b5>

### JEL codes:

L16

L25

L72

O12

O13

Q30

### Keywords:

Mining

Natural resources

Business environment

Firm-level constraints

## ABSTRACT

We estimate the impact of local mining activity on the business constraints experienced by 25,777 firms across nine large and resource-rich countries. We find that the presence of active mines in firms' immediate vicinity (<20 km) deteriorates the business environment in tradeable sectors. Access to inputs and infrastructure becomes more constrained for these firms and this adversely affects their growth. In contrast, nearby active mines have a positive effect on firms in non-tradeable sectors. Moreover, we show that the presence of mines at a greater distance (21–150 km) relaxes business constraints of all firms, in line with positive regional spending effects.

© 2019 Elsevier B.V. All rights reserved.

## 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 and minerals. 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 a 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 can 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.<sup>3</sup> 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 firms across nine countries with large mining sectors: Brazil,

\* Corresponding author.

E-mail addresses: [dehaasr@ebrd.com](mailto:dehaasr@ebrd.com) (R. De Haas), [steven.poelhekke@auckland.ac.nz](mailto:steven.poelhekke@auckland.ac.nz) (S. Poelhekke).

<sup>1</sup> Also affiliated with CEPR and Tilburg University.

<sup>2</sup> Present address: University of Auckland, Department of Economics, Owen G. Glenn Building, 12 Grafton Rd., Auckland 1010, New Zealand. Also affiliated with CESifo, Munich.

<sup>3</sup> 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".

Chile, China, India, Indonesia, Kazakhstan, Mexico, 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.

We test this hypothesis using three main data sets. First, we use detailed data on 25,777 firms from the EBRD-World Bank Business Environment and Enterprise Performance 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 public goods affects firm performance.<sup>4</sup> Firms’ perceptions of the importance of external constraints on their activity can be used to find out which constraints affect economic activity the most ([Carlin et al., 2010](#)). These constraint variables measure competition for public goods directly, as they reflect firms’ intended rather than actual use of such goods, and can therefore be interpreted as the shadow prices of public inputs. We exploit variation across firms in the reported severity of external constraints to assess how local mining activity, by affecting the quality and quantity of public good provision, influences the ability of local firms to grow.

Second, we use comprehensive firm-level panel data from Orbis. While Orbis does not include information on business constraints as perceived by firms, it does contain data on the balance sheets and profit and loss accounts of over 100,000 firms for on average five years. This allows us to measure the impact of mining by comparing one and the same firm before and after one or more mines open in its direct or wider vicinity.

Third, 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 5595 mines producing 31 different metals and minerals in our country sample. Depending on the year, we observe the operating status of between 1828 and 2511 mines.

Merging 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 and to do so 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 “factor reallocation effect”, we uncover heterogeneous mining impacts in the immediate vicinity ( $\leq 20$  km) 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 have real effects in terms of total employment. Our results indicate that moving a producer of tradeables from an area without mines to an area with average mining intensity (2.7 mines) would reduce the number of employees by 2.2%. In contrast to firms in tradeable sectors, we find that nearby mining activity alleviates business constraints for firms in non-tradeable sectors.

Second, in line with a sub-national “spending effect” we find that both tradeable and non-tradeable firms report an improvement in the provision of public goods if mining activity increases 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 transport infrastructure and other aspects of the business environment on a wider geographical scale. Such improvements may either reflect increased government spending or infrastructure investment by mining companies themselves.<sup>5</sup> Two examples, both based on mines in our data set, can illustrate how mining can improve regional infrastructure. In Chile, starting up the Escondida copper mine required large investments in the local power supply. These investments reduced the cost of power in the wider Antofagasta region as well. Moreover, new roads were constructed between the mine and the Antofagasta region that were open for public use and hence reduced regional transport constraints ([McPhail, 2009](#)). In Indonesia, new roads were built when the Minahasa Raya gold mine was commissioned in 1994. These roads improved regional connectivity by better linking the mining area to Manado, the nearest regional capital. The resulting reduction in travel time had a positive effect on the local economy ([Mamonto et al., 2012](#)).

Our baseline results are based on regression specifications that include region-sector-year fixed effects so that we effectively compare—within one and the same region, sector, and year—firms with and without nearby mines. In robustness tests, we experiment with different ways to cluster our standard errors, assess the sensitivity of our results to excluding individual countries, and control for oil and gas fields. None of this affects the main results.

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 Dutch disease); worsening institutions and governance ([Besley and Persson, 2010](#); [Dell, 2010](#)); rent seeking ([Mehlum et al., 2006](#); [Beck and Laeven, 2006](#)) and increased conflict ([Collier and Hoeffler, 2004](#); [Miguel et al., 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](#)).

<sup>5</sup> Countries tax mining revenues through a combination of standard corporate tax, a mining (royalty) tax, and export fees. While these taxes are typically collected by the central government, a substantial portion of them are either redistributed back to the mining regions or used by the central government to fund infrastructure and other projects in those regions. For instance, the Brazilian constitution stipulates that states and federal districts are assured a “share in the results” of mineral resource exploitation in their respective territory ([Otto, 2006](#)). Alternatively, countries can give tax breaks to mining companies in return for investments in regional infrastructure that is open to other users. As an example, in 2014 the Government of Guinea gave mining multinational Rio Tinto a tax rebate in return for the construction of a highway, open to third parties, as part of the development of the Simandou iron ore mine ([Collier and Laroche, 2015](#)).

<sup>4</sup> 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](http://www.enterprisesurveys.org) provides additional background information. The surveys also provide a rich array of firm covariates, such as industry, age, sales, employment, and ownership structure.

To strengthen identification, recent papers exploit micro data to estimate the impact of natural resource discoveries on local living standards.<sup>6</sup> 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 linkages are strong enough.<sup>7</sup> Lippert (2014) and Loayza and Rigolini (2016) also document positive impacts on living standards for Zambia and Peru, respectively. For the case of Ghana, Fafchamps, Koelle and Shilpi (2017) find that gold mining has led to agglomeration effects that benefit non-farm activities.<sup>8</sup> Consistent with these country studies, Von der Goltz and Barnwall (2019) show for a sample of developing countries that mining boosts local wealth but 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 to gain insights into the mechanisms through which mining affects local economic activity (and ultimately household incomes).<sup>9</sup> We not only observe firm outcomes 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 (2018) show that historical hydrocarbon booms benefited county-level economic growth through positive agglomeration effects, backward and forward linkages, and lower transport costs.<sup>10</sup> In contrast, 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 work on the relationship between the business environment and firm performance. This literature has moved from using country-level proxies for the business environment (Kaufmann, 2002) to firm-level, survey-based indicators of business constraints. Dethier et al. (2011) point to the typically strong correlation between firms' subjective assessments of the severity of business constraints and more objective indicators. For instance, Pierre and Scarpetta (2004) show that in countries with strict labor regulations there is a higher share of firms that report labor regulations as a problem. While various papers find negative correlations between firm-level indicators of business constraints and firm performance, endogeneity concerns linger.<sup>11</sup> Commander and Svejnar (2011) link

firm performance in 26 transition countries to firms' own assessments of 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.

Another related literature investigates the negative externalities (congestion) and positive externalities (agglomeration) of geographically concentrated economic activity.<sup>12</sup> Congestion occurs when firms compete for a limited supply of infrastructure or other public goods.<sup>13</sup> 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 et al. (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 and more distant firms.

Lastly, this paper also speaks to recent work on the impact of (exogenous) local labor supply shocks, in the form of immigration, on specialization across sectors. Hong and McLaren (2015) show theoretically and empirically (for the U.S.) how positive immigration shocks not only increase local labor supply but also the local demand for non-traded services. This raises real wages through entry and leads to more employment in the non-tradeables sector (Brezis and Krugman (1996) provide a similar theoretical framework). Relatedly, Peters (2017) uses a two-sector (agriculture and manufacturing) general equilibrium model to guide his analysis of the local impact of ethnic Germans migrating to Germany after WWII. He shows how migrant inflows, by increasing the size of local markets and related agglomeration effects, can encourage firm entry. The two main mechanisms that we consider when assessing the local impact of mining activity are closely related to this literature. First, while the above papers analyze a positive labor supply shock, the opening of mines can drive up wages and attract workers from other sectors, which is a negative labor supply shock from the perspective of those sectors (the factor reallocation effect). Second, the profits from natural resources, and the higher wages and/or the increase in the local population due to immigration, can increase the local demand for non-tradeables (the spending effect).

We proceed as follows. Section 2 derives our main hypotheses based on a structured discussion of related theoretical literature. Sections 3 and 4 then describe our data and empirical strategy, after which Section 5 presents our results. Section 6 concludes.

## 2. Hypothesis development

While Dutch disease models initially focused on reallocation between sectors at the national level—Corden and Neary (1982) and Van Wijnbergen (1984)—they have recently been adapted to include multiple regions within a country (Allcott and Keniston, 2018). Such multiregional models provide a useful theoretical framework to build intuition on how mining booms affect local as well as more distant firms in both tradeable and non-tradeable sectors.

More specifically, we can consider a multiregional economy in which labor is (imperfectly) mobile and where the government redistributes natural resource rents between regions. For our purposes it is instructive to think about an economy with three sectors: (i) the

<sup>6</sup> See Cust and Poelhelke (2015) for a survey. Others estimate impacts on health and behavioral outcomes such as infant mortality (Benshaul-Tolonen, 2019) 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 et al., 2015; Berman et al., 2017).

<sup>7</sup> 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.

<sup>8</sup> Aragón and Rud (2016) show the flipside of Ghanaian gold mining: increased pollution, lower agricultural productivity and more child malnutrition and respiratory diseases.

<sup>9</sup> Glaeser et al. (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).

<sup>10</sup> 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 et al. (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 (2018) show how mining booms in India result in the election of criminal politicians.

<sup>11</sup> For instance, Johnson et al. (2002); Beck et al. (2005); Dollar et al. (2006); Hallward-Driemeier et al. (2006) and Bah and Fang (2015). Some papers use industry or city averages of business constraints as either regressors or instruments to reduce endogeneity concerns.

<sup>12</sup> See Combes and Gobillon (2015) for a survey of the agglomeration literature.

<sup>13</sup> A recent literature investigates the spatial impact of infrastructure on economic activity. Donaldson (2018) shows how new railways in colonial India integrated regions and boosted welfare gains from trade. In a similar vein, Bonfatti and Poelhelke (2017) 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 et al., 2012). In the United States, Chandra and Thompson (2000) and Michaels (2008) exploit the construction of interstates to document agglomeration effects.

manufacturing sector, which produces goods that are tradeable internationally and across regions; (ii) services, which are non-tradeable across regions; and (iii) the tradeable natural resource sector. In such a set-up, the prices of manufacturing goods and minerals are set on world markets while those of non-traded services are endogenous and vary by region.

Labor input can be assumed to be used in a fixed proportion to public goods, such as infrastructure. A higher demand for labor then translates into a higher demand for public goods as well. Such public goods are not mobile across regions, exogenously provided by a higher layer of government, and increasing in national natural resource rents. Typically, the supply of public 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 public goods (which are non-excludable but rivalrous in consumption). This means that congestion of public goods and competition for private inputs can 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 an 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.

In such an economy, a local resource boom can be defined as an exogenous shock to the natural resource sector in the local region where a mine is discovered and opened.<sup>14</sup> Such a shock will then work itself through the economy via five distinct channels:

1. First, the demand for labor and public goods in the mineral sector rises and wages increase in the local region. To the extent that labor supply is not perfectly inelastic, immigration from the wider region dampens this increase in wages. For perfectly elastic supply, the increase in labor demand in the local mineral sector is completely met by supply from the wider region. Moreover, to the extent that supply chains are local, firms with strong upstream linkages to mines may benefit from an increased demand for intermediate inputs (Moretti, 2010).
2. Second, the local resource boom raises services prices and thus induces a real appreciation in the local region (a spending effect as in Corden and Neary, 1982). The production of non-traded services increases too. Higher wages (if local labor demand is not fully met through immigration) are passed on to higher non-traded prices through a rise in local aggregate demand.
3. Third, if wages increase, manufacturing profitability declines because the traded sector is a price taker on world markets. Manufacturing consequently contracts as firms compete with establishments in the wider region that do not suffer from increased input costs (Moretti, 2011). This is a factor reallocation effect (Corden and Neary, 1982).
4. 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 local region results in excess labor demand in the wider region and possibly a shrinking of services and manufacturing sectors in this wider region. Unless labor is highly mobile, this effect attenuates with distance.
5. Higher aggregate demand in the local region spills over into higher demand for manufactured goods, which must be supplied through imports from the wider region (or from other countries). This increases the demand for manufacturing goods in the wider region. This trade effect is particularly strong if no rent redistribution takes place and local income increases by the full amount of rents. In addition to positive spatial spill-overs due to an increased demand for tradable goods, the increase in mineral rents can also spread to the

wider region through transfers (a spending effect). 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).

This discussion suggests two main testable hypotheses regarding the impact of mining on the business constraints faced by different types of firms at different distances (that is, the local region and the wider region):

- I. In line with local factor reallocation 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) than firms in non-tradeable sectors or in the natural resource sector. Positive spending effects benefit firms across all sectors.
- II. Negative factor reallocation effects near mines are associated with a deterioration of the business environment for local firms. In the wider region, at a greater distance from mines, these negative effects are partially or more than compensated by positive spending effects as the business environment improves or the provision of public goods expands. Moreover, manufacturing firms in the wider region benefit from an increased demand for their products from booming mining localities.

### 3. Data

For our purposes, we need data on the business constraints experienced by individual firms, their main characteristics such as sector and age, employment, as well as detailed information on the presence of mines near each firm. We therefore merge our firm-level Enterprise Survey data from nine emerging markets—Brazil, Chile, China, India, Indonesia, Kazakhstan, Mexico, Russia and Ukraine—with the geographical coordinates of the near universe of minerals (including coal) and metal mines in these countries. In addition, we merge these mining data with balance sheet and financial statement data from Bureau van Dijk's Orbis company database. While Orbis does not contain information about firms' perceived business constraints, it has two main strengths: it provides a larger sample than the Enterprise Survey and it provides such data for several years, effectively giving us a firm-level panel data set.

Our sample of nine emerging markets is constructed by taking the full list of Enterprise Survey countries as a starting point. For each of these countries we then calculate the number of mines in the SNL Metal and Mining data set. We select all countries with the largest number of mines for which we know the operating status, taking 75 as a minimum cut-off. These are China ( $n = 696$ ), Russia (497), India (376), South Africa (344), Ukraine (300), Brazil (154), Peru (137), Mexico (126), Chile (108), Indonesia (85), and Kazakhstan (85). We then plot these mines, as well as the Enterprise Survey firms, on country-level maps to assess their geographical dispersion within each country. This leads us to exclude Peru and South Africa, where all firms are concentrated in just four locations per country. Since each of these locations is in another region, there is no within-region variation to be exploited in these two countries.

#### 3.1. Mining data

We download data from the leading provider of mining information, SNL's Metal & Mining (formerly Raw Materials Group). Of the (non-coal) mines in our data set, 26% are state-owned while the remainder is evenly split between firms owned by private domestic investors and those owned by foreign investors (37% each). The data set contains for each mine annual information on the production levels for every mineral as well as the GPS coordinates of its center point and the mine's

<sup>14</sup> New discoveries are assumed to be exogenous as exploration is spatially homogeneous within region-years in the sense that it is uncorrelated with pre-existing economic activity and other local characteristics.

operation status. This allows us to distinguish between active (operating) and inactive mines and to count the number of active mines near each firm. This status is typically driven by exogenous world prices: when prices rise, more mines (re-)open. We assemble this information for the 5595 mines scattered across the nine countries. For a subset of active mines, we also know metal production and for a small subset ore production, measured in millions of tons (metric megaton, Mt) of ore mined per year.<sup>15</sup> 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, this is unfortunately only recorded for one in ten mine-year observations.

We focus on mines rather than the extraction of oil and gas as hydrocarbon production 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 5.6.

### 3.2. Firm data

To measure firms' business constraints, we use various rounds of the EBRD-World Bank Business Environment and Enterprise Performance Survey (BEEPS) and the equivalent World Bank Enterprise Surveys. Face-to-face interviews were held with 25,777 formal registered firms in 3351 locations across our country sample to measure to what extent particular aspects of the business environment hold back firm performance. The surveys were administered using 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) so that we can use industry fixed effects in our regression framework. While mines were not surveyed, upstream and downstream natural resource firms are included. The first six columns of Appendix Table A3 summarize the number of observations by year and country while Table A4 gives a sector breakdown. We have data for the years 2004, 2005, 2007, 2008, 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 obstacle", a "Moderate obstacle", a "Major obstacle" or a "Very severe obstacle" to the current operations of your establishment?". Similar information was elicited about 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; 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  $(\text{value} - \text{minimum value}) / (\text{maximum value} - \text{minimum value})$ . Section 5.1 provides tests that confirm that our results are robust to different rescaling strategies.

For each firm we construct *Average business constraints*, which measures the average of the above-mentioned 10 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); *Infrastructure constraints* (electricity and transport); and *Institutional constraints* (crime, informal competitors, access to business licenses, corruption, and court quality). These measures again range between 0 and 100. The average constraint intensity is 28.8 but there is wide variation across firms; the standard deviation is 20.3. The most binding constraints are those related to access to inputs (32.6), followed by infrastructure (28.5) and institutional constraints (22.7).

We also create firm-level covariates. These include firm *Age* in number of years and dummies for *Small firms*, *Medium-sized firms* and *Large firms*; *International exporters* (firms whose main market is abroad); *Foreign firms* (foreigners own 10% or more of all equity); and *State firms* (state entities own at least 10% of the firm's equity). Moreover, we create log *Employment* as firm-level outcome and construct the following sector dummies: *Manufacturing*; *Construction*; *Retail and wholesale*; *Real estate, renting and business services*; and *Others*.<sup>16</sup> We also use the Orbis database to construct an analogous log *Employment* variable for a larger firm-level panel data set.

For each firm we know the name and geographical coordinates of its location (city or town). We exclude firms in capital cities because limited fiscal redistribution may keep rents disproportionately in the capital. Table A1 in the Appendix provides all variable definitions while Table 1 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. Fig. 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 rectangles 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).<sup>17</sup> Throughout all our main specifications, we include region-sector-year fixed effects so that we compare firms with and without local mines within one and the same geographical region (and in the same industry and year).

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, 22% of all Enterprise Survey firms have at least one mine within a 20 km radius while 75% have at least one mine within a 21–150 km radius. These numbers are 5 and 23% for Orbis firms, respectively. Orbis collects and aggregates firm-level data from official business registers, annual reports, newswires, and webpages. Instead, the enterprise surveys take the universe of firms (typically obtained from a country's statistical office) as the initial sampling framework. Stratified random sampling is then used to select the firms to be interviewed. One of the sampling strata is the geographic region within a country. This stratification helps to

<sup>15</sup> Mines typically produce ore that contains several minerals with varying grades. Appendix Table A2 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.

<sup>16</sup> Once we categorize firms into traded, non-traded, construction and natural resource related sectors, we replace sector dummies with dummies for these categories.

<sup>17</sup> In defining the distance bands, we draw circles around firms and disregard all borders, both national and within-country administrative ones. In Section 5.2 we explicitly distinguish between mines inside and outside administrative borders.

**Table 1**  
Summary statistics.

	Obs.	Mean	Median	St. dev.	Min	Max
<i>Dependent variables</i>						
Average business constraints	25,778	28.79	25	20.30	0	100
Input constraints	25,762	32.62	33	24.46	0	100
Infrastructure constraints	25,766	28.51	25	27.29	0	100
Institutional constraints	25,763	22.71	20	24.15	0	100
Employment (ln, Enterprise Survey)	24,313	4.66	4.61	1.74	0	13.50
Employment (ln, ORBIS)	328,615	3.51	3.22	1.08	2.30	11.70
<i>Independent variables</i>						
$N_e$ active mines 0–20 km	25,778	0.55	0	1.77	0	22
$N_e$ active mines 21–150 km	25,778	7.50	3	15.13	0	169
Total mining output 0–20 km (ln)	5,451	18.52	18.52	0.98	15.18	22.69
Total mining output 21–150 km (ln)	5,451	20.21	20.19	1.12	15.71	22.25
$N_e$ oil and gas fields 0–20 km	25,778	0.01	0	0.08	0	1
$N_e$ oil and gas fields 21–150 km	25,778	0.27	0	0.70	0	5
Oil and gas reserves 0–20 km (ln)	25,778	0.04	0	0.59	0	8.48
Oil and gas reserves 21–150 km (ln)	25,778	1.17	0	2.69	0	9.83
Oil and gas remaining reserves 0–20 km (ln)	25,778	0.03	0	0.35	0	5.37
Oil and gas remaining reserves 21–150 km (ln)	25,778	0.78	0	1.86	0	9.28
Small firm	25,778	0.24	0	0.43	0	1
Medium-sized firm	25,778	0.29	0	0.46	0	1
Large firm	25,778	0.43	0	0.50	0	1
Firm age	25,778	15.52	11	14.56	0	203
Foreign firm	25,778	0.13	0	0.34	0	1
State firm	25,778	0.14	0	0.35	0	1
Firm competes internationally	25,778	0.11	0	0.31	0	1

Notes: This table provides summary statistics for all variables used in the analysis. Table A1 in the Appendix contains all variable definitions.

explain why the enterprise surveys over-sample firms outside the main cities and in regions with more mines.

At the intensive margin, we measure the number of mines around firms ( $N_e$  active mines). On average, a firm has 0.6 active mines within a 20 km radius but there is wide variation: this variable ranges between 0 and 22 mines. Within a 21–150 km distance band, the number of active mines is on average 7.5 and again ranges widely between zero and 169 mines (all numbers based on the Enterprise Survey data). We also create similar variables that measure inactive mines and mines with an unknown operating status and use these as control variables.

#### 4. Empirical strategy

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

$$Y_{fsrct} = \beta M_{fsrc,t-2} + \gamma X_{fsrct} + S_{srt} + \varepsilon_{fsrct} \quad (1)$$

where  $Y_{fsrct}$  indicates for firm  $f$  in sector  $s$  in region  $r$  of country  $c$  in year  $t$  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.  $M_{fsrc,t-2}$  contains a number of two-year lagged indicators of local mining activity within a 0–20 or 21–150 km spatial band around firm  $f$ .<sup>18</sup>  $X_{fsrct}$  is a matrix of covariates related to firm age, size and ownership.

<sup>18</sup> While it may take time for mining to affect local firms, impacts and employment generation may already be substantial during the investment phase (Benshaul-Tolonen, 2019). Unreported tests show 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.

We saturate the model with sector–region–year fixed effects— $S_{srt}$ —to wipe out (un)observable variation at this level and to rule out that our results reflect industry-specific demand shocks or region-specific production structures. These fixed effects mean that we consistently compare—within one and the same geographical region of a country—firms with and without nearby mines. They also take care of any (unintended) differences in survey implementation across countries, years and sectors and they absorb time-invariant differences (such as geography) as well as time-varying differences (such as in the business climate) between resource-rich and resource-poor regions in a country that may correlate with both resources and firm constraints.<sup>19</sup>

Lastly, we double cluster robust standard errors by country–sector–year level and by region. Appendix Table A5 shows that our results are robust to alternative clustering strategies. We are interested in the OLS estimate of  $\beta$ , which we interpret as the impact of local mining intensity on firms' business constraints.<sup>20</sup> In a second part of the analysis, we will regress employment on thus predicted business constraints.

Our data also 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 but negative for firms in tradeable sectors. We therefore also estimate:

$$Y_{fsrct} = \beta M_{fsrc,t-2} \times N_s + \gamma X_{fsrct} + S_{srt} + \varepsilon_{fsrct} \quad (2)$$

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 et al., 2005). The only assumption we need is that spatial exploration intensity within region–years is homogeneous in the sense that it is uncorrelated with pre-existing business constraints and other local characteristics. 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 sector–region–year fixed effects.

#### 5. Results

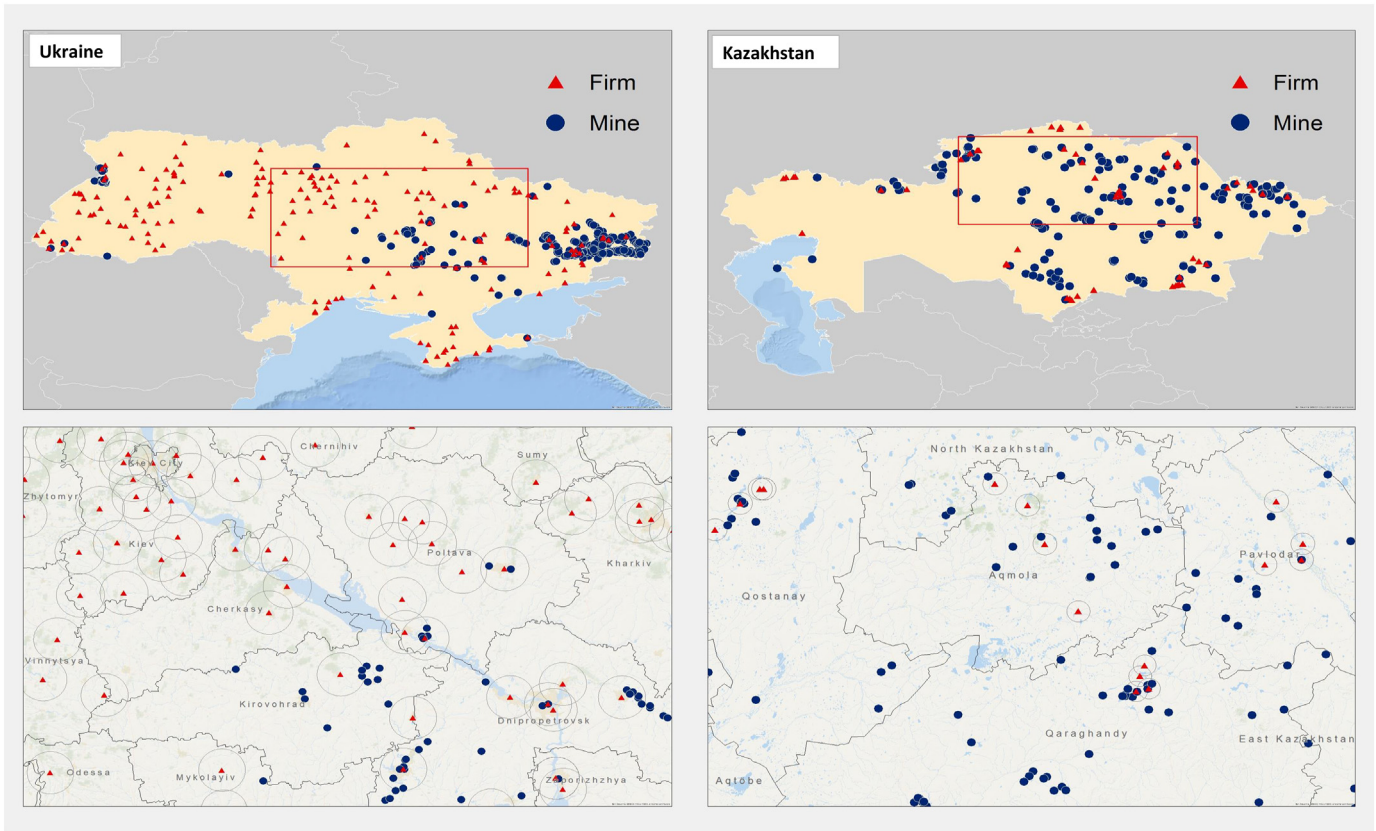
##### 5.1. Baseline results

Table 2 reports our baseline results on the impact of mining on local business constraints. The dependent variable is the average of the business constraints as perceived by a firm. In line with our discussion in Section 2, we find that nearby mining activity increases the business constraints experienced by firms. In light of hypothesis I, this suggests that the negative effect for tradeable sector firms dominates in this sample of all firms. In contrast, mining activity relaxes constraints at a longer distance: between 21 and 150 km we find mostly beneficial mining impacts, providing prima facie evidence for hypothesis II.<sup>21</sup> This holds regardless of whether we saturate the model with country–sector–year

<sup>19</sup> We use the estimator developed by Correia (2016) to deal with large datasets with multiple levels of fixed effects in a computationally efficient way.

<sup>20</sup> Alternatively, one can estimate (1) 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 465 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).

<sup>21</sup> The unreported covariate coefficients show that larger firms are more and foreign-owned firms less constrained on average. Firm age does not matter much.



**Fig. 1.** Geographical distribution of firms and mines. These graphs depict the geographical distribution of the firms and mines in our dataset for Ukraine (left) and Kazakhstan (right). Scale varies by country. Similar maps are available for Brazil, Chile, China, India, Indonesia, Mexico, and Russia in the online Appendix. Red triangles (blue dots) indicate individual firms (mines). The lower maps zoom in to the area highlighted by the red rectangles in the upper maps. The circles around firms have a 20 km radius. Source: EBRD-World Bank BEEPS Surveys and SNL Metals and Mining. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

**Table 2**  
Local mining and business constraints.

Dependent variable →	Average business constraints		No active mines 0–20 km	No active mines 21–150 km	Average business constraints	Average business constraints		
			1st stage		2nd stage			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
No active mines 0–20 km	1.051*** (0.377)	1.358** (0.648)			0.257** (0.130)	0.178** (0.069)	0.226*** (0.063)	0.226*** (0.083)
No active mines 21–150 km	–1.648* (0.980)	–1.939** (0.941)			–0.224*** (0.084)	–0.056* (0.032)	–0.111** (0.047)	–0.111* (0.061)
Total mining output 0–20 km (ln)			2.237*** (0.416)	–1.766* (1.072)				
Total mining output 21–150 km (ln)			0.052 (0.089)	9.647*** (1.371)				
Definition “No active mines”	Ln(n + 1)	Ln(n)	Count	Count	Count	Count	Count	Count
Country-Sector-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Region-Sector-Year FE	No	No	No	No	No	No	Yes	Yes
Region FE	No	No	No	No	No	Yes	No	No
Clustering	CSY	CSY	CSY	CSY	CSY	CSY	CSY	CSY + R
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for inactive mines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for active mines	No	Yes	No	No	No	No	No	No
Combined 1st stage F-test			20.35					
Observations	25,777	25,777	5451	5451	5451	25,770	25,651	25,651
R-squared	0.260	0.260			0.032	0.327	0.357	0.357

Notes: This table shows OLS regressions (columns 1–2 and 6–8) and IV regressions (columns 3–5) to estimate the impact of local mining activity on firms’ business constraints. In columns 3–8, No. active mines 0–20 km (21–150 km) are count variables. In column 1, the No. active mines variables are expressed as the log of the number of active mines plus 1. In column 2, the No. active mines variables are expressed as the log of the number of active mines where missing values are set to zero (while adding separate dummy variables Any active mine 0–20 km (21–150 km)). In columns 3–5, we instrument the number of active mines with the median amount of metal or mineral produced by other mines within each country-mineral/metal cell multiplied by the world price of the mineral/metal. Robust standard errors are clustered by country-sector-year and shown in parentheses. In column 8, standard errors are clustered by both country-sector-year (CSY) and by region (R). \*\*\*, \*\*, \* correspond to the 1%, 5%, and 10% level of significance, respectively. All specifications include country-year-sector fixed effects (except columns 7 and 8 which include region-sector-year fixed effects), firm controls (size, age, international exporter and ownership), controls for inactive mines in the vicinity of firms, and a dummy for whether a mine of any status exists in the administrative region of the firm. Sectors are Manufacturing; Construction; Retail and wholesale; Real estate, renting and business services; Other. Table 1 contains summary statistics and Appendix Table A1 contains variable definitions and data sources.

fixed effects (columns 1–5), country-sector-year effects and region fixed effects (column 6) or even more stringent region-sector-year fixed effects (columns 7–8 and following tables).<sup>22</sup> Moreover, the results hold when clustering standard errors at the country-sector-year level (columns 1–7) and when double clustering at that level and at the regional level (column 8).

We experiment with 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 column, we take the log of the number of mines plus one, to allow for possible concavity in mining impacts. In column 2, the *No. active mines* variables are expressed as the log of the number of active mines where missing values are set to zero. We now also add two (unreported) dummy variables that separate out localities with and without mining activity in the two distance rings. 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. Because concavity in the mining impact does not change the baseline impacts, we measure mining activity by the mine count in the remainder of the paper.

Unobservable within-country shocks may influence both local mining activity and firm constraints. To mitigate such concerns, columns 3–5 provide an IV framework in which we instrument the number of *active mines* around each firm. To construct our instrument *Total mining output*, we first multiply the world price of the main metal produced by each mine with the median mine size (annual amount of metal produced) of the other mines in the same country that produce the same metal. We do this because the volume of ore produced—and its mineral content—is only recorded for a subset of mines.<sup>23</sup> We then take the sum of this variable for all mines (of any operating status) near a firm. If the operational status of mines is indeed driven by exogenous world prices, then the prices of locally available commodities should be a strong predictor of whether mines are open or not. This turns out to be the case: the first stages for the number of active mines in the 0–20 km and 21–150 km bands yield F-statistics that are comfortably above 10 (column 3 and 4).<sup>24</sup> In the second stage (column 5), we replicate both the strong adverse effects in the 0–20 distance band and the strong beneficial effects in the wider 21–150 band.<sup>25</sup>

In sum, Table 2 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 longer distance. Conditioning on the presence of any mines, we find that this effect is stronger when there are more mines. These results are in line with negative local factor reallocation effects and positive regional-spending effects. A one standard deviation increase in nearby mining increases the average business constraint by 0.4 percentage points (compared with an average of 28.8) while more distant mining activity reduces constraints by 1.7 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.

Lastly, it is important to point out that we are agnostic about the spatial range within which mines can affect firms. We therefore explored various spatial rings used in the literature.<sup>26</sup> We assess distance circles of radius 10, 20, 50, 100, 150, and 450 km. Table 3 shows positive effects on firms' constraints up to 20 km (that is, a deterioration of the business environment) after which the sign switches to negative effects (an improvement) up to 150 km. After 150 km the effects become very small and insignificant. This is visualized in the graph on the left-hand side of Fig. 2 in which each point represents a separate regression. 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 bands show significant and economically meaningful results (see the right-hand side graph in Fig. 2 in which each panel is the result of a single regression). Our results are robust to redefining these two distance bands by reducing or expanding them by 10%.

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

Our hypotheses I and II state that local mining activity affects tradeable and non-tradeable sectors in different ways. 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*).

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 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 Ellison and Glaeser's 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  $s_{sd}$  is the share of industry  $s$ 's employment in region  $d$  and  $x_d$  the share of aggregate employment in region  $d$ :

$$G_s = \sum_d (s_{sd} - x_d)^2$$

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

$$H_s = \sum_f z_{sf}^2$$

<sup>22</sup> As regions we use the highest administrative level in each country, such as states in Brazil and Mexico (*estado*), regions in Chile (*región*), mainland provinces in China, oblasts in Kazakhstan and Ukraine, and federal subjects in Russia.

<sup>23</sup> Some metals tend to occur in smaller quantities than others such that a high price per metric ton on the world market has a larger effect on larger (and thus more valuable) deposits. For instance, a typical lead mine only produces 1 Mt. of ore per year while the average copper mine produces 14.5 Mt.

<sup>24</sup> 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.

<sup>25</sup> These IV results are robust to multi-way clustering by country-sector-year and by region.

<sup>26</sup> Kotsadam and Tolonen (2016) and Benschaul-Tolonen (2019) 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 (2016) use a 20 km radius to study agricultural productivity near African gold mines while Van der Goltz and Barnwall (2018) 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 et al. (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., 2016 and Allcott and Keniston, 2018).



**Table 3**  
Average business constraints as a function of mines at varying distances from firms.

	$s = 10$	$s = 20$	$s = 50$	$s = 100$	$s = 150$	$s = 450$	$s = 20$	$s = 20$	$s = 20$
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
$N_s$ active mines within $s$ km	0.474* (0.254)	0.155** (0.076)	-0.064+ (0.044)	-0.068*** (0.025)	-0.072** (0.032)	0.003 (0.007)	0.163** (0.080)	0.226*** (0.063)	0.226*** (0.083)
$N_s$ active mines 21–150 km							-0.081*** (0.023)	-0.111** (0.047)	-0.111* (0.061)
$N_s$ active mines 151–450 km							0.013 (0.011)		
Region-Sector-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	CSY	CSY	CSY	CSY	CSY	CSY	CSY	CSY	CSY + R
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for inactive mines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	25,651	25,651	25,651	25,651	25,651	25,651	25,651	25,651	25,651
R-squared	0.355	0.355	0.355	0.356	0.357	0.355	0.357	0.357	0.357

Notes: This table shows OLS regressions to estimate the impact of local mining activity, measured at varying distances from firms, on firms' average business constraints. Robust standard errors are clustered by country-sector-year (CSY), and in column 9 also by region (R), and shown in parentheses. \*\*\*, \*\*, \*, + correspond to the 1%, 5%, 10%, and 15% level of significance, respectively. All specifications include region-sector-year fixed effects, firm controls (size, age, international exporter, and ownership), controls for inactive mines measured within the same distance from firms as the number of active mines, and a dummy for whether a mine of any status exists in the administrative region of the firm. Constant included but not shown. Table 1 contains summary statistics and Appendix Table A1 contains variable definitions and data sources.

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

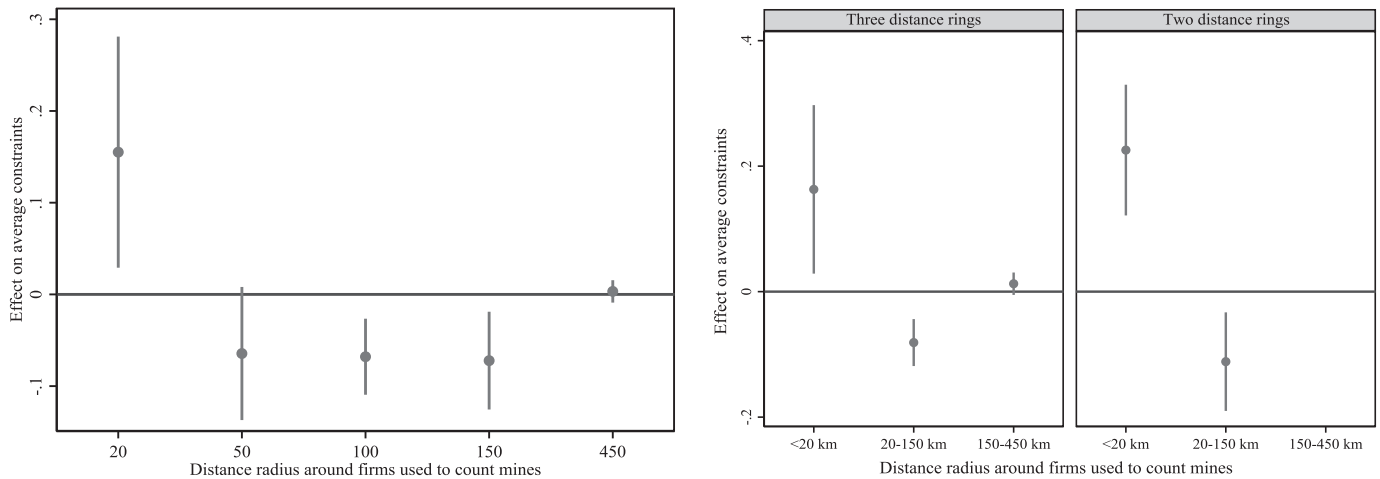
$$\gamma_s = \frac{G_s - \left(1 - \sum_d x_d^2\right) H_s}{\left(1 - \sum_d x_d^2\right) (1 - H_s)}$$

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)  $\gamma_s$  approaches  $G_s / (1 - \sum_d x_d^2)$  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  $\gamma_s$  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-year distribution.

When we compare both classification methods, the overall differences are limited. Firms in construction and natural resources never change sector by definition. At the margin, different methodologies cause some firms to switch between tradeable and non-tradeable status, but the differences in terms of sample size by classification are minimal. We note that the average index value of the Ellison-Glaeser index is close to zero (-0.298) for tradeable sectors, but much more negative (-2.164) for the non-tradeable sectors, indicating more dispersion.

In Table 4 we use our baseline classification based on Mian and Sufi (2014), except for column 3 where we use the Ellison and Glaeser (1997) classification. Using either split, we find that only traded firms, which take world or national output prices as a given, suffer from nearby mining while natural resource and non-traded firms benefit. These opposite impacts are consistent with the predictions of Corden and Neary (1982) and our discussion in Section 2. The precision of the estimates for non-tradeables varies depending on the type of fixed effects we include. The baseline effect on tradeable firms is strong throughout.



**Fig. 2.** Local mining and business constraints: Distance decay. These graphs show correlations between local mining activity (measured as  $N_s$  active mines) and the average business constraints as perceived by nearby firms. The left-hand graph shows the estimated coefficients from separate regressions (see Table 3) where  $N_s$  active mines counts all mines within a circle with a radius of 20, 50, 100, 150 or 450 km around individual firms. The right-hand graph shows the estimated coefficients when using three distance rings (<20 km, 20–150 km, 150–450 km) or two distance rings (<20 km and 20–150 km) simultaneously in one regression. Vertical lines depict 90% confidence bands. All specifications include region-sector-year fixed effects, firm controls (size, age, international exporter, and ownership), controls for inactive mines measured within the same distance from firms as the number of active mines, and a dummy for whether a mine of any status exists in the administrative region of the firm.

**Table 4**  
Local mining and business constraints: Sector heterogeneity.

Dependent variable →	Interaction with ↓	Average business constraints					Principal component main business constraints	Average main business constraints	Average business constraints		
									Regional split		
		Ellison-Glaeser index		Excl. firms age < 4					Mines inside region	Mines outside region	F-test
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	
No active mines 0–20 km	x Traded	0.528*** (0.114)	0.339*** (0.095)	0.301*** (0.097)	0.339*** (0.108)	0.296** (0.112)	0.016** (0.008)	0.406** (0.175)	0.300* (0.172)	1.395*** (0.288)	18.88***
	x Construction	-0.596+ (0.383)	-0.356 (0.435)	-0.357 (0.438)	-0.356+ (0.220)	-0.462*** (0.155)	-0.009 (0.013)	-0.166 (0.291)	-1.139** (0.545)	0.664 (0.914)	2.19
	x Non-traded	-1.183** (0.496)	-1.103 (0.912)	-0.672*** (0.143)	-1.103 (0.882)	-1.287 (0.986)	-0.058 (0.044)	-1.433 (1.118)	-1.568*** (0.441)	0.284 (0.406)	7.42***
	x Natural resources	-0.246*** (0.030)	0.048 (0.041)	0.044 (0.040)	0.048 (0.137)	0.105 (0.129)	0.006+ (0.004)	0.050 (0.115)	-0.233*** (0.056)	-0.248 (0.192)	0.00
No active mines 21–150 km	x Traded	-0.114 (0.111)	-0.147** (0.058)	-0.142** (0.058)	-0.147* (0.085)	-0.149* (0.084)	-0.006** (0.003)	-0.163** (0.076)	-0.288*** (0.079)	-0.085 (0.090)	7.81***
	x Construction	-0.231+ (0.150)	-0.131 (0.290)	-0.123 (0.287)	-0.131 (0.290)	-0.138 (0.295)	-0.008 (0.011)	-0.181 (0.281)	-0.423** (0.163)	-0.158 (0.184)	1.00
	x Non-traded	-0.039 (0.103)	0.006 (0.113)	0.036 (0.121)	0.006 (0.131)	-0.000 (0.133)	0.001 (0.007)	0.029 (0.165)	-0.143* (0.076)	-0.004 (0.124)	0.86
	x Natural resources	-0.279*** (0.095)	-0.187*** (0.060)	-0.182*** (0.060)	-0.187*** (0.058)	-0.149* (0.081)	-0.008*** (0.002)	-0.206*** (0.049)	-0.322*** (0.090)	-0.260** (0.123)	0.47
Country-Sector-Year FE	Yes	No	No	No	No	No	No	Yes			
Region-Sector-Year FE	No	Yes	Yes	Yes	Yes	Yes	Yes	No			
Clustering	CSY	CSY	CSY	CSY + R	CSY + R	CSY + R	CSY + R	CSY			
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Controls for inactive mines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Observations	24,435	24,340	24,354	24,340	22,956	23,749	24,336	24,435			
R-squared	0.270	0.363	0.353	0.363	0.368	0.361	0.350	0.272			

Notes: This table shows OLS regressions to estimate the impact of local mining activity on firms' business constraints. All columns include country-sector-year fixed effects except for columns 2–7 which include region-sector-year fixed effects. Robust standard errors are clustered by country-sector-year (CSY) in all columns except columns 4–7 where they are clustered by both country-sector-year and region (R). In column 3, sectors are classified using Ellison and Glaeser (1997) so that (non-)tradeables are defined according to their geographical concentration. The index is a measure of excess concentration with respect to a random distribution of sectors across space, where excess concentration may either reflect natural advantages or agglomeration economies. Column 5 is based on a sample of firms that are at least four years old. In columns 6 (7), the dependent variable is the principal component (average) of the five business constraints that were included in each survey wave and country (electricity, transport, crime, access to finance, and educated workforce). In columns 8 and 9, local mine counts are split according to whether they are inside or outside the administrative region of the firm, respectively. Column 10 shows F-statistics for a test of equal coefficients in columns 8 and 9. Standard errors are shown in parentheses. \*\*\*, \*\*, \*, + correspond to the 1%, 5%, 10%, and 15% level of significance, respectively. All specifications include firm controls (size, age, international exporter, and ownership) and controls for inactive mines in the vicinity of firms. Constant included but not shown. Table 1 contains summary statistics and Appendix Table A1 contains variable definitions and data sources.

The results show that a one standard deviation increase in the number of active mines within a radius of 20 km leads to a 0.6 percentage point increase in the average business constraints for firms in tradeable sectors. In contrast, an increase in local mining activity reduces business constraints by up to 1.9 percentage points for firms in non-tradeable sectors and by 0.6 percentage points for construction firms (see also column 1 in Table 6, where we report these marginal effects).

At a longer distance, most firm types tend to benefit from local mining activity. These effects are most precisely and robustly estimated for firms in the tradeable sector. The results in column 2 indicate that a one standard deviation increase in mining activity in the 21–150 km band leads to a decline in business constraints of 2.2, 2.0 and 1.3 percentage points for firms in the traded, construction and natural resource sectors, respectively.

In column 5, we limit the sample to firms that are at least four years old. This should mitigate worries that the location of firms is endogenous to (recent changes in) mining activities. Our results hold up well. In Tables 5 and 7 we will address this issue more directly by using panel data that allow for the inclusion of firm fixed effects.

In columns 6 and 7, we provide two robustness tests regarding the construction and scaling of the business constraint variables. In column

6, we take the principle component of the five main business constraints<sup>27</sup> whereas in column 7 we take the simple average. Questions on these main constraints—electricity, transport, crime, access to finance, and educated workforce—were included in each survey wave and each country. Importantly, with the exception of the 2005 wave in Kazakhstan, Russia and Ukraine, these questions were also consistently asked on a 5-point scale. In both columns the main results hold up well: in the immediate vicinity of mines, tradeable-sector firms suffer whereas at a larger distance tradeable-sector firms as well as firms in the natural-resource sector are less constrained.

Lastly, and importantly, in columns 8 and 9 we split the mine count near firms according to whether mines are inside (8) or outside (9) the administrative region in which the firm is located. The stark heterogeneity in the effects of mining activity on firms in different sectors and at different distances is clearly visible for mines that are located within the firm's administrative region itself. Column 10 provides an F-test for the equality of the estimated coefficients for the effect of mines that are within the firm's region and mines that are near but outside the firm's administrative region. Within the 20 km circle, we find two important effects. First, traded firms are not only negatively affected by nearby

<sup>27</sup> We apply the iterated principal factor method and keep the first factor only.

**Table 5**  
Local mining, business constraints and firm performance.

Dependent variable →	1st stage	2nd stage					
	Average business constraints	Employment (ln)			Employment (ln)		
Sample →		All	Exclude 5% largest firms	Exclude 5% largest firms and Traded only	All	Exclude 5% largest firms	Exclude 5% largest firms and Traded only
Data type →	[1]	Cross-sectional data			Panel data		
		[2]	[3]	[4]	[5]	[6]	[7]
		−0.027**	−0.033**	−0.012***	−0.004	−0.003	−0.030***
		(0.012)	(0.016)	(0.001)	(0.022)	(0.022)	(0.006)
N <sub>e</sub> active mines 0–20 km	x Traded	0.335*** (0.109)					
	x Construction	−0.347+ (0.214)					
	x Non-traded	−1.088 (0.882)					
	x Natural resources	0.024 (0.127)					
N <sub>e</sub> active mines 21–150 km	x Traded	−0.139+ (0.086)					
	x Construction	−0.120 (0.280)					
	x Non-traded	0.008 (0.120)					
	x Natural resources	−0.159** (0.059)					
Region-Sector-Year FE Clustering	Yes CSY + R	Yes CSY + R	Yes CSY + R	Yes CSY + R	Yes CSY + R	Yes CSY + R	Yes CSY + R
Firm FE	No	No	No	No	Yes	Yes	Yes
Firm and inactive mine controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,417	24,252	22,587	17,906	588	574	362
N <sub>e</sub> clusters, smallest dimension	49	49	49	13	24	24	6
Kleibergen-Paap F-statistic		5.294	12.48	12.48	–	–	–
Hansen J-test p-value		0.263	0.392	0.392	–	–	–

Notes: This table shows 2SLS regressions to estimate the impact of local mining activity on firm performance. Columns 5–7 show panel regressions with firm fixed effects based on a subset of firms that were surveyed in at least two years. Robust standard errors are shown in parentheses and clustered by country-sector-year (CSY) and by region (R). \*\*\*, \*\*, \*, + correspond to the 1%, 5%, 10%, and 15% level of significance, respectively. All specifications include region-sector-year fixed effects, firm controls and controls for inactive mines in the vicinity of firms. Constant included but not shown. Table 1 contains summary statistics and Appendix Table A1 contains variable definitions and data sources.

mines in their own region but even more so by nearby mines 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 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 whereas nearby mines just *outside* the administrative boundary have no impact or even hurt non-traded firms (the coefficient is positive but imprecisely estimated). A likely reason for these contrasting effects on traded and non-traded sector firms is that nearby mines just outside the firm's administrative region do not contribute to a spending effect through the government of the region where the firm is located, but nevertheless add to competition for inputs and for access to scarce infrastructure. In other words, the competition effect transcends administrative borders, while the spending effect does not.

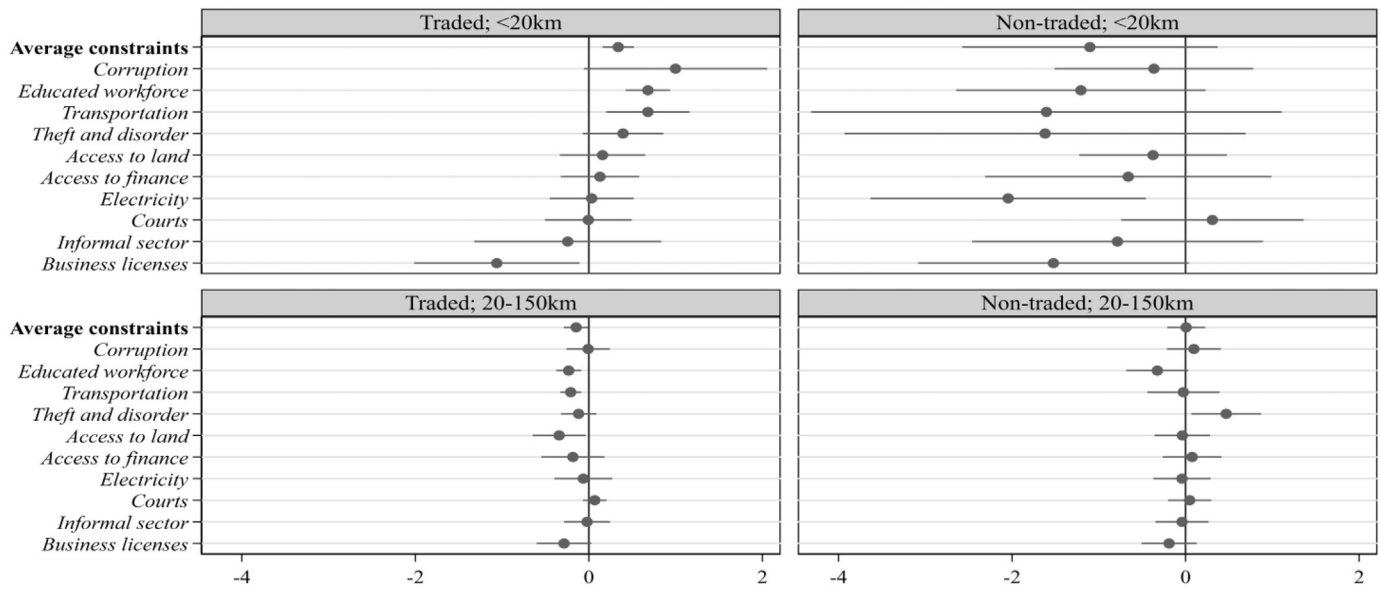
Next we unpack the average business constraint variable to understand *how* local mining affects firms in different sectors. To get at the underlying mechanisms, Fig. 3 disaggregates the firm impacts by showing both point estimates (dots) and 90% confidence intervals (horizontal lines) from OLS regressions to estimate the impact of local mining on business constraints in tradable (left) and non-tradable (right) sectors. The top-left graph shows that tradeable-sector firms mainly experience tighter constraints related to increased corruption, problematic access to qualified employees, and transport infrastructure. In line with recent findings by Couttenier et al. (2017) and Berman et al. (2017) there is also a small increase in crime. The upper right chart of Fig. 3 shows some

quite large beneficial effects of nearby mines on non-traded firms, which underlie the aggregate constraint impacts in Table 4. However, only few of these individual effects are estimated precisely. Non-tradeable firms report the clearest improvements in their access to electricity and to an educated workforce.

The beneficial (though generally smaller) effects of mining at a larger distance manifest themselves mainly in the form of fewer problems in accessing inputs. This is due to better access to an educated workforce, better infrastructure, and better access to land (Fig. 3, bottom left graph). The infrastructure results suggest that governments in our country sample use natural resource revenues to invest in regional public infrastructure, in line with some of the examples given in Section 1. Finally, it is possible that there are unmeasured positive local effects if the informal sector supplies services to mines. However, the results for the business constraint “informal sector competition” suggest that informal activity does not become more prevalent when mines open. If anything, the negative coefficients suggest a reduction in such competition.

### 5.3. Real effects

An important empirical question is whether the impact of mining on business constraints also translates into measurable effects on firm performance. Commander and Svejnar (2011, henceforth CS) examine the impact of local business constraints on firms 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



**Fig. 3.** Local mining and individual business constraints. These graphs depict the point estimates (dots) and 90% confidence intervals (horizontal lines) from OLS regressions to estimate the impact of local mining activity on firms' business constraints in tradable (left) and non-tradable (right) sectors. In the underlying regressions, robust standard errors are clustered by country-sector-year and by region and all specifications include region-sector-year fixed effects, firm controls (size, age, international exporter, and ownership), controls for inactive mines in the vicinity of firms, and a dummy for whether a mine of any status exists in the administrative region of the firm. Table 1 contains summary statistics and Appendix Table A1 contains variable definitions and data sources.

countries and hence conclude that country-level institutions (and other characteristics) are responsible for holding back firms.

To assess the relation between business constraints and firm performance, we use a 2SLS approach. 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 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 mining regions. It also reduces concerns about measurement error and cultural biases in self-reported statistics.

We focus on firm performance as measured by total employment (and control for other firm characteristics). Alternative measures such as sales are only available for a small subset of firms that report these numbers (for instance, the 2005 survey wave did not include questions about assets or sales in China, Kazakhstan, Russia and Ukraine). In

**Table 6**  
Marginal effect of a one standard deviation increase in mining.

	Interaction with ↓	Average constraints	Employment
		[1]	[2]
N <sub>e</sub> active mines 0–20 km	All sectors	0.4	–1.2%
	x Traded	0.6	–1.9%
	x Construction	–0.6	1.9%
	x Non-traded	–1.9	6.0%
	x Natural resources	0.1	–0.3%
N <sub>e</sub> active mines 21–150 km	All sectors	–1.7	5.2%
	x Traded	–2.2	6.9%
	x Construction	–2.0	6.1%
	x Non-traded	0.1	–0.3%
	x Natural resources	–1.3	4.1%

Notes: This table shows marginal effects of a one standard deviation increase in mining by main sector types. Coefficients for column 1 are taken from Table 2 column 8 ('All sectors') and Table 4 column 5 ('by sector'). Coefficients for column 2 are taken from Table 5 column 2.

Table 7, we will also assess the impact of local mining on firm-level employment using data from Orbis.

Table 5 provides our results while column 2 in Table 6 summarizes the related marginal effects. Column 1 in Table 5 reports the first-stage regression, which also includes interaction terms between local mining activity and the four main economic sectors. The specification again contains region-sector-year fixed effects and our standard firm-level covariates. We exclude firm size as it is likely a "bad control" that is affected by mining activity itself. As before, we find that mining activity in a 21–150 km band around firms reduces average business constraints for firms whereas mining in the immediate vicinity (<20 km) hurts firms in tradeable sectors. Local mining activity is overall a strong predictor of average business constraints. This is confirmed by the generally strong first stage F-test on the excluded instruments. 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 on the average of reported constraints (columns 2–7).<sup>28</sup> Here too, we include firm covariates related to ownership and age and saturate the model with region-sector-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 both national institutions and regional characteristics.

The results in columns 2–4 show that predicted business constraints reduce employment and that the effect is economically significant: a one standard deviation increase in local mining activity reduces employment by 1.5%.<sup>29</sup> Of course the exclusion restriction may not hold completely: for some firms mining activity might have a direct effect on demand and hence employment. We therefore also show sub-

<sup>28</sup> 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.

<sup>29</sup> 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 2 and 4, 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 the endogeneity of firms' demand for inputs in the sense that more productive firms need more inputs and thus feel more constrained.

samples where we drop firms for which the risk of an invalid exclusion restriction is the highest: large firms and non-tradeable firms. Excluding the largest firms also disregards firms that are likely to be less sensitive to the local business environment. The results show that when we exclude the 5% largest firms (column 3) and non-traded firms (column 4) our results go through.<sup>30</sup>

While our main data set consists of repeated but independently sampled rounds of cross-sectional survey data, about 5% of all firms were interviewed at least twice (in separate survey rounds) in Chile, Kazakhstan, Mexico, Russia and Ukraine. We can use this panel to observe the same firms at different points in time and to compare firms that experienced an increase in local mining activity with 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. It also helps to assuage concerns about endogenous location choice of (certain types of) firms.

Columns 5 to 7 in Table 5 show the second-stage results. Note that this sample is much smaller (588 observations versus 24,252) and covers only 24 region-year-sectors versus 49 when using the repeated cross-sections. This is partly due to dropping 'singleton' observations where only one firm is observed in a region-sector-year cell. Nevertheless, we continue to find negative effects although these are only estimated with precision when we again exclude the largest firms and focus on the tradeable sector (column 7). It is reassuring that when using this much smaller panel data set, we find negative impacts of mining-related business constraints on firm growth that are similar in size and statistical significance as those derived from the cross-sectional regressions in the previous columns.

An obvious limitation of the panel regressions in columns 5–7 of Table 5 is that they are based on small samples (less than a thousand observations). We therefore now move to comprehensive firm-level panel data from Orbis. We download all firms that are present in Orbis for our nine sample countries and geocode the addresses for firms that exist (that is, report data) for at least two years during our sample period. We have to exclude Chile, India, Indonesia and Kazakhstan for lack of coverage. We drop micro firms and instead focus on enterprises with at least ten employees to maximize comparability with the BEEPS sample (and its firm-size distribution). We further need to restrict the sample to those firms for which we know the status of nearby mines in at least two years such that the coefficients can be interpreted as difference-in-difference estimates. This strategy nevertheless dramatically increases our sample size as we can now measure employment for over 100,000 firms for an average of 5 years.

In our panel regressions we can again include region-sector-year fixed effects as well as firm fixed effects, effectively measuring the impact of mining by comparing one and the same firm before and after mines open in its direct or wider vicinity. An important limitation of Orbis is that these are not survey data and we therefore no longer have access to firms' own perceptions about the main business constraints. We thus move to a specification where we directly link local mining activity to firm-level employment.

Table 7 provides the results. Fully in line with the results based on the Enterprise Survey/BEEPS data set, we find robustly that in the direct vicinity of mines, tradeable firms are negatively affected. A one standard deviation increase in local mining activity is associated with 5.1 percentage point lower employment for the typical tradeable-sector firm. In contrast, firms in non-traded sectors as well as firms upstream or downstream to mines expand employment. The effect for (downstream) natural resource sector firms is especially large. However, this appears driven by the largest firms in our data, because the coefficient no longer can be estimated once we drop the

**Table 7**

Local mining, business constraints and firm performance: ORBIS panel data.

Dependent variable →		Employment (ln)		
Sample →		All	Exclude 5% largest firms	Exclude 5% largest firms and Traded only
		[1]	[2]	[3]
No active mines 0–20 km	x Traded	−0.032 (0.026)	−0.034** (0.014)	−0.034** (0.014)
	x Construction	0.004 (0.050)	0.018 (0.033)	
	x Non-traded	0.024** (0.011)	0.030*** (0.010)	
	x Natural resources	0.646* (0.337)	–	
No active mines 21–150 km	x Traded	0.009* (0.005)	0.010** (0.004)	0.010** (0.004)
	x Construction	−0.001 (0.007)	0.005 (0.004)	
	x Non-traded	0.015*** (0.005)	0.017*** (0.005)	
	x Natural resources	−0.043** (0.021)	−0.052*** (0.020)	
Observations	328,615	300,159	126,596	
R-squared	0.938	0.897	0.898	
No clusters	112	107	28	
Firm FE	Yes	Yes	Yes	
Region-Sector-Year FE	Yes	Yes	Yes	
Clustering	CSY + R	CSY + R	CSY + R	
Firm and inactive mine controls	Yes	Yes	Yes	

Notes: This table shows OLS panel regressions, using a sample of firms on which information is available in ORBIS, to estimate the impact of two-year lagged local mining activity on firm employment. Robust standard errors are shown in parentheses and clustered by country-sector-year (CSY) as well as by region (R). \*\*\*, \*\*, \*, + correspond to the 1%, 5%, and 10% level of significance, respectively. All specifications include region-sector-year fixed effects and firm controls (exporter status, legal form dummy and a dummy for listed firms). Constant included but not shown. Table 1 contains summary statistics and Appendix Table A1 contains variable definitions and data sources.

5% largest firms. This also improves the standard error for the coefficient of tradeable sector firms.

In the 21–150 distance band from firms, we find significant positive effects for tradeable-sector firms, reflecting the robustness of the previous results based on the survey data. Non-traded sector firms still benefit but to a lesser degree. The only difference with the survey results is that the natural resource sector no longer benefits at the wider distance band.

Overall, also in this large panel sample, we find that negative effects of mining are local and decay with distance, while positive spending effects have measurable and significant effects at a wider geographical scope.

#### 5.4. Robustness: clustering standard errors

Our baseline approach is to double cluster standard errors at both the country-sector-year and the regional level. In Appendix Table A5, we show that our baseline results—here replicated in column 1—are robust to alternative clustering methods. In columns 2 and 3, we cluster by country-sector-year and by country-year, respectively. In column 4, we divide all region-year-sectors into cells with mining versus cells without mining and cluster standard errors within each group. In column 5, we cluster at regions defined by grids of 5 by 5 degrees (550 by 550 km). The grids are defined within country borders. Lastly, we cluster standard errors by country-sector-year and by region year (column 6), by country-

<sup>30</sup> Top-5% firms have on average 4,700 employees and the largest ten firms have over 50,000 employees each, whereas the median firm in our dataset has 100 employees.

sector and region (column 7), or by sector-year and region (column 8). In all cases, our results are precisely estimated.

### 5.5. Robustness: cross-country heterogeneity

Since our data set spans nine very different countries, we investigate in Appendix Table A6 whether our main results—a negative impact of local mining on nearby tradeable firms that contrasts with a beneficial impact on more distant firms—are stronger in some countries as compared to others. To do so, we rerun our baseline regression nine times, each time leaving out one of our sample countries. The size of the estimated impacts may differ across countries for a variety of reasons. These include geographical differences that make our standard distance bands less applicable (as distance decay differs) and the size of the administrative units over which distribution (if any) of mineral revenues takes place.

We find that our baseline regressions are remarkably robust across countries and are not dependent on the inclusion of any one country. When we exclude China, we find more precisely estimated negative effects (that is, improved business constraints) for non-tradeable firms in the 0–20 km distance band as well as more significant negative effects (again, business environment improvements) for tradeable sector firms in the wider ring. Overall, Table A6 therefore indicates that while the strength of our results differs across countries, both the negative short-distance and positive long-distance mining impacts are remarkably common across countries (with both effects less strong in China).

### 5.6. 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 (2011) who reports both the geographic coordinates and the size of 996 giant onshore and offshore oil and gas fields (with a minimum pre-extraction size of 500 million barrels of oil equivalent), of which 293 were discovered in our sample of countries.<sup>31</sup>

In Appendix Table A7 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. While there are on average 0.5 mines within 20 km of a firm, there are only 0.01 oil and gas fields within that distance. In fact, no firms in Brazil, Chile, Kazakhstan, or Mexico have any fields within 20 km. This suggests that most fields are in remote regions and that the negative effect is driven by very few observations.

<sup>31</sup> Oil, condensate and gas are summed using a factor of 1/0.006 to convert gas trillion cubic feet to oil equivalent million barrels.

## 6. Conclusions

We estimate the local impact of mining activity on the business constraints of 25,777 firms in nine resource-rich countries. We exploit spatial variation in local mining activity within these countries to facilitate 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 strong but heterogeneous impacts that differ by sector and distance. We show first of all 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. Importantly, 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 tradeable-sector firms and they generate less employment. In sharp contrast, firms in the services sector and in upstream and downstream natural resource sectors benefit from local mining.

In line with our theoretical priors, our results provide evidence for negative-factor reallocation effects in the immediate vicinity of mines while we document broad-based net positive effects at a greater distance. 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. This automatically leads to the question about the overall, general-equilibrium effects at the country level. While our methodology and empirical findings provide insights into the (heterogeneous) within-country effects of mining, it is not straightforward to extrapolate from these effects to aggregate impacts at the country level. In that sense, our findings have little to say about whether natural resources are a curse or a blessing at the country level.

Making an informed statement about the general-equilibrium effects of mining would require a quantitative spatial equilibrium model. Such a model, calibrated with key moments based on our microdata, would then put empirical structure on the main channels at work and provide a comprehensive framework to assess how the local negative effects on tradeables interact with more positive effects at a larger geographic scale and, finally, nominal exchange rate appreciation effects at the national level. Such an analysis would also need to account for longer-term labor mobility across regions within countries and for input-output linkages (and the associated spill-overs) between non-tradeable and tradeable sectors (and the mining sector in particular).<sup>32</sup> We leave this as an important and promising avenue for future research.

From a public policy perspective, our results suggest that to minimize localized negative effects on the business environment, policy makers should ensure that local firms can share the infrastructure that is privately built as part of the exploitation process. Already when negotiating infrastructure contracts, authorities can request that new infrastructure will allow for multiple uses and users. This may reduce the infrastructure bottlenecks and congestion effects that are apparent in our 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 spill-overs, policy-makers can also help firms to become fit to supply local mining-related supply chains. These measures can help meet the

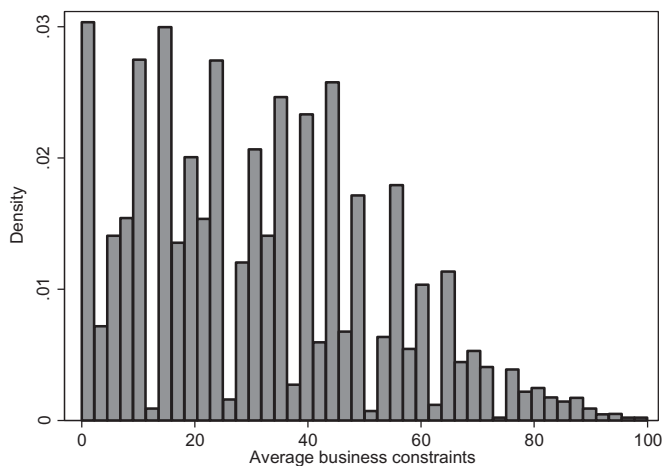
<sup>32</sup> Building on Allen and Arkolakis (2014) and Redding (2016), Faber and Gaubert (2019) develop such a model to assess the aggregate effects of Mexico’s ‘natural resources’—that is, its white beaches and archaeological sites—on tourism and the country’s wider economic development.

preconditions for a resource boom to trigger agglomeration and positive long-term impacts.

## Acknowledgments

The authors thank Martin Acht, Francesca Dalla Pozza, Oana Furtuna, Alex Stepanov, and Teodora Tsankova for excellent research assistance and the Editor (Andres Rodriguez), two anonymous referees, Simon Commander, Sergei Guriev, Beata Javorcik, Juan Pablo Rud, Helena Schweiger, Pablo Selaya, Paul Pelzl, Rick van der Ploeg, Pierre-Louis Vezina, Yuanyuan Yi and participants at the World Bank-OxCarre-Natural Resource Governance Institute Workshop on the Sub-National Resource Curse, the 2016 CSAE Conference (Oxford), the European Association of Environmental and Resource Economics Conference (Zürich), the 31st Annual Congress of the European Economic Association (Geneva), DEGIT XXI in Nottingham, the Dutch Economists Day 2016, and seminars at the Tinbergen Institute, Vrije Universiteit Amsterdam, EBRD, Norwegian School of Economics, University of Oxford, University of Sydney, University of Auckland, University of St. Andrews, and the Federal Reserve Bank of Dallas for useful comments. The views expressed are those of the authors and not necessarily of the institutions they are affiliated with.

## 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.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?

## Appendix C. . Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jinteco.2019.01.006>.

## References

- Allcott, H., Keniston, D., 2018. Dutch disease or agglomeration? The local economic effects of natural resource booms in modern America. *Rev. Econ. Stud.* 85 (2), 695–731.
- Allen, T., Arkolakis, C., 2014. Trade and the topography of the spatial economy. *Q. J. Econ.* 129 (3), 1085–1139.
- Aragón, F.M., Rud, J.P., 2013. Natural resources and local communities: evidence from a Peruvian gold mine. *Am. Econ. J. Econ. Pol.* 5 (2), 1–25.
- Aragón, F.M., Rud, J.P., 2016. Polluting industries and agricultural productivity: evidence from mining in Ghana. *Econ. J.* 126 (597), 1980–2011.
- Arezki, R., Bhattacharyya, S., Mamo, N., 2015. Resource Discovery and Conflict in Africa: What Do the Data Show?. CSAE Working Paper No WPS/2015–14. Centre for the Study of African Economies, University of Oxford, Oxford.
- Asher, A., Novosad, P., 2018. Rent-Seeking and Criminal Politicians: Evidence from Mining Booms', Mimeo.
- Auty, R.M., 2001. *Resource Abundance and Economic Development*. Oxford University Press, Oxford, UK.
- Bah, E.H., Fang, L., 2015. Impact of the business environment on output and productivity in Africa. *J. Dev. Econ.* 114, 159–171.
- Banerjee, A., Duflo, E., Qian, N., 2012. On the Road: Access to Transport Infrastructure and Economic Growth in China (NBER Working Paper No 17897).
- Beck, T., Laeven, L., 2006. Institution building and growth in transition economies. *J. Econ. Growth* 11, 157–186.
- Beck, T., Demirgüç-Kunt, A., Maksimovic, V., 2005. Financial and legal constraints to growth: does firm size matter? *J. Financ.* 60 (1), 131–177.
- Benshaul-Tolonen, A., 2019. Local industrial shocks and infant mortality. *Econ. J.* (forthcoming).
- Berman, N., Couttenier, M., Rohner, D., Thoenig, M., 2017. This mine is mine! How minerals fuel conflicts in Africa. *Am. Econ. Rev.* 107 (6), 1564–1610.
- Besley, T., Persson, T., 2010. State capacity, conflict and development. *Econometrica* 78 (1), 1–34.
- Black, D., McKinnish, T., Sanders, S., 2005. The economic impact of the coal boom and bust. *Econ. J.* 115 (503), 449–476.
- Bonfatti, R., Poelhekke, S., 2017. From mine to coast: transport infrastructure and the direction of trade in developing countries. *J. Dev. Econ.* 127, 91–108.
- Brezis, E.S., Krugman, P.R., 1996. Immigration, investment, and real wages. *J. Popul. Econ.* 9 (1), 83–93.
- Brollo, F., Nannicini, T., Perotti, R., Tabellini, G., 2013. The political resource curse. *Am. Econ. Rev.* 103 (5), 1759–1796.
- Carlin, W., Schaffer, M.E., Seabright, P., 2010. A Framework for Cross-Country Comparisons of Public Infrastructure Constraints on Firm Growth', CEPR Discussion Paper No. 7662. Centre for Economic Policy Research, London.
- Caselli, F., Michaels, G., 2013. Do oil windfalls improve living standards? Evidence from Brazil. *Am. Econ. J. Appl. Econ.* 5 (1), 208–238.
- Chandra, A., Thompson, E., 2000. Does public infrastructure affect economic activity? Evidence from the rural interstate highway system. *Reg. Sci. Urban Econ.* 30 (4), 457–490.
- Chinitz, B., 1961. Contrasts in agglomeration: New York and Pittsburgh. *Am. Econ. Rev. Pap. Proc.* 51 (2), 279–289.
- Collier, P., Hoeffler, A., 2004. Greed and grievance in civil war. *Oxf. Econ. Pap.* 56, 563–595.
- Collier, P., Laroche, C., 2015. Harnessing Natural Resources for Inclusive Growth', IGC Growth Brief Series 001. March, International Growth Centre, London.

- Combes, P.-P., Gobillon, L., 2015. The empirics of agglomeration economies. In: Duranton, G., Henderson, J.V., Strange, W.C. (Eds.), *Handbook of Regional and Urban Economics*. Vol. 5. Elsevier, Amsterdam, pp. 247–348 Chapter5.
- Commander, S., Svejnar, J., 2011. Business environment, exports, ownership, and firm performance. *Rev. Econ. Stat.* 93 (1), 309–337.
- Corden, W.M., Neary, J.P., 1982. Booming sector and de-industrialization in a small open economy. *Econ. J.* 92, 825–848.
- Correia, S., 2016. A Feasible Estimator for Linear Models with Multi-Way Fixed Effects', Mimeo.
- Couttenier, M., Grosjean, P., Sangnier, M., 2017. The wild west is wild: the homicide resource curse. *J. Eur. Econ. Assoc.* 15 (3), 158–585.
- Cust, J., 2015. The Spatial Effects of Resource Extraction: Mining in Indonesia. Oxcarré Discussion Paper. University of Oxford.
- Cust, J., Poelhekke, S., 2015. The local economic impacts of natural resource extraction. *Ann. Rev. Resour. Econ.* 7.
- Dell, M., 2010. The persistent effects of Peru's mining mita. *Econometrica* 78 (6), 1863–1903.
- van der Ploeg, F., 2011. Natural resources: curse or blessing? *J. Econ. Lit.* 49 (2), 366–420.
- van der Ploeg, F., Poelhekke, S., 2010. The pungent smell of "red herrings": subsoil assets, rents, volatility and the resource curse. *J. Environ. Econ. Manag.* 60 (1), 44–55.
- Dethier, J.-J., Hirm, M., Straub, S., 2011. Explaining enterprise performance in developing countries with business climate survey data. *World Bank Res. Obs.* 26 (2), 258–309.
- Dollar, D., Hallward-Driemeier, M., Mengistae, T., 2006. Investment climate and international integration. *World Dev.* 34 (9), 1498–1516.
- Donaldson, D., 2018. Railroads of the Raj: estimating the impact of transportation infrastructure. *Am. Econ. Rev.* 108 (4–5), 899–934.
- Dube, O., Vargas, J.F., 2013. Commodity price shocks and civil conflict: evidence from Colombia. *Rev. Econ. Stud.* 80 (4), 1384–1421.
- Eggert, R.G., 2001. Mining and Economic Sustainability: National Economies and Local Communities', MMSD Report № 19, Mining, Minerals and Sustainable Development, Colorado School of Mines.
- Ellison, G., Glaeser, E.L., 1997. Geographic concentration in U.S. manufacturing industries: a dartboard approach. *J. Polit. Econ.* 105 (5), 889–927.
- Faber, B., 2014. Trade integration, market size and industrialization: evidence from China's national trunk highway system. *Rev. Econ. Stud.* 81 (3), 1046–1070.
- Faber, B., Gaubert, C., 2019. Tourism and economic development: evidence from Mexico's coastline. *Am. Econ. Rev.* (forthcoming).
- Fafchamps, M., Koelle, M., Shilpi, F., 2017. Gold mining and proto-urbanization. Recent evidence from Ghana. *J. Econ. Geogr.* 17 (5), 975–1008.
- Glaeser, E.L., Kerr, S.P., Kerr, W.R., 2015. Entrepreneurship and urban growth: an empirical assessment with historical mines. *Rev. Econ. Stat.* 97 (2), 498–520.
- Gorodnichenko, Y., Schnitzer, M., 2013. Financial constraints and innovation: why poor countries don't catch up. *J. Eur. Econ. Assoc.* 11, 1115–1152.
- Greenstone, M., Hornbeck, R., Moretti, E., 2010. Identifying agglomeration spillovers: evidence from winners and losers of large plant openings. *J. Polit. Econ.* 118 (3), 536–598.
- Hallward-Driemeier, M., Wallstein, S.J., Xu, L.C., 2006. Ownership, investment climate and firm performance. *Econ. Transit.* 14, 629–647.
- Hirschman, A.O., 1958. *The Strategy of Economic Development*. Yale University Press, New Haven, CT.
- Hong, G., McLaren, J., 2015. Are Immigrants a Shot in the Arm for the Local Economy? (NBER Working Paper No. 21123)
- Horn, M.K., 2011. Giant fields 1868–2003 (CD-ROM). In: Halbouty, M.K. (Ed.), *Giant Oil and Gas Fields of the Decade, 1990–1999*. 78. AAPG Memoir, Houston.
- Humphreys, D., 2010. The great metals boom: a retrospective. *Res. Policy* 35, 1–13.
- James, A., 2015. The resource curse: a statistical mirage? *J. Dev. Econ.* 114 (C), 55–63.
- Johnson, S., McMillan, J., Woodruff, C., 2002. Property rights and finance. *Am. Econ. Rev.* 92 (5), 1335–1356.
- Kaufmann, D., 2002. Governance crossroads. In: *Global Competitiveness* (Ed.), Report. Oxford University Press, New York, pp. 2002–2003.
- Kotsadam, A., Tolonen, A., 2016. African mining, gender, and local employment. *World Dev.* 83, 325–339.
- Lippert, A., 2014. Spillovers of a Resource Boom: Evidence from Zambian Copper Mines. Oxcarré Working Paper. University of Oxford.
- Loayza, N., Rigolini, J., 2016. The local impact of mining on poverty and inequality: evidence from the commodity boom in Peru. *World Dev.* 84, 219–234.
- Mamonto, P., Sompie, C., Mekel, P., 2012. Sustainable development for post-closure. A case study of PT Newmont Minahasa Raya. In: Fourie, A., Tibbett, M. (Eds.), *Proceedings of the Seventh International Conference on Mine Closure*. Australian Centre for Geomechanics, Perth, pp. 279–293.
- Marshall, A., 1920. *Industry and Trade*. Macmillan, London.
- McPhail, K., 2009. The challenge of mineral wealth: Using resource endowments to foster sustainable development. In: Richards, P. (Ed.), *Mining, Society, and a Sustainable World*. Springer, Heidelberg, pp. 61–74.
- Mehlum, H., Moene, K., Torvik, R., 2006. Institutions and the resource curse. *Econ. J.* 116 (508), 1–20.
- Mian, A., Sufi, A., 2014. What explains the 2007–2009 drop in employment? *Econometrica* 82 (60), 2197–2223.
- Michaels, G., 2008. The effect of trade on the demand for skill: evidence from the interstate highway system. *Rev. Econ. Stat.* 90 (4), 683–701.
- Michaels, G., 2011. The long-term consequences of resource-based specialization. *Econ. J.* 121 (551), 31–57.
- Miguel, E., Satyanath, S., Sergenti, E., 2004. Economic shocks and civil conflict: an instrumental variables approach. *J. Polit. Econ.* 112, 725–753.
- Moretti, E., 2010. Local multipliers. *Am. Econ. Rev. Pap. Proc.* 100, 1–7.
- Moretti, E., 2011. Local labor markets. In: Ashenfelter, O., Card, D. (Eds.), *Handbook of Labor Economics* 4B, pp. 1237–1313 Chapter14.
- Otto, J., 2006. *Mining Royalties: A Global Study of their Impact on Investors, Government, and Civil Society*. World Bank, Washington D.C.
- Peters, M., 2017. *Refugees and Local Agglomeration: Evidence from Germany's Post-War Population Expulsions*, Mimeo.
- Pierre, G., Scarpetta, S., 2004. *Employment Regulations Through the Eyes of Employers: Do They Matter and How Do Firms Respond to Them?* IZA Discussion Paper No. 1414, Bonn
- Redding, S.J., 2016. Goods trade, factor mobility and welfare. *J. Int. Econ.* 101, 148–167.
- Sachs, J.D., Warner, A.M., 1997. Natural resource abundance and economic growth. In: Meier, G., Rauch, J. (Eds.), *Leading Issues in Economic Development*. Oxford University Press, Oxford.
- Von der Goltz, J., Barnwall, P., 2019. Mines. The local wealth and health effects of mining in developing countries. *J. Dev. Econ.* (forthcoming).
- van Wijnbergen, S.J.G., 1984. The 'Dutch Disease': a disease after all? *Econ. J.* 94 (373), 41–55.
- Wilson, N., 2012. Economic booms and risky sexual behavior: evidence from Zambian copper mining cities. *J. Health Econ.* 31 (6), 797–812.
- World Bank, 2002. *Treasure or Trouble? Mining in Developing Countries* Washington, D.C.
- Wright, G., Czelusta, J., 2007. Resource-based growth past and present. In: Lederman, D., Maloney, W. (Eds.), *Natural Resources: Neither Curse nor Destiny*. Stanford University Press, Stanford, CA.