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EXTRACTIVE INDUSTRIES AND LOCAL DEVELOPMENT IN THE PERUVIAN HIGHLANDS[1]

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Abstract

During the last twenty years, the mining sector in Peru has been experiencing sustained growth. Using Census, administrative, nationally and regionally representative data we compare districts in the Peruvian Highlands with a recent mining development with suitable counterfactuals. We find that the new mining activities attract migration inflows, and have some positive effects over educational indicators and these impacts, on average, are smaller in districts with lower levels of corporate social expenditure However, the results of this study suggest that the local potential welfare impact of the mining boom is largely untapped and corporate social responsibility has had a limited role in improving this effect.

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1. Introduction

Over the last twenty years, international metal prices have surged. Since the early 2000s, IMF Commodity Metals Price Index has seen a more than a three-fold increase and investments in mineral exploration in developing countries have been consistently increasing (Bebbington *et al.* 2008; Hinojosa *et al*., 2010). Moreover, metal prices are expected to remain elevated in comparison to historical standards. As a result, mineral abundant areas have increasingly hosted new mining operations (SNL Metals Economics Group [SNL MEG], 2013).

Populations in close proximity to mines are likely to enjoy the potential benefits of the mining industry: direct job creation, the construction of new infrastructure and local multiplier effects. At the same time, communities living close to mines are typically the most exposed to environmental externalities of the mining industry; they are likely to compete with mines for water and land use; they can experience economic, social and cultural repercussions from inflows of new workers. How are living standards of these communities affected by mining operations? Does mining development improve access to basic services and education for local populations? What is net impact on the structure of local economies? Does corporate social responsibility (CSR) influence impact on mining communities? This paper tries to answer these questions by studying the nexus between the mining boom and a set of local development indicators in Peru.

We have chosen to focus on Peru for its illustrative value since it is one of the countries with the highest concentration of mining activities in the world. Moreover, most mining operations are spread along the Highlands, a vast portion of national territory with relatively homogenous environmental, climatic, and socio-economic characteristics. This, in combination with good quality and widely available data, allows us to obtain a considerable sample of the size and level of comparability between mining and non-mining areas.

Our results suggest that the potential benefits of the recent mining boom on local economies are largely untapped. The recent mining boom has created labour opportunities in this sector and affected internal migration flows, but it has generated negligible spill-overs for non-mining activities. Moreover, populations living in new and non-mining areas have experienced no statistically different changes in welfare and housing conditions and in access to basic services. A set of institutional reforms and policy measures introduced since the 1990s have contributed to limiting the adverse effects of extractive industries that the country experienced in its long mining tradition, but they have been less effective in unleashing the local potential benefits of mineral resource wealth. In addition, based on our estimates, we argue that, so far, corporate social responsibility (CSR) spending has not substantially improved the effects of local mining. The results of this paper, therefore, are consistent with the interpretation of the growing climate of social tensions as a manifestation of the incongruity between the fast growth of large mining operations and the low level of resulting gains produced for local populations.

The paper is organized as follows. Section 2 presents a brief literature review about the local impacts of extractive activities. Next, in section 3, we describe recent changes in the history of the Peruvian mining sector. Section 4 develops a simple conceptual framework showing that the impacts of mining growth on local populations are theoretically ambiguous. Sections 5 and 6 present the methodology and data we use to construct a counterfactual scenario to evaluate the effect of new mining activities in Peru. Section 7 discusses the main results and Section 8 summarizes the key findings and offers our main conclusions.

2. Literature review

Numerous case studies on the local impacts of extractive activities have tried to assess whether the mining industry benefits or has an adverse effect on the wellbeing of communities living close to mines. Most of them focus on a limited area, firms or subsectors.

They often describe the environmental and health impacts of mining activities on local populations and the risk that most benefits of mining exploitation will be transferred outside the zone of extraction or processing (International Institute for Environment and Development [IIED] & World Business Council for Sustainable Development [WBCSD], (2002); Yelpaalaa & Ali, 2005; Crowson, 2009; and, above all, numerous documents provided by journalists and activist organizations).[2] Other works, instead, emphasise the progressive role of mining operations in local development and in the control of negative externalities (McMahon & Remy, 2001; evidences described by the industry association International Council on Mining and Metals [ICMM]). Case studies conducted in Peru also reveal both the advantages and disadvantages what may be accrued from the interactions between mines, local communities and local economies (Glave and Kuramoto, 2007; Aragón and Rud, 2009; De Echave *et al*. 2010). These works can provide useful insights into the local impacts of the mining industry, but usually consider emblematic examples which may not fully reflect general patterns and trends.

Systematic statistical and international evidence is provided by the literature on resource abundance which is converging towards some stylized facts: point-source wealth tends to jeopardize economic growth; better institutions can reduce the likelihood of a resource curse, but a rich point-sourced resource dependence may be deleterious for the quality of institutions and their pro-development role (Isham *et al*., 2005; Mehlum *et al*. 2006; Mavrotas *et al*. 2011; van der Ploeg, 2011). However, conclusive claims cannot be made on the basis of this literature alone. Some authors challenge the econometric methodology, specification or the measurement of resource abundance and find results which are not consistent with the existence of a negative relationship between resource abundance and economic development or growth (Brunnschweiler and Bulte, 2008; Alexeev and Conrad, 2009). Moreover, most of

[2] See, for instance, information and documents at the following websites: http://www.earthworksaction.org/;, http://www.minesandcommunities.org/; http://www.nodirtygold.org/; http://www.conflictosmineros.net/

the literature on curse hypothesis is based on cross-country studies and it does not focus on local impacts. Not all channels that are relevant at local level are equally translated at national level. The effect of extractive activities on migration, for example, may be more important within the national borders, while the environmental impact can be concentrated in the areas close to the mining operations. Cross-country studies may fail to capture these effects.

To circumvent these weaknesses, this paper contributes to the literature on the role of mineral resource wealth in local economic development by providing nationally representative evidence based on variations within the country. We estimate the impact of the mining boom in the decade up to 2007 from a set of local socio-economic indicators in Peru by combining difference-in-difference estimations with propensity scores matching techniques (PSM-DD) to construct a proper counterfactual for comparing non-mining and mining districts. This approach can provide more systematic evidence than anecdotal and case studies. It is also more robust than cross-country studies since, focussing on a single country, many geographical, institutional, political and cultural characteristics which may affect both mining operations and their impact can be considered common to all observations and therefore they do not produce biases in the estimates. Finally, the PSM-DD technique permits the control of other confounding factors which may vary across districts. In particular, this technique allows us to compare mining districts and 'comparable' districts, namely districts that, in the absence of a mining boom, would have similar outcome indicators.

This paper integrates a recent strand of literature of country-level works which study the link between resource abundance and local development using different regions within the same country as units of analysis (Papyrakis and Gerlagh, 2007; Domenech, 2008; Boyce and Emery, 2011; Michaels, 2011; Caselli and Michaels, 2013) or controlling for the proximity to extractive activities (Aragón and Rud, 2012). This paper can be considered as an extension of Zegarra *et al*. (2007) which estimates the impact of mining in Peru using a similar methodology. However, our paper departs from this work in at least three main aspects. First, since we use Census data, we can consider a greater number of districts and we can apply difference-in-difference, rather than cross-sectional estimations as in Zegarra *et al*. (2007). In this way, we can correct potential biases due to time-invariant confounding unobservable variables. Second, our work redefines the unit of analysis. We find that is possible to construct a proper counterfactual for new mining areas but not for old mining areas. Consequently, the impacts of mining can only be evaluated for the wave of investments that began in the mid-1990s. Third, the scope of the research has been expanded. The analysis incorporates the effects on migration and labour outcomes. This is an important extension since we find that the most significant impacts of the recent mining boom have been those on incidence of migrants and on the distribution of employment. Moreover, we try to assess whether a relevant engagement of mining companies in CSR initiatives can change their impact on local communities.

This work, therefore, also relates the debate on the role of CSR and institutional quality can play in mitigating possible adverse effects of extractive activities, enhancing the potential benefits of mines in surrounding areas and managing social conflicts. International organizations (McMahon & Remy 2001; World Bank, 2008), industry associations,[3] research centres (IIED and WBCSD, 2002) and major NGOs (Herbertson *et al*., 2009) are converging to produce a set of guidelines for inclusive and sustainable mining which pivot around institutional conditions: transparency in dispute resolution and in managing mining revenues; long-term vision in managing price and revenue volatility; informed and capacitated participation of all stakeholders; government credibility and capacity of enforcement, supervision and regulation. At the same time, CSR has gained increasing importance in the relations between extractive activities and local communities with the idea that a coherent

[3] See website of ICMM (http://www.icmm.com).

CSR strategy can be a win-win solution for corporate goals and for the wellbeing of the society. Some examples include the Global Reporting Initiatives, the UN Global Compact, the Centre for Social Responsibility in Mining, and the Corporate Social Responsibility Initiative. The contribution of CSR projects or a real change in production and management practices, however, is contested (Pesmatzoglou *et al*., 2012).

Peru offers an interesting case study also with respect to these issues. From the early 1990s, the country has introduced important reforms and it has tried to comply with the current international consensus on sustainable mining development. Moreover, some of the biggest mining companies have invested heavily in CSR initiatives. In theory, the recent mining boom, thus, has occurred in an institutional context that encourages a positive interaction between mines and local populations. In practice, the recent mining boom has seen a proliferation of new mining-related social conflicts. To provide an explanation for these apparent contradictions, the study concentrates on new mining areas that, at the beginning of the boom, had not previously experienced a tradition of mining development. A focus on new mining districts allows us to assess the specific impact of the new institutional setting without combining it with the long-lasting effects of mining activities which took place before the institutional reforms of the 1990s. Then, we focus the analysis further on districts characterized by a low social corporate spending in order to evaluate if CSR strategies of mining firms were able to mediate their impact.

3. The Peruvian 21st century mining boom

Throughout its long history of mining exploitation, Peru did not manage to transform its enormous mineral wealth into a sustained process of economic and human development. In the 1990s, however, the country promoted a set of economic and institutional reforms that reinvigorated the positive auspices of the pro-development role of this sector. The government passed several legislative measures to reduce obstacles to foreign capital inflows towards the mining industry, to promote privatization and to ensure a favourable fiscal regime and a stable and clear legal framework. In the late 1990s, these new investment conditions, economic stabilization of the Peruvian economy, and the recovery of the international economic cycle led to a surge in mining investment and production. Between 1996 and 2009, annual mining investments increased from 387 to 2,771 Million US$ (Ministry of Energy and Mines [MINEM], 2004 and 2009). From 1995 to 2005, mining GDP grew at yearly average rates of 8.2% compared to a total GDP growth of 3.2%. In this period, Peru enhanced its position as a metallic producer and in 2008, it was the first and second world producer of, respectively, silver and zinc, and the third world producer of copper, tin and bismuth. The decade of the mining boom also witnessed a strengthening of the role of the State in environmental regulation and monitoring. Furthermore, since 2000-2002, Peru has promoted fiscal and political decentralization and the current fiscal legislation provides for redistributive mechanisms that should prioritise those areas more exposed to potential negative effects of mining operations. These new rules and the surge in mining production led to a rapid increase of transfers to regional governments that in 2007 reached a level 38 times higher than in 2002. In 2008, revenues generated by the mining sectors accounted for a large share of total transfers to regional (60 percent) and local governments (39 percent).[4] Mining expansion has also created new labour opportunities especially in areas at high altitudes where several economic activities are not viable or remunerative. According to the estimates of the Instituto de Ingenieros de Minas del Perú (IIMP), in 2009 more than 2.5 million people were directly or indirectly depended on mining (IIMP, 2010).

At the same time, Peru has fostered public-private partnership and consultative mechanisms in managing community-mine relationships (Arellano-Yangua, 2008), while multinational corporations have been increasingly investing in development and infrastructure projects.

[4] 2008 data reported by IIMP (2010).

Between 2000 and 2099, expenditure of mining companies for infrastructure and social programs grew from US$ 30.5 to US$ 73.5 million (Hoyos Ordonez, 2002; IIMP, 2010).

Despite this notable progress in the legal and institutional settings, the mining industry has been facing growing unrest from local interest groups. The number of concessions for mining exploration and exploitation rose from 1525 in 1994 to 2100 in 2007 (MINEM, 2012). In 2009, about 24%of the 21 major populated watersheds were subject to mining concessions (elaborated from Bebbington and Bury, 2009). This rapid extension of the territorial influence of mining has increased the contacts between enterprises and local communities as well as competition for other human and productive water and land uses. In 2009, the Peruvian Ombudsman's office recorded 129 socio-environmental conflicts and about 65% of them (83) were mining-related disputes. Most mining conflicts are, primarily, struggles over the use and contamination of water resources (60 percent) and for land acquisition and access (15 percent) (Glave and Kuramoto, 2007). Management of mining revenues has also received criticism. Some authors suggest that, in Peru, management and distribution of mining taxes and royalties tends to be problematic (Barrantes *et al*., 2005; Arellano Yanguas, 2008). Moreover, direct investment by mines in social development and infrastructure is highly concentrated: in 2008, two companies alone financed 36 % of all funds allocated in that year (IIMP, 2010).

Qualitative evidence suggests that local populations and their organizations,[5] overall, agree that the mining companies, so far, have not produced a sizable positive impact on their living conditions. They claim that labour opportunities in mines are very limited and not stable, while fiscal revenues distributed at local level are lower than expected. In some cases, rural organizations have denounced unfair land transactions with mines or damage to health, soil and water resources.

[5] For this information we refer to Barrantes *et al.* (2005) and to De Echave *et al.* (2010).

This rapid overview clearly shows a complex dynamic systems where perceptions, expectations, real and potential impacts are difficult to evaluate and to unscramble. In the following section, we identify and briefly discuss the main channels of potential impacts of the mining industry on a set of socio-economic dimensions. We then try to understand which of these potential effects have materialised on the ground by comparing mining districts with suitable counterfactual non-mining districts.

4. A schematic conceptual framework

This section offers a schematic conceptual framework of the linkages between different economic dimensions (assets, prices, and population dynamics) that can be activated or affected at the local level by the expansion of existing mining activities or the opening of new mining operations. Based on the empirical and theoretical literature discussed in the previous section, we expect that mining activities can spur a range of interconnected local effects:

(a) *Public goods and access to public services:* Mining industries can lead to an increase in public goods and services through different channels (Ticci, 2007):

- Increase in demand for public goods and services, rise in political opportunity for their provision and reduction in their financial cost due to changes in size, income and geographical distribution of population;
- Loosening of government budget constraints due to a rise in inflows of mining revenues. Indeed, the international emphasis on the issue of resource revenues transparency (as emblematically represented by the case of EITI) suggests that financing of public expenditure is one of the main pro-developmental roles of mining industries in resource-rich countries (Liebenthal *et al.*, 2005)
- Increase in private investment in construction and maintenance of infrastructure;
- Promotion of local development projects by mining firms.

(b) *Physical and human capital*: local public expenditure and funds directly managed by mining companies can finance health and educational services and infrastructure, or transport, communication and power projects with positive effects on physical and human capital accumulation. In contrast, air, water and soil pollution of mines can negatively affect human capital by causing health problems.[6] Finally, to the extent that mining growth expands or reduces business and labour opportunities, it can also affect the capacities and incentives of households to invest both in human and in physical capital.

(c) *Migration flows and urbanization.* Mining activities can encourage:

- Environment and land-related movements: farm households that have lost their lands or have been negatively affected by environmental externalities of mining may move to other districts or to urban areas.
- Labour-related migrations: mining areas usually attract immigration flows of people who seek jobs in the mining industry or in other sectors with upstream or downstream linkages.

(d) *Farming activities.* The potential impact of mining development on farming activities is ambiguous. On one hand, mining operations can crowd out the agricultural sector since they often require an intensive use of water resources, are land demanding and can create heavy environmental externalities. On the other hand, in some cases, large mining corporations finance agriculture development projects (from extension services and technical assistance to capacity building, access to credit and irrigation infrastructures) or construction of rural roads with positive effects on agricultural productivity and farmers' access to markets. In addition, if mines attract new workers and their families, local food markets might develop resulting in increased returns to agriculture. Some case studies confirm the

[6] In its mining history, Peru has witnessed some of the most emblematic examples of health damages due to mining pollution, such as high lead concentration in the blood of children (Dirección General de Salud Ambiental [DIGESA], 1999) and high incidence of breathing affections (Balvín, 1995).

possibility of these opposite effects. Aragón and Rud (2009), for instance, found that, in Peru, the gold mine Yanacocha has produced a positive impact on households' income by stimulating the demand for local goods, agricultural products included, while, in Ghana, they estimated (Aragón and Rud, 2012) that areas closest to gold mines have seen a decline by about forty percent of agricultural productivity, probably because of pollution.

(e) *Relative and absolute local prices, wages, employment and sector composition of local economy*. A mining boom can be associated with changes in population size and in composition of population by age, income, occupation and education. Expansion of mining operations can increase local labour demands through direct labour employment and through an increase in demand for local goods and services. All these factors are likely to shape the level and structure of employment[7] as well as incomes in different sectors and relative prices of locally traded and untradeable goods compared to tradable goods. Increasing return to service and mining-related manufacturing activities can, for example, induce economic diversification of household income sources out of the farming sector.

All these potential effects of mining growth are likely to manifest themselves as an impact on level and distribution of household economic wealth and expenditure. The final effect, however, is ambiguous. Figure 1 illustrates the main mechanisms at stake. The blocks in italics show the different channels of transmission, but not all of them are always activated in all mining areas and neither do their effects always have the same characteristics. In addition, political and institutional contextual settings, mines' attitudes, CSR practices and

[7] For instance, Moretti (2010), by examining US Census data, found that an exogenous increase in the number of jobs in the tradable sector generates a local employment multiplier which varies across tradable and non tradable sectors, industries and skill intensities. This differentiated impact is explained by heterogeneous effects on prices and demand of local goods and services and on local wages.

procurement policies,[8] initial household asset endowments, ex-ante specialization and tradition of local economic conditions can mediate or feed the various interlinks.

Figure 1 here

This means that the impact of the recent mining boom on local economies is context-specific, is not univocally predictable and can change across different countries or regions. The effects of mining on local economies (from asset endowments and sector composition of employment, to local prices and households' welfare) remain, therefore, an empirical question[9] which requires econometric analysis which controls for those factors which may influence the exposure to a mining boom, the initial conditions and the final local outcomes. The next section develops an econometric analysis with these characteristics.

5. Estimation methodology

We estimate the effects of the mining boom on a set of outcomes by combining a difference-in-difference (DD) estimate with propensity score matching (PSM). In this study, districts located in the Highlands constitute our units of analysis and the exposure to the 1993-2007 mining boom represents the 'treatment' for which we want to study the effects.

The simple comparison between the mean outcomes of treated and untreated units might be misleading if some factors influence both the outcome and the probability of participating in the treatment. We need, instead, to use 'comparable' districts, namely districts that, in the absence of a mining boom, would have shown similar outcome indicators. For this purpose,

[8] The case of Yanacocha mine in Cajamarca region of Peru offers a telling example. In the late 1990s, Kuramoto (1999) observed that the company established limited commercial and production relations with local agents. Ten years later and after a change in the attitude of the company towards a more inclusive local procurement and employment policy, Aragón and Rud (2009) found that that the same enterprise generates positive effects on local real income due to mine's demand for local inputs.

[9] This position is in line with earlier literature. Aragón and Rud (2009) develop a spatial general equilibrium model where a mine's demand of local inputs is treated as the main transmission channel. They show that the impact of mining expansion on local manufacturing industry, on real wages and income is ambiguous.

we resort to the propensity score matching technique to balance for observable characteristics and create groups that are as similar as possible in terms of confounding variables.[10] Let Y_i^1 be the outcome value of district *i* if *i* is treated (i.e. is a mining district) and Y_i^0 the outcome value of district *i* if *i* is not treated (i.e. is a non-mining district). We also define *D(Z)* as the observed participation status, with *D=1* in case of treatment, *D=0* otherwise, and *Z* indicating the set of variables which determine treatment group membership (i.e. exposure to the mining boom). PSM assumes that there are no other unobservable variables which are linked to the exposure to the mining boom and which also affect expected impacts *Y*. If this condition is not met, the matching method will generate biased estimates of impacts. However, if the unobservable variables that have these features are permanent, the bias may be eliminated coupling PSM with difference-in-difference estimates (Heckman *et al.*, 1998). For example, this method controls for the bias arising from a change in the economic environment – a macroeconomic change or a weather shock such as El Niño – that involves all districts and that might affect both outcome variables and mining operations. Moreover, by focusing the analysis on the Highlands region, the assumption of homogenous impacts across districts appears more plausible.

PSM-DD estimator of the 'Average Treatment Effect on Treated' (ATT) is constructed by comparing the before and after mining boom mean change in outcome measures for the mining districts with those for the matched non-mining districts:

$$ATT = E_{p(Z/D_i=1)}\left\{E(Y_i^{1,t+1} - Y_i^{1,t} / D_i = 1, p(Z_i)) - E(Y_i^{0,t+1} - Y_i^{0,t} / D_i = 1, p(Z_i)) / D_i = 1\right\}$$

This study calculates propensity scores using a logit regression and applies nonparametric kernel matching. The PSM estimator for ATT can be analytically expressed as (Guo and Fraser, 2010):

[10] The use of differences matching estimators in non-experimental settings has been extensively reviewed (Smith and Todd, 2005) showing that they have better performance than the cross sectional estimators.

$$ATT = \frac{1}{n_1} \sum_{i \in I_1 \cap S_p} \{ (Y_i^{1,t+1} - Y_i^{1,t}) - \sum_{j \in I_0 \cap S_p} W(i)(Y_j^{0,t+1} - Y_j^{0,t}) \}$$

where n_1 is the number of mining districts, $i \in I_1$ are mining districts, $j \in I_0$ are non-mining districts, *Sp* is the common support region, and $W(i,j)$ is the weight given to the *j*-th non-mining district in making a comparison with the *i*-th mining district. Weights are assigned according to a kernel function of the predicted propensity score following Heckman *et al*. (1997). Standard errors are estimated using the bootstrapping method. In order to ensure robust findings, we exclude districts with a history of mining exploitation and we restrict the analysis by comparing non-mining areas and areas where mining activities have grown after 1993 (hereafter referred as 'new mining districts'). Former specialization in the mining sector, indeed, is likely to affect both the participation in the mining boom and its impact.[11] This twofold effect impedes the construction of an appropriate counterfactual for old mining districts. A focus on new mining areas, therefore, allows us to avoid the risk of confounding past effects of mining development with those triggered by the recent mining boom.

5. Data sources and classification of mining areas

Our empirical analysis is based on the combination of various data sources. Data on socio-demographic characteristics and labour indicators at district level comes from the Population and Housing Census of 1993 and 2007. The Mining Directory of the Ministry of Energy and Mines provided the list of all mining units in activity in the Peruvian territory. For additional mining information, we rely on the Datamart system of the Ministry of Energy and Mines

[11] A number of factors can explain why a mining tradition is expected to influence the probability to attract further mining investments as well as their effects on local economy. First, firms usually prefer to increase the exploitation of productive capacity already in place or to acquire existing mining firms than to finance green field investments. Second, in old mining areas, new companies are more likely to find complementary services and infrastructures as well as specialised labour force. As far as impacts are concerned, districts with a mining tradition might be better equipped to exploit labour and business opportunities offered by the mining expansion, but they can be affected by previous and long-lasting environmental problems and usually host old mining firms which could use more polluting techniques than new companies

(MINEM, 2012). Data on agricultural production and agricultural producer prices are drawn from SISAGRI, the source for aggregated Ministry of Agriculture data, while other information on agricultural and farming stocks comes from the 1994 Peru National Agricultural Census (CENAGRO 1994). This information is also linked to other data on geographical characteristics that are gathered by National Statistical Office.

After the construction of the dataset, the first step to investigating the welfare and distributive impacts of mines at local level is the creation of a dummy variable which identifies those areas that have been exposed to the influence of the recent mining boom. We use districts, the third-level country administrative subdivision after departments and provinces, as units of analysis. This choice presents some advantages. It appears a reasonable compromise between larger units, that might fail to capture the effects of localised environmental externalities, and smaller units which are not suitable to embody economic linkages that go beyond the nearest areas to mines. Moreover, a district level analysis ensures a large sample size and a sufficient degree of homogeneity: in the Highlands, there are 1,207 districts with a lower average and standard deviation in terms of surface than on the Coast and in the Jungle, the other two natural regions of Peru**.**

We define mining areas as those districts where the number of mining workers in 2007 was above the average within the group of districts with at least one mining worker (108) or where there is at least one medium-large operative mining unit. All remaining districts are defined as non-mining or untreated (UD). Mining districts, in turn, are divided between new (NMD) and old mining districts (OMD) defined as mining districts where the number of mining workers in 1993 was, respectively, below and above the average. Finally, we denote mining districts with high (or low) social corporate spending in all mining districts where average per capita spending for social projects in 2007 was above (below) the average within districts with positive companies' social spending (195 soles).[12] This classification identifies 1,074 UD and 95 NMD which are homogenously distributed along the Highlands and 38 old mining districts which are more concentrated in Central and South Eastern Highlands (see Table 1 in Annex).

A number of reasons and arguments underpin the choice of this definition:

(a) The selection of district with *operative* large and medium mining units ensures that the list of mining areas does not include those districts where firms undertake only exploration work, are no longer or not yet in activity. We do not use this criterion for small and artisanal mines since data might not be complete due to the presence of informal activities. The possibility of a wide diffusion of small and artisanal activities is controlled for by considering the incidence of mining employment which is measured by Census data rather than by administrative data.

(b) The criterion based on the number of mining workers allow us to avoid the risk of some districts being classified as non-mining even if there are companies operating in the territory but with a headquarters in a close district.

(c) Identification of old mining districts is based only on the number of people employed in the mining sector in 1993 since, to our knowledge, detailed data on metallic mining operations prior to mining boom is not available.

(d) The use of average values as threshold levels appears to be the most consistent criterion with the results of the analysis, namely the estimates of average effects of the mining development on districts which participated in the mining boom between the 1990s and the 2000s.

[12] Impact heterogeneity alongside the social corporate responsibility dimension might be possible, but we avoid to estimate multiple "treatment effects" for different social spending levels for small sample considerations.

(e) Further restrictions imposed in the analysis[13] (see next paragraph) ensure that, both in 1993 and in 2007, the number of mining workers in non-mining districts used for the construction of counterfactuals is below the average values employed in the classification. The same holds for CSR spending.

We recognize that other slightly different criterions could be applied. In an earlier study, one of the authors (Ticci, 2011) classified as mining those districts with a share of district surface under mining concessions above a certain threshold and conducted robustness checks using different thresholds. Further, she selected old mining districts according to the presence of operative mining firms in 1994. However, concessions could also include areas which were not really exploited and data on operative units in the early 1990s was not disaggregated by size. The approach proposed in the present work addresses these imprecise elements. Finally, by using additional information, we assess the capacity of the proposed classification to reflect the scope of socio-economic direct and indirect impacts of mining development that we have identified in the conceptual framework of section 4. The average amount of land under mining concessions for each type of operation – exploitation, exploration, inactive and abandoned mines – and the average amount of mining tailings are much greater in mining than in non-mining districts (see Table 2 in Annex). Therefore, there is evidence that the proposed classification mirrors the exposure of district territory to intense mining activities.

Furthermore, the incidence of mining canon on the main public transfers to local governments is higher among mining than non-mining districts, but in this case the gap is less defined. In line with the legislation, mining canon also reaches non-mining districts. But the main feature of mining canon distribution is its temporal and geographical concentration. Mining canon transferred to local governments have accelerated only in recent years (see Table 3) and is concentrated on a limited number of districts: the top 20 districts (about 1.7

[13] We used only observations within the common support.

percent of all Highlands districts considered in the analysis) account for 34 percent of total mining canon received by local governments in 1996-2005 period. The distribution of CSR spending and mining classification shows a greater correspondence (see Table 3 in Annex) with a sharp divide between non-mining and new mining districts. However, these flows are also concentrated in a restricted number of districts which might capture the bulk of benefits: the top 20 districts (about 1.7 percent of all Highlands districts considered in the analysis) account for 34 percent of total mining canon received to local governments in 1996-2005 period. By interpreting this descriptive evidence on the basis of our schematic framework, two main considerations can be pointed out. First, the proposed classification matches the relevance of mining sector at the district level. Second, we can reasonably expect that, in Peru, the impact of the mining boom acts more through its effects on land rights, incentives for labour-related migration and demand for local inputs, goods and services rather than through local public expenditure and CSR initiatives of mining companies. Estimates of the impacts might provide additional evidence to evaluate this interpretation.

6. Constructing the counterfactual

In order to create a comparable control group for mining districts and to estimate the propensity scores, we evaluate a set of potentially relevant control Z variables that are exogenous and might affect both changes in outcome variables and the likelihood of participating in the mining boom:

(a) ***Known metallic deposits in 1997***: investors are likely to firstly target areas where the presence of metallic deposits is documented.

(b) ***Land utilization and the presence of farm activities prior to the mining boom.*** Mining investments might be discouraged in districts where land disputes with local populations are more likely, namely in districts with greater utilization of land for productive uses and a higher return to farming activities before the mining boom. At the same time, farming specialization might affect both the exposure of the local economy to mining risks and its capacity to capture mining benefits. The analysis uses a set of proxies of these factors drawn from 1994 CENAGRO: agriculture land as a share of total district area, average share of farmers' land used for farming or breeding in the district, average share of farmers' non-irrigated agricultural area in the district and the share of non-formally titled plots of land.

(c) ***Average district altitude:*** the presence of metal resources is more likely in districts at high altitudes, but these areas can also be less accessible and less endowed with public services because costs for the provision of public services are higher than in other areas. This, in turn, might influence the return to economic activities and migration decisions. Moreover, altitude tends to correlate with climate conditions that affect types and productivity of farming activities.

(d) ***Mining exploration operations and exploitation activities in the surrounding districts prior to the mining boom:*** existence of these operations can prefigure successive activities of mining exploitation in the district. At the same time, exploration activities can also lead to land disputes or transactions, while local populations can change their investment and migration choices as they anticipate a future mining expansion. We therefore include a dummy that indicates whether in the district there was at least one concession for mining exploration in 1994-1997 and a dummy that takes value 1 if the district belongs to a province where another district had at least one mining exploitation concession in 1994-1997.

(e) ***Protected areas in the district*** can prevent mining investments and influence other economic activities, infrastructural development and distribution of human settlements.

(f) ***Regional dummies*** are used to control for historical and political factors, for differences in rock composition, in distribution of mineral deposits and availability of water resources which are important inputs for mining, energy and farming production.

(g) ***Human capital at household level prior to the mining boom***. Some initial household characteristics could correlate with the probability of living in mining or non-mining areas but also with affordability in meeting private costs associated with access to public services (private costs of connection, preparation of home facilities etc.) and with changes in overall social and economic welfare status. In order to control for these effects, we introduce the average education level of the heads of households in 1993 and share of heads of households whose mother tongue was a native language in 1993.

(h) ***Change in welfare index in the earlier period***. We include the *growth rate* of welfare index, a key and representative outcome variable, before the mining boom to assess the presence of correlation between unobservables and the probability of receiving the treatment.

In order to estimate a population-level treatment effect, we estimate the propensity scores applying the Stata module pscore elaborated by Becker and Ichino (2002) and using weighted logit regression.[14] Weights are calculated according to the reference population of each outcome variable. The matching procedure passes the balancing test which is restricted to the common support to improve the quality of the matches (Caliendo and Kopeinig, 2008). Table 1 shows that the matching allows a substantial reduction in bias for all confounding variables. Standardized differences between NMD and UD in the matched sample are very low and not statistically significant.

Table 1 here

7. Average treatment effects

This section uses the propensity score calculated above to estimate the average treatment effects of the mining boom on a set of outcome variables that cover various dimensions of

[14] The estimation are available from the authors upon request, however it is worth reporting that the coefficient of welfare change between 1981 and 1993 is not significant. This means that, prior to (that is in absence of) treatment, non-mining and mining districts did not experience a systematic different growth rate in this outcome variable. This result supports the use of PSM techniques and our selection of confounding variables.

local development: demographic trends, access to public goods, housing conditions, employment and diversification of local economy. Recalling the scheme in Fig.1, this means that we focus on the dimensions representing the final outcomes (light and dark grey blocks) rather than on the transmission channels (blocks with dashed lines). Each mining district is matched with a weighted average of a share of non-mining districts in the control group on common support. This share is determined by the choice of bandwidth. We show the results when the bandwidth is set at 0.06 but, to check robustness of the results, estimates are replicated for other bandwidths, 0.01, 0.08 and 0.5. Tables 2a and 2b present the mean average changes in the outcome variables across NMDs and UMDs within the common support and the PS-DD estimates of average impacts experienced, overall, by NMDs and by NMDs with low corporate social spending. Old mining districts are excluded from the sample.

We find that new mining areas saw a significantly faster growth of total and urban populations than non-mining areas probably reflecting their capacity to attract migration flows or contain outmigration. While, on average, non-mining districts experienced a decrease in immigrant populations, new mining areas received migrants from other districts. These differences, however, are smaller or not significant when the analysis focused on districts with lower corporate social spending. Therefore, the presence of mining firms with active social responsibility policies might have acted as catalyst for migration flows.

As far as sectorial labour allocation is concerned, overall, the districts of the Highlands experienced a generalised reduction in the labour share of farming activities and this pattern was more marked in rural mining areas. However, we cannot unequivocally state that the mining boom caused a deterioration of the agriculture sector since our estimates do not highlight an impact on crop producer prices and on the district value of agriculture production. This data, therefore, does not allow us to conclude whether the reduction in agriculture labour share is explained by the negative effect of mining on access to or quality of land and water resources or by the arrival of new workers employed in mining-related activities. Mining growth, in fact, has also produced a positive effect on the share of the labour force employed in the mining sector both in urban areas and, to a greater extent, in rural areas. The mining boom in the decade up to 2007, however, seems to have blocked economic diversification towards non primary sectors. The proliferation of new mining operations has had a large and negative impact on the share of the population working in non-mining and non-agricultural activities which remained almost unchanged between 1993 and 2007 in NMDs compared to a growth by 3-5 percentage points in non-mining rural and urban areas of the common support. When we restrict the analysis to districts with a low level of corporate social spending, the effect on mining and agriculture labour share remains significant but smaller, while the impact on the remaining sectors is unchanged. These outcomes indirectly suggest that those areas that enjoyed a higher participation of mining companies in development and assistance projects might have been more able to exploit labour opportunities in mining, but corporate social responsibility has not helped to trigger multiplicative effects on other sectors.

The risk of mining specialization with few spill-overs for manufacturing and service sectors is confirmed by the results on labour market. The reduction in the labour share of non-primary sectors is not accompanied by an expansion of labour and business opportunities able to respond to the growing labour supply. In rural areas of NMDs, we found significant positive impacts for the involvement of adults in economic activities and, in the considered period, the share of the rural population above 15 years and engaged in productive activities grew more in NMDs than in UDs. However, in urban areas the role of mining boom in vitalising labour market was less evident with non-significant impacts on labour participation and unemployment.

New mining operations did not improve access to public services. In the period 1993-2007, the Highlands's rural areas saw considerable advances in access to water, electricity and, albeit to a lower extent, to sanitation services, but the mining boom in the decade up to 2007 did not accelerate this progress. Moreover, our results suggest that, so far, corporate social responsibility has not helped to overcome bottlenecks in materialising these potential benefits: there is no sign of impact on access to basic services, not only when the analysis focuses on districts with low levels of corporate social expenditure, but also in the overall sample. These findings are in line with widespread concerns regarding total amount of mining revenues (which has grown only recently) as well as their management and geographical concentration.

The mining boom seems to have contributed to the improvement of educational outcomes that many Highlands districts have achieved since the mid-1990s. We found a negative impact (albeit very small) on child labour and a positive effect on primary and secondary school attendance in rural areas. It is not easy to conclude whether this link is explained by changes in demographic composition of district populations due to migration inflows, by greater financial resources for educational services and facilities or by higher expected returns to education in the local labour market. However, it is worth observing that corporate social responsibility might have enhanced the effect on primary and secondary school attendance since this impact, respectively, decreases or becomes non statistically significant in the sample restricted to districts with low corporate social spending.

Finally, we estimated the mean impact of the mining boom on changes in poverty rates and on welfare ratio[15] which is a proxy of the real per capita expenditure. PS-DD estimates of ATT are not significant in all samples we considered. Therefore, the arrival of new mining

[15] The welfare ratio is obtained by dividing the per-capita expenditure by the region-specific time-specific poverty line.

firms did not lessen nor exacerbate the growth in poverty rates experienced by Highland districts between 1993 and 2007.

Table 2a here

Table 2b here

8. Discussion of results and concluding remarks.

The main impacts that the mining boom introduced into new mining areas are those related to demographic trends and to occupational distribution. Mining expansion has positively affected immigration inflows and has fostered a change in labour sectorial composition towards mining activities while producing a negative impact on labour share of agriculture and non-primary sectors. Therefore, the opening of new mining operations can have a propulsive role for local economies but the main risk relates to falling into a trap of mining specialization with little links with other industries. In fact, the local employment effect of mining growth, at least so far, has also been negligible. A possible explanation is that the impact of mining development on employment opportunities is still incipient in new mining districts and it was not able to exceed the increase in labour supply associated with population growth and migration flows. However, it is also worth highlighting that we consider a rather protracted period and that descriptive evidence on districts with a long tradition of mining development are not encouraging: during the entire period of mining growth (1993-2007) the labour share of non-primary activities in old mining districts was higher than in the remaining districts, but it declined over time.

Our findings indicate that greater corporate social responsibility may have increased opportunities for mining employment and attracted larger inflows of migrants, but it has largely failed to support local populations in taking advantage of business and labour opportunities that mining growth and its indirect effects could have opened in non-primary sectors. With the exception of slightly positive effects on school attendance in rural areas, our analysis does not allow us to draw definitive conclusions on the role of corporate social expenditure in enhancing the positive effects of mining activities on economic status and living conditions of local populations. Despite the great emphasis on the potentialities of CSR practices, our results suggest that, if there is an effect, it is likely to be small and this interpretation is consistent with evidences of a great concentration of CSR spending in few districts.

It is clear that the main findings of this study relate to the impacts that do not emerge. Some of the most anticipated impacts are, indeed, ‘missing’: we found no sign of impacts on improvement in access to basic services and on some of the principal welfare indicators such housing conditions, poverty rate and per capita real expenditure.

In conclusion, our results indicate a mismatch between the limited impact on several dimensions of wellbeing (employment, basic needs, poverty) and the indications of great expectations revealed by positive effects on demographic growth and share of immigrant population. This contrast not only implies a delay in the materialization of local potential benefits of mineral resource wealth but may have also a role in fuelling conflicts between local communities, governments and mining firms. This risk is particularly high in countries with a long mining history as Peru. Data limitations prevent us from identifying a good strategy for old mining districts. Thus, we refrained from estimating the effect of the recent mining boom in these areas, but the former history of mining exploitation reveals many episodes of environmental and health damage and the creation of economic enclaves (Ticci, 2007). In the absence of clear evidence of tangible benefits and outcomes, the consequent negative reputational effects of the mining industry are likely to have fostered a climate of hostility even if the new institutional contexts have helped to diminish or avoid the negative side-effects of mining activities that local communities have experienced in the past. In other words, Peru’s efforts to follow international consensus and create an institutional environment in line with the international "sustainable mining" agenda have given a positive but not conclusive contribution to build an inclusive local mining development. In the case of Peru, the reform of regulatory and legal frameworks seems to have not been sufficient to ensure that the extractive sector serves as a lever for local development. Further in-depth and country-specific research might help understand whether additional factors need to be considered, from ex-ante conditions to conflicting and chancing objectives of different stakeholders.

References

Alexeev, M. and R. Conrad (2009), 'The elusive curse of oil', *Review of Economics and Statistics* 91(3): 586–598.

Arellano-Yanguas, J. (2008), 'A thoroughly modern resource curse? The new natural resource policy agenda and the mining revival in Peru', IDS Working Paper 300, Institute of Development Studies, Brighton.

Aragón, F., and J. P. Rud (2009), 'The blessing of natural resources: Evidences from a Peruvian Gold mine', Working Paper 2009-015, Banco Central de Reserva del Perú, Lima.

Aragón, F., and J. P. Rud (2012), 'Mining, Pollution and Agricultural Productivity: Evidence from Ghana', Discussion Papers 12-08, Department of Economics, Simon Fraser University, Burnaby.

Balvin, D. (1995), *Agua, Mineria, y Contaminacion: El Caso Southern Peru*, Ilo: Labor.

Barrantes, R., P. Zarate, and A. Durand (2005), *Te quiero pero no: mineria, desarrollo y poblaciones locales*, Lima: Instituto de Estudios Peruanos and Oxfam America.

Bebbington, A., L. Hinojosa, D. Humphreys Bebbington, M.L. Burneo, and X. Warnaars (2008), 'Contention and Ambiguity: Mining and the Possibilities of Development', *Development and Change* 39(6): 887-914.

Bebbington, A., and J. Bury (2009), 'Institutional challenges for mining and sustainability in Peru', *Proceedings of the National Academy of Sciences* 106(41): 17296-17301.

Becker, S. O. and A. Ichino (2002), 'Estimation of average treatment effects based on propensity scores', *The Stata Journal* 2(4): 358-77.

Boyce, J. R. and J.C. Herbert Emery (2011), 'Is a negative correlation between resource abundance and growth sufficient evidence that there is a "resource curse"', *Resources Policy* 36(1): 1-13.

Brunnschweiler, C.N. and E.H. Bulte (2008), 'The Resource Curse Revisited and Revised: A Tale of Paradoxes and Red Herrings', *Journal of Environmental Economics and Management* 55(3): 248–64.

Caliendo, M. and S. Kopeinig (2008), 'Some practical guidance for the implementation of propensity score matching', *Journal of Economic Surveys* 22(1): 31-72.

Caselli, F. and G. Michaels (2013), 'Do Oil Windfalls Improve Living Standards? Evidence from Brazil', *American Economic Journal: Applied Economics* 5(1): 208-38.

Crowson, P. (2009), The Resource Curse: A Modern Myth?, in J.P. Richards (Ed.), *Mining, Society, and a Sustainable World*. Berlin Heidelberg: Springer-Verlag.

De Echave, J., R. Hoetmer, and M. Palacios (2010), *Minería y territorio en el Perú: Conflictos, resistencias y propuestas en tiempos de globalización*, Lima: CONACAMI, Programa Democracia y Transformacion Global, and Cooperaccion.

Dirección General de Salud Ambiental (1999), *Estudio de Plomo en sangre en una población seleccionada de la Oroya*, Lima: DIGESA.

Domenech, J. (2008), ‘Mineral resource abundance and regional growth in Spain, 1860-2000’, *Journal of International Development* 20: 1122–35.

Glave, M. and J. Kuramoto (2007), ‘La minería peruana: lo que sabemos y lo que aún nos falta por saber’, in Grupo de Análisis para el Desarrollo, *Investigación, políticas y desarrollo en el Perú*, Lima: GRADE**.**

Guo, S. and M.W. Fraser (2010), *Propensity Score Analysis, Statistical Methods and Application*, Thousand Oaks: SAGE Publications, Inc.

Heckman, J., H. Ichimura, and P. Todd (1997), ‘Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Program’, *Review of Economic Studies* 64(4): 605-654.

Heckman, J., H. Ichimura, J. Smith, and P. Todd (1998), ‘Characterizing selection bias using experimental data’, *Econometrica* 66(5): 1017–1098.

Herbertson, K., A. Ballesteros, R. Goodland, and I. Munilla (2009), *Breaking Ground: Engaging Communities in Extractive and Infrastructure Projects*, Washington, DC: World Resources Institute.

Hinojosa, L, A. Bebbington, and T. Addison (2010), ‘Social Policy and State Revenues in Mineral-Rich Contexts’, Social Policy and Development Programme Paper 44, UNRISD, Geneva.

Hoyos Ordonez, J. (2002), *Balance Social de la Minería*, Lima: Institute of Mining and Energy Studies.

International Institute for Environment and Development & World Business Council for Sustainable Development (2002), *Breaking New Ground: The Report of the Mining, Minerals and Sustainable Development Project*, London: Earthscan Publications Ltd.

Instituto de Ingenieros de Minas del Perú (2010), *Contribución al Desarrollo Económico y Social*, Lima: IIMP.

Isham, J., M. Woolcock, L. Pritchett, and G. Busby (2005), 'The Varieties of Resource Experience: Natural Resource Export Structures and the Political Economy of Economic Growth', *World Bank Economic Review* 19(2): 141-74.

Kuramoto, J. (1999), 'Las Aglomeraciones Productivas Alrededor de la Minería: El Caso de Minera Yanacocha', Documento de Trabajo No. 27, GRADE, Lima.

Liebenthal, A., R. Michelitsch, and E. Tarazona (2005), *Extractive Industries and Sustainable Development An Evaluation of World Bank Group Experience*, Washington, DC: World Bank, International Finance Corporation, Multilateral Investment Guarantee Agency.

Mavrotas, G., S. Mansoob Murshed, and S. Torres (2011), 'Natural Resource Dependence and Economic Performance in the 1970–2000 Period', *Review of Development Economics* 15(1): 124-138.

McMahon, G. and F. Remy (2001), *Large mines and the community: socioeconomic and environmental effects in Latin America, Canada, and Spain*, Ottawa and Washington D.C.: International Development Research Centre and World Bank.

Mehlum, H., K. Moen, and R. Torvik (2006), 'Institutions and the resource curse', *The Economic Journal* 116 (508): 1-20.

Michaels, G. (2011), 'The Long Term Consequences Of Resource-Based Specialisation', *The Economic Journal* 121(551): 31-57.

Ministry of Energy and Mines (2004), *Anuario Minero 2004*, Lima.

Ministry of Energy and Mines (2009), *Mining Annual Report 2009*, Lima.

Ministry of Energy and Mines (2012), Datamart de Minéria, available online at http://intranet2.minem.gob.pe/datamart/dac_publico/datamart_index.htm.

Moretti, E. (2010), 'Local Multipliers', *American Economic Review* 100(2): 373–377.

Papyrakis, E. and R. Gerlagh (2007), 'Resource abundance and economic growth in the United States', *European Economic Review* 51(4): 1011–39.

Pesmatzoglou, D., I.E. Nikolaou, K.I. Evangelinos, and S. Allan (2012), 'Extractive multinationals and corporate social responsibility: a commitment towards achieving the goals of sustainable development or only a management strategy?' *Journal of International Development* DOI: 10.1002/jid.

Smith, J. A. and P. Todd (2005), 'Does matching overcome LaLonde's critique of nonexperimental estimators?' *Journal of Econometrics* 125(1-2): 305-353.

SNL Metals Economics Group (2013), *World Exploration Trends 2013: A Special Report from SNL Metals Economics Group for the 2013 PDAC International Convention*.

Ticci, E. (2007), 'How much do environmental goods matter for the poor? From a theoretical approach to the case of rural communities affected by mines in Peru'. Ph.D. thesis. Department of Economics, University of Florence.

Ticci, E. (2011), 'Extractive Industries and Local Development in the Peruvian Highlands: Socio-Economic Impacts of the Mid-1990s Mining Boom', RSCAS EUI Working Papers 2011/14, European University Institute, Florence.

van der Ploeg, F. (2011), 'Natural Resources: Curse or Blessing?', *Journal of Economic Literature* 49(2): 366–420.

World Bank (2008), *Implementing the Extractive Industries Transparency Initiative. Applying Early Lessons from the Field*. Washington, DC: World Bank.

Yelpaala, K. and S.H. Ali (2005), 'Multiple scales of diamond mining in Akwatia, Ghana: addressing environmental and human development impact', *Resources Policy* 30(3): 145-155.

Zegarra, E., J.C. Orihuela, and M. Paredes (2007), 'Minería y economía de los hogares en la sierra peruana: Impactos y espacios de conflicto', Documento de Trabajo 51, GRADE, Lima.

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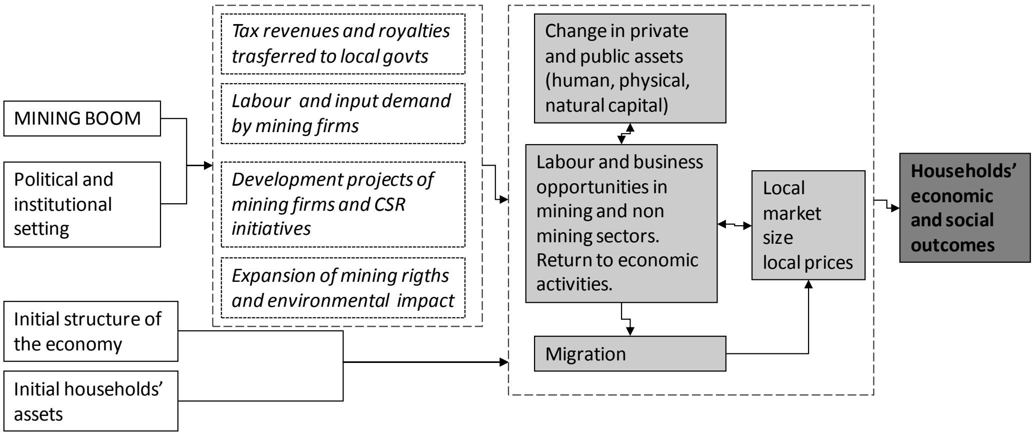
Figure 1



Main channels of mining impacts on local economies

List of tables

Table 1: Mean values of overall and matched sample

	Unmatched			Matched	
Variable	Treated	Control		Treated	Control
Metallic deposits	0.38	0.17	***	0.35	0.34
Share of agricultural district land	0.49	0.48		0.50	0.49
Average share of non irrigated land	0.26	0.28		0.27	0.27
Average share of farmers' agricultural land	0.33	0.37	*	0.34	0.35
Share of untitled plots	0.42	0.45		0.42	0.44
Mining exploration in 1994-97	0.81	0.42	***	0.80	0.76
Average education level of household heads	1.38	1.32	***	1.36	1.36
District average altitude	3704	3537	**	3655	3658
Protected areas	0.09	0.12		0.09	0.09
Mining operations in districts of the same province in 1994-97	0.74	0.56	***	0.73	0.71
Mother tongue of household heads (Share of native)	0.35	0.43	**	0.35	0.37
Change in welfare index 1981-1993	-0.03	-0.03		-0.03	-0.03

Note: *, ** and *** indicate significance levels of 10%, 5%, 1% respectively of t-tests for equality of means in the groups of new mining and non-mining districts, both before and after matching. T-tests are based on a regression of the variable on a treatment indicator. Before matching this is an unweighted regression on the whole sample, after matching the regression is weighted using the weight assigned to the matched observation by the Kernel-based matching and based on the on-support sample. Regional dummies are included but not reported.

Table 2a: Double difference estimates

All sample: non-mining districts (UD) and new mining districts (NMD)							
			Mean change in outcome indicators[1]		**PS-DD estimates of ATT**		
			UD	NMD	ATT	std err	
Access to basic service and housing quality	***Change in share of rural population...***	*with access to electricity*	0.28	0.26	-0.05	0.04	
		with improved water services	0.24	0.28	-0.05	0.04	
		improved sanitation services	0.09	0.10	0.00	0.01	
		who live in households with safe walls	0.01	0.03	0.01	0.01	
	Change in share of urban population …	*with access to electricity*	0.32	0.28	0.04	0.05	
		with improved water services	-0.06	-0.03	0.05	0.06	
		improved sanitation services	0.28	0.24	-0.01	0.03	
		who live in households with safe walls	0.07	0.12	0.02	0.01	
Migration and demographic trends	***Change in share of…***	*recent migrants in rural areas*	-0.01	-0.03	0.02	0.02	
		recent migrants in urban areas	-0.03	-0.02	0.03	0.01	**
		recent migrants	-0.02	-0.02	0.03	0.01	**
	Relative change[2] ***in…***	*rural population*	-3.77	-7.69	-1.32	12.33	
		urban population	45.31	64.65	55.47	20.78	***
		total population	8.17	26.42	18.29	5.50	***
Labour market and occupational distribution	***Change in share of rural…***	*population 15+ engaged in ec. activities*	0.05	0.14	0.07	0.02	***
		labour force that is unemployed	0.01	0.00	-0.01	0.01	
		labour in mining activities	0.00	0.09	0.17	0.02	***
		labour in agricultural activities	-0.04	-0.11	-0.12	0.02	***
		labour in other sectors	0.03	0.02	-0.06	0.02	***
	Change in share of urban...	*population 15+ engaged in ec. activities*	0.07	0.10	-0.01	0.01	
		labour force that is unemployed	0.01	-0.01	0.00	0.01	
		labour in mining activities	0.01	0.06	0.10	0.02	***
		labour in agricultural activities	-0.06	-0.06	-0.03	0.02	
		labour in other sectors	0.05	0.01	-0.07	0.02	***
Poverty and welfare status	***Change in…***	*welfare index*	-0.02	-0.01	0.00	0.00	
		poverty rate	0.12	0.08	-0.01	0.02	
Agricultural indicators	***Change in…***	*agricultural price index*	0.01	-0.05	0.01	0.04	
		agricultural production index	0.23	0.27	-0.07	0.10	
Education and child labour	***Change in share of child workers...***	*in rural areas*	0.000	0.003	-0.01	0.004	**
		in urban areas	0.004	0.002	-0.002	0.004	
	Primary school attendance	*in rural areas*	0.18	0.19	0.04	0.01	***
		in urban areas	0.14	0.13	0.02	0.01	
	Secondary school attendance	*in rural areas*	0.14	0.13	0.04	0.01	***
		in urban areas	0.10	0.08	0.00	0.02	

Table 2b: Double difference estimates.

Subsample: non-mining districts (UD) and new mining districts (NMD) with low CSR expenditure							
			Mean change in outcome indicators		**PS-DD estimates of ATT**		
			UD	NMD	ATT	std err	
Access to basic service and housing quality	***Change in share of rural population...***	*with access to electricity*	0.28	0.26	-0.07	0.04	
		with improved water services	0.24	0.29	-0.05	0.04	
		improved sanitation services	0.09	0.10	0.00	0.01	
		who live in households with safe walls	0.01	0.04	0.01	0.01	
	Change in share of urban population …	*with access to electricity*	0.32	0.26	0.02	0.05	
		with improved water services	-0.06	-0.02	0.08	0.06	
		improved sanitation services	0.28	0.24	0.00	0.03	
		who live in households with safe walls	0.07	0.12	0.02	0.02	
Migration and demographic trends	***Change in share of…***	*recent migrants in rural areas*	-0.01	-0.04	0.02	0.02	
		recent migrants in urban areas	-0.03	-0.03	0.02	0.01	
		recent migrants	-0.02	-0.02	0.02	0.01	
	Relative change[2] in…	*rural population*	-3.74	-8.57	-2.87	12.33	
		urban population	45.10	63.00	56.25	32.18	*
		total population	8.40	26.60	17.75	7.50	**
Labour market and occupational distribution	***Change in share of rural…***	*population 15+ engaged in ec. activities*	0.05	0.10	0.06	0.02	**
		labour force that is unemployed	0.01	0.00	-0.01	0.01	
		labour in mining activities	0.00	0.10	0.15	0.03	***
		labour in agricultural activities	-0.04	-0.10	-0.10	0.03	***
		labour in other sectors	0.03	0.00	-0.06	0.02	***
	Change in share of urban...	*population 15+ engaged in ec. activities*	0.07	0.10	-0.01	0.02	
		labour force that is unemployed	0.01	0.00	0.01	0.01	
		labour in mining activities	0.01	0.00	0.08	0.02	***
		labour in agricultural activities	-0.06	-0.10	-0.02	0.02	
		labour in other sectors	0.05	0.00	-0.07	0.03	**
Poverty and welfare status	***Change in…***	*welfare index*	-0.02	-0.01	0.00	0.00	
		poverty rate	0.12	0.08	-0.01	0.02	
Agricultural indicators	***Change in…***	*agricultural price index*	0.00	-0.09	-0.03	0.04	
		agricultural production index	0.26	0.24	-0.13	0.13	
Education and child labour	***Change in share of child workers..***	*in rural areas*	0.001	0.003	-0.010	0.004	***
		in urban areas	0.004	0.002	-0.002	0.003	
	Primary school attendance	*in rural areas*	0.18	0.19	0.04	0.01	***
		in urban areas	0.14	0.13	0.01	0.01	
	Secondary school attendance	*in rural areas*	0.14	0.13	0.03	0.02	
		in urban areas	0.10	0.08	-0.02	0.01	

Notes: i) [1] Mean changes in outcome indicators between 1993 and 2007 are restricted to only those districts determined by PSM; ii) [2]ATT estimates of relative changes are calculated without combining propensity score matching with difference-in-difference; iii) *, ** and *** indicate significance levels of 10%, 5%, 1%

respectively, when testing the null hypothesis of equality of mean changes between UD and NMD; iv) PS kernel matched standard errors are obtained by bootstrapping (100 repetitions); v) Numbers of observations in the common support varies across indicators because of data availability. ATT estimates in the overall sample are based on a number of observations ranging from 1005 and 959 observations (873/917 comparison and 86 NMD). ATT estimates in the subsample are based on a number of observations ranging from 975 and 895 observations (827/917 comparison and 68 NMD)); vi) PS-DD estimates refer to the 1993-2007 period for all indicators with the exception of changes in agriculture indicators which are related to the 1999-2007 period.

Annex

Table 1: Geographical distribution of mining and non-mining districts in the Peruvian Highlands

	Regions	*Non-mining districts*	*New mining districts*	*Old mining districts.*	*Total*
All sample	Central-Northern Sierra	307	27	3	337
	South-Eastern Sierra	256	29	18	303
	Central-Southern Sierra	261	20	4	285
	Central Sierra	250	19	13	282
	Total	1074	95	38	1207
Subsample: districts with low corporate social expenditure	Central-Northern Sierra	305	23	2	330
	South-Eastern Sierra	253	23	17	293
	Central-Southern Sierra	257	15	3	275
	Central Sierra	250	14	9	273
	Total	1065	75	31	1171

Table 2: Average mining tailings and hectares under metallic mining concession

District classification	*Average mining tailings in 2004-2008 (tons)*	*Average district surface under concessions for mining exploitation in 2007 , ha*	*Average district surface under concessions for exploration operations in 2007, ha*	*Average district surface under concessions for all types of mining activity in 2007, ha*
Non-mining	15	23	1,792	4,055
New mining	2,700	702	3,239	15,463
Old mining	2,388	1,097	3,094	11,238
All	260	96	2,145	5,082

Source: author's elaboration based on MINEM. **Note:** the top 2 percent of districts is cut. Unweighted averages.

Table 3: District mining canon and CSR spending by mining status

District classification	*Mining canon as a share of the main transfers to local governments (%)*		*Per capita CSR spending (Nuevos Soles)*
	1996-2005	*2003-2005*	*2007*
Non-mining	9	16	6
New mining	16	27	219
Old mining	18	30	84
All	10	17	25

Note: Main transfers to local governments include Canons, Vaso de Leche Program, and Foncomun. The top 2 percent of districts is cut. Unweighted averages.