Natural Resources and Local Communities: Evidence from a Peruvian Gold Mine

By Fernando M. Aragón and Juan Pablo Rud*

This paper examines the local economic impact of Yanacocha, a large gold mine in Northern Peru. Using annual household data from 1997 to 2006, we find evidence of a positive effect of the mine's demand for local inputs on real income. The effects are only present in the supply market and surrounding areas, and reach unskilled workers in non-mining sectors. Consistent with a general equilibrium framework, we also find an increase in the local price of non-tradable goods. Taken together, our results underline the potential of backward linkages from extractive industries to create positive spillovers in less developed economies.
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> The grudge against what has become known as the "enclave" type of development is due to this ability of primary products from mines, wells, and plantations to slip out of a country without leaving much of a trace in the rest of the economy.
>
> Hirschman (1958, p. 110)

Developing countries have access to many of the world's richest oil and mineral reserves. They are among the largest producers of key minerals and account for most of the recent growth in mineral production (Humphreys 2009). Despite resource abundance being deemed as an economic opportunity (World Bank 2002), we still lack a good understanding of how it can be managed to generate economic prosperity.

The existing empirical literature suggests that abundance of natural resources may fail to improve living standards, or even hinder economic performance, especially in the presence of bad institutions (Sachs and Warner 1999, Sachs and Warner 2001, Mehlum, Moene and Torvik 2006). Most of the evidence, however, comes from aggregate data at country level and offers little guidance about

* Aragón: Simon Fraser University, Burnaby, British Columbia, V5A 1S6, Canada, faragons@sfu.ca. Rud: Royal Holloway, University of London, Egham, Surrey, TW20 0EX, United Kingdom, juan.rud@rhul.ac.uk. We are particularly grateful to Tim Besley for his support and advice during this research project. We thank two anonymous referees and the editor for helpful comments, We also thank Nava Ashraf, Oriana Bandiera, Konrad Burchardi, Dave Donaldson, Claudio Ferraz, Greg Fischer, Maitreesh Ghatak, Guy Michaels, Gerard Padró i Miquel, Torsten Persson, Tony Venables and several seminar participants at the London School of Economics, Royal Holloway, Oxcarre, Alicante, SITE, Pompeu Fabra, Notre Dame, Houston, Simon Fraser University, UBC, LACEA, Royal Economic Society, and the World Congress of the Econometric Society for useful comments and suggestions.

the local economic effects of resource abundance. In this paper we investigate whether natural resources can improve living conditions of the local population. Furthermore, we try to understand what are the potential mechanisms that could generate positive effects. These are key issues to better assess the net impact of extractive industries, and to design policies that mitigate potential side effects that have an inherent local scope, such as pollution and population displacement.

This paper contributes to this debate by examining the local impact of a large mine in the context of a developing country. We show that, at least in the short run, the expansion of the mine has a positive impact on the living standards of the local population, and that the effects are driven mainly by the mine's backward linkages.

We use the case of Yanacocha, one of the largest gold mines in the world. The mine is located near the city of Cajamarca in the Northern Highlands of Peru. This region is extremely poor and predominantly rural and, before Yanacocha, had no history of mining.[1] The economic interactions between the mine and the local economy are scant. Yanacocha, like most large modern mines in developing countries, is an export-oriented, capital-intensive operation and most of its inputs are not procured locally. The most visible contribution of the mine is the revenue windfall to local governments, who benefit from a share of the mine's tax payments. However, since 2000, the demand for local inputs has also increased significantly. As we document below, this expansion was driven by the growth of gold production and the implementation of a corporate policy directed at increasing local employment and supply linkages.

The increase in the demand for local inputs provides the opportunity to study the effects of a localized demand shock of labor-intensive services originated by a large mine, and its geographical spillovers. To that end, we use the framework of local labor demand shocks provided by Moretti (2010, 2011) to generate a set of testable predictions in the context of Yanacocha. The first order effects of this demand shock are the increase of nominal wages in the service sector in Cajamarca city and surrounding areas, relative to locations farther away. To the extent that workers are mobile between sectors, this shock should also increase the wage of other workers, not directly linked to the mine. Subsequently, the increase in the local budget constraint should increase the demand and price of local goods, such as housing and locally traded food. These general equilibrium effects would benefit home-owners and local producers. In the presence of low levels of inter-regional labor mobility and an upward sloping supply of local goods, we would expect positive effects on households' real income.

With this framework in mind, we examine the effect of the expansion of the mine on local living standards using households' survey data for the period 1997 to 2006. Our identification strategy exploits the expansion of the mine's demand for

[1]This region was not subject to the *mita* system during the Spanish colony. This feature reduces concerns of the presence of long term effects associated with this institution, as found by Dell (2010) in the Peruvian South.

local inputs and distance to Cajamarca city, the mine's supplying market. More specifically, we implement a difference in difference approach using the expansion of the mine as a treatment and comparing households located close to Cajamarca city to households farther away. The validity of the identification strategy relies on the assumption that the effects of the mine expansion decrease with distance, and that households in areas both close and far from Cajamarca city would have experienced similar performance in the absence of the mine.

We find that the expansion of the mine has a positive effect on nominal and real income. In particular, a 10 percent increase in the mine's demand for local inputs is associated with a 1.7 percent increase in real income. The raise in income is paralleled by an increase in household consumption and poverty reduction. The results are similar using alternative measures of mine activity, such as number of workers and quantity of gold produced, and remain robust to the exclusion of groups that may have benefited directly from the mine expansion, such as mining and public sector workers. The effects are present in Cajamarca city and the surrounding rural areas. We show that the effects decline monotonically with distance to the city and become insignificant beyond 100 km.

We subsequently present a set of results that are consistent with the proposed analytical framework. First, there is a relative increase in the price of goods traded only locally, such as housing and regional food crops. Second, there is evidence of direct and indirect effects: the increase in income is present for workers in the service industry (mostly located in the city) and agricultural producers (mostly located in the hinterland). Third, consistent with the fact that Yanacocha targeted non-critical services intensive in unskilled labor, we find that unskilled workers benefit most.

Finally, we explore some issues that may invalidate the identification strategy. We are particularly concerned by the (potential) changes of population composition due to internal migration and that the increase in income may be due to the significant revenue windfall accruing to local governments. The increase in income, however, does not seem to be a spurious result driven by these confounding factors. For example, we find that effects on income for households close to Cajamarca city hold for municipalities outside the Department of Cajamarca, i.e. localities that have not received any of the revenue windfall levied from Yanacocha. We interpret these findings as evidence that the local population benefited from the expansion of the mine due to the presence of backward linkages[2].

This paper contributes to the literature regarding the effect of natural resources on development. A main finding in this literature is that resource abundance may have a negative effect on growth (Sachs and Warner 1999, Sachs and Warner 2001). This natural resource curse has been linked to bad institutions (Mehlum, Moene and Torvik 2006) and, more recently, to conflict (Ross 2006, Brückner and Ciccone 2010) and the undermining of democracy (Tsui 2011). By studying the

[2]These findings are consistent with Auty (2001), who argues that the distribution of rents from natural resources through market channels may be more beneficial than through political channels.

local economic effects of resource abundance within a country, we can analyze other mechanisms that may be relevant at local level. In particular, we document a case where mineral abundance has a positive effect on local communities, and identify backward linkages as a plausible mechanism for this occurrence.

There is an emerging literature exploiting within country variation to analyze the effect of resource boons. For example, Michaels (2011) studies the effect of oil abundance on specialization and long-term income in U.S., while Monteiro and Ferraz (2010) find a relation between oil royalties and corruption among Brazilian mayors. Within this literature, our paper is closely related to Caselli and Michaels (2009). They study the effect of a fiscal windfall from oil royalties to Brazilian municipalities. Consistent with our results, they find that the fiscal windfall has no effect on local income and little improvement on living standards. Our paper complements their findings by showing that, in the presence of strong enough backward linkages, the effect can be positive.

This paper also relates to a literature empirically examining the effect of local demand shocks on regional markets; see for example Carrington (1996), Greenstone and Moretti (2003), and Black, McKinnish and Sanders (2005). This literature, predominantly using U.S. data, finds evidence of positive effects of demand shocks -such as construction projects, coal price fluctuations, and new industrial plants- on local wages, employment and welfare. We show that similar phenomena can occur in the context of a rural, poor economy.

In the next section, we provide an overview of the Yanacocha case while Section II discusses the analytical framework. In Section III we present the data and discuss the empirical strategy. Section IV presents the main results while Section V explores alternative explanations. Section VI concludes.

I. The Case of Yanacocha Gold Mine

Peru has a long tradition as a mining country and ranks among the top producers of minerals in the world. One of the most important mines is Yanacocha, the second largest gold mine in the world, and producer of around 45 percent of Peruvian gold.

Yanacocha mine is located in the Department of Cajamarca in the North Highlands of Peru, a very mountainous area located almost 800 km from Lima, the country's capital.[3] The region where the mine is located is very poor and mostly rural.[4] The mine site is located 50 km away from Cajamarca city, the department's regional government center and, with almost 200,000 inhabitants, the largest urban settlement.[5]

[3] A department is the largest sub-national jurisdiction in Peru. It is divided in provinces and districts. There are 24 departments in Peru, 194 provinces and more than 1800 districts.

[4] In 2000, around 65 percent of the population was poor and, despite the mining sector representing almost half of the regional output, the employment share in agriculture was around 70 percent.

[5] There are also other three major cities in the surrounding area (Trujillo, Chiclayo and Chachapoyas) and some small and medium-scale mines in the neighboring department of La Libertad. These mines produce much less than Yanacocha and production levels remained stable over the period of analysis.

The extraction of gold is from open pits using a capital intensive technology.[6] All the gold is exported as ingots, without further local processing or added value. In addition, the mine is privately owned but its owners are not local residents.[7] These features preclude the creation of forward linkages and the increase in local income due to the distribution of profits.

Yanacocha's workforce is composed by skilled workers hired directly by the mine and low-skilled workers employed indirectly, through service contractors. The mine procures some inputs from local suppliers.[8] These goods tend to be relatively simple and with low quality requirements such as construction materials, chemicals and cleaning products, and basic hardware. Crucially, the mine does not purchase local agricultural products. Due to the proximity to Yanacocha, most mine workers and local suppliers live in the city. This feature facilitates our analysis, because the mine purchases local goods and services exclusively in Cajamarca city.

During the first years of operation, Yanacocha had little economic interaction with the regional economy. The number of workers hired by the mine was small and few inputs were purchased locally (Kuramoto 1999). However, in the late 1990s there was a change in this trend, as shown in the value of local purchases and wage bill paid to contractors (see Figure 1). This was driven by an explicit corporate policy aimed to increase the participation of local firms and workers.[9] This policy was promoted by the International Finance Corporation, one of Yanacocha's shareholders and Newmont's main lender, as a way to increase the economic impact of the mine in the region and minimize the risk of conflict with the local population (Jenkins et al. 2007). We exploit this increase in demand for local goods and services as a source of variation to study the effect of the expansion of the mine on the local economy.

In addition to the increase in local procurement and employment, the expansion of Yanacocha has created another significant source of transfers, namely a revenue windfall to local governments, due to a tax-sharing scheme called *canon minero*. This scheme allocates 50 percent of the mine's corporate tax revenue to local governments located in the department of Cajamarca.[10] This source of local fiscal revenue has increased significantly (see Figure 1), even though the timing and geographical destination of resources might be different to the expenditure

[6]The production process starts by drilling holes in the ground, filling them with explosives and removing the ore with controlled demolitions. The ore is transported to leaching pads where the gold is separated using a cyanide solution. The gold-rich solution is then processed to separate the gold from the cyanide using a Merrill-Crowe process. The resulting gold is smelted and refined to obtain ingots. Finally, the waste material is returned to its original position, covered with soil and reforested.

[7]The mine's shareholders are Newmont Mining Corporation, a US based company, Minas Buenaventura, located in Lima, and the International Finance Corporation, a member of the World Bank Group.

[8]For a firm to be considered local it has to be registered in Cajamarca and have at least 50 percent of local residents among their shareholders.

[9]The most important features of the mine procurement policy were to give priority to local suppliers and workers in competitive bids, and to encourage suppliers to hire local workers.

[10]The amount each local government receives is defined by a formula that takes into account population size and density, as well as poverty incidence (Minera Yanacocha 2006). The tax collection and sharing scheme is managed by the central government without involvement of local authorities.

on local purchases. [11]

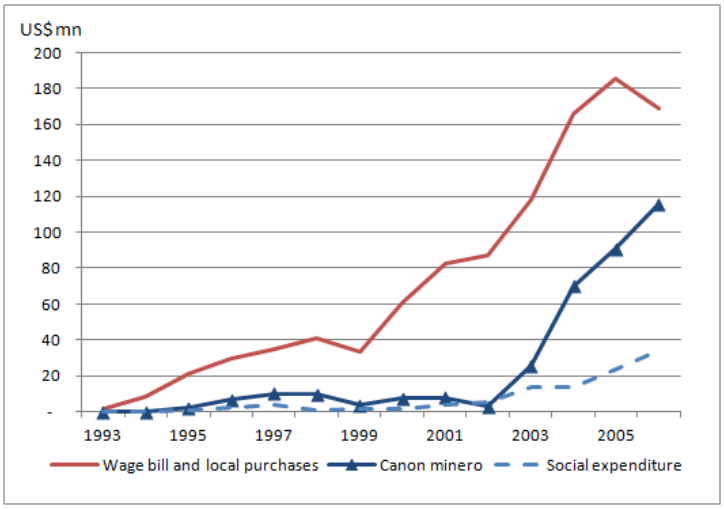

FIGURE 1. YANACOCHA'S LOCAL EXPENDITURE AND CONTRIBUTIONS

II. Analytical framework

As pointed out by Hirschman (1958) in the opening quote, natural resource ventures in poor areas are often perceived as 'enclaves' that do not generate local positive effects. These ventures tend to be capital intensive with almost no local employment, foreign-owned (i.e. no profits distributed), and with almost no linkages to the economy, whether forward (e.g. production of inputs of production) or backward (e.g. local procurement of goods and services). This is a fair description of Yanacocha before the procurement policy change (see Kuramoto (1999)).

In this context, it becomes relevant to understand under which circumstances Yanacocha's new procurement policy could be an instrument for regional income growth. Conceptually, we can treat the expansion of the mine's demand for local inputs as a shock to labor demand in Cajamarca city. A suitable analytical framework for studying these local shocks, and the associated general equilibrium effects, is provided by Moretti (2010, 2011).

In the simpler version of the model in Moretti (2010), there are two competitive local economies that use homogeneous labor to produce nationally traded goods and non-traded goods. Typically, one of the non-traded goods is assumed to be

[11] Yanacocha also funds development projects in small rural villages within a few kilometers of the mine pits, but this social expenditure has increased only recently and is much smaller than the amount transferred as *canon minero* or spent on local inputs.

housing. The price of nationally traded goods is given, while the price of non-traded goods is endogenous. The slope of the labor supply depends on workers' preference over a given location, while the slope of housing supply depends on geography and land use regulations. Both are assumed to be upward sloping.

We can re-interpret this model to fit the features of the Yanacocha case. In particular, we can think of Cajamarca city and surrounding areas as one local economy, and settlements located farther away as another.[12] In addition, we can think of the non-traded goods more generally as goods whose price is determined locally. Most typically this category would include housing. But we can also include in this category some agricultural goods that are both produced and consumed locally, such as potatoes and maize. This is mainly due to the high transportation costs in the Peruvian highlands.

With these modifications in mind, we can start analyzing the direct and indirect effects of the mine's expansion of local procurement. Recall that the Yanacocha's local procurement policy targeted labor-intensive services localized in Cajamarca city. As in Moretti (2010), the first effect of this demand shock is to increase nominal wages in the service sector in Cajamarca city and surrounding areas, relative to locations farther away. To the extent that workers are mobile between sectors, this shock should also increase the wage of other workers, not directly linked to the mine. Second, the increase in the city's budget constraint would increase the demand and the price of local goods such as housing and local food in Cajamarca city and surrounding areas. These general equilibrium effects would benefit home-owners and local producers.

We next ask what happens with real wages and workers' real income. With perfect labor mobility[13], real wages would equalize across locations. However, with imperfect labor mobility, the demand shock would increase real wages, and real income, of workers.[14] As we discuss in Section V.B, evidence suggests that workers are mobile within the local economy (i.e. between Cajamarca city and surrounding areas), but are less mobile between Cajamarca and other, more distant, locations. In terms of the model in Moretti (2011), this implies a low level of labor mobility.

This first result generates the following testable predictions:

1) There is an increase in nominal and real income of workers in Cajamarca city and surrounding areas, relative to areas located farther away.[15] The extent of this increase depends of the substitutability of labor between different sectors and the inter-regional mobility of labor.[16]

[12]This assumption can be motivated, for example, by transportation costs proportional to distance. This is the approach taken in new economic geography models such as the mono-centric city model developed by Fujita and Krugman (1995).

[13]Or perfectly inelastic supply of non-traded goods.

[14]The model also predicts that the real wage in farther locations would also increase, due to migration reducing the price of local non-traded goods. The extent of this increment would depend on the degree of labor mobility. The less mobile labor between both locations, the larger the difference in real wage.

[15]In the empirical analysis, we focus on real income because there is no data available on wages.

[16]Note that with perfect labor mobility, the real wage in all areas is equal in equilibrium, and the

2) There is an increase in the price of local goods such as housing and local food. This price increase transmits the benefit of the demand shock to home-owners and local producers.

A subsequent relevant question is who benefits from the shock to labor demand. The previous analysis suggests the presence of a direct welfare effect of workers in the service sector and, through general equilibrium effects, an increase in welfare of other workers, home-owners and local producers.

Moretti (2011) also points out to heterogeneous effects across sectors (tradable and non-tradable sectors) and skills. In particular, the model predicts that the demand shock would benefit mostly the non-tradable sector. The effect on tradable sectors, however, is ambiguous. On one hand, it may be negative due to the increase in costs of production. Conversely, it may benefit from increasing agglomeration economies. This is an important discussion, that we will not be able to explore due to the small number of workers in the tradable sector in our sample.[17]

Another prediction of the model relates to the relative performance of skilled and unskilled workers. Recall that the increase in the mine's local procurement targeted unskilled workers. To the extent that both types of labor are imperfect substitutes, the increase in wages would benefit unskilled workers more than skilled workers. If skill and level of income are correlated, this result also suggests that workers with low income might be benefiting more from the expansion than high skill-high income workers.

This conceptual discussion provides us with some intuition about what the expected effects of a labor shock to a local economy are in our setting. It also helps us understand under which circumstances we should expect the effects to be present and how the benefits are distributed. But most importantly, it provides us with some guidance as to how to proceed in the empirical exercise presented below.

III. Data and Methods

A. Data and main variables

The empirical analysis combines household data with information about Yanacocha's activities for the 10-year period between 1997 and 2006. For households, we use repeated cross sections of the Peruvian Living Standards Survey (ENAHO), an annual household survey collected by the National Statistics Office (INEI). The survey consists of a stratified household sample representative at the regional level. We focus on the North Highlands statistical region, the area where

demand shock is entirely capitalized by land values.

[17] Moretti (2010) defines the tradable sector as manufacturing. In our sample, workers in this sector represent only 5.6% of the total number of workers.

the mine is located and restrict our attention only to households with an employed head.[18] The data set includes in total more than 7700 households located in 101 districts.[19]. The main outcome variable is income, that we deflate using the poverty line.[20]

To quantify exposure to the mine's center of activities, Cajamarca city, we construct a measure of the distance from the household's location to the city. This measure varies at district level. In particular, we measure distance as the length of the shortest route between the main town of the district and Cajamarca city using the existing road network.[21] The measure of distance ranges from 0 to 400 km, with an average value of 100 km. Table 1 shows some summary statistics of the main variables from the household survey. We estimate the means and standard errors using sample weights and clustering by primary sampling unit to account for the sampling design.

To measure the expansion of the mine activities, we collect data from Yanacocha reports on total payment to workers, local purchases and total production (Minera Yanacocha 2006). The frequency of this data is annual and covers the period 1993 to 2006. Local purchases include goods and services bought to local suppliers and contractors. This variable includes the wages of workers that work for mine contractors. The wage bill includes all work-related payments to Yanacocha's directly employed workers. This includes wages, bonuses and a share of the mine's profits.[22] We include this last item as part of the wage bill, since it is effectively part of the total remuneration to workers.[23]

We measure the mine's demand for local inputs as the sum of the wage bill and local purchases[24]. Table 1 presents summary statistics for the firm level data over the period 1997 to 2006. The value of wage bill and local purchases is measured in millions of US dollars while the quantity produced is measured in millions of ounces[25].

B. Identification strategy

The aim of the empirical exercise is to evaluate the effect of the mine expansion on measures of living standards, such as real income, as well as changes in local prices. To do that, we exploit two sources of variation. First, we use the significant increase in Yanacocha's demand for local inputs that started in 2000. As

[18]This filter reduces the sample by just 46 observations and does not affect the results.

[19]It represents an average of 770 observations per year.

[20]The poverty line is estimated by the Statistics Office as the value of the minimum consumption basket that guarantees an adequate living standard. It is calculated using local prices and varies within region and over time. S ee Appendix III.A for a discussion on the choice of the price deflator.

[21]The results are robust to alternative measures of distance.

[22]8 percent of the mine profits are distributed among mine workers. This benefit is defined by law and accrue only to workers directly employed by the mine, not to workers employed through contractors.

[23]The results are robust to the exclusion of the workers share of mine's profits of the measure of wage bill.

[24]This measure includes direct and indirect hiring of labor-intensive services.

[25]See the on-line Appendix III.A more details about the data used in the paper.

Table 1—Summary statistics

Variables	Mean N=7,738	Standard error
Household head		
Years of education	5.4	0.1
Age	47.4	0.2
% female	15.7	0.4
Household		
Income per capita	212.0	3.4
Consumption per capita	190.2	2.2
Poverty line	173.3	0.3
% poor	63.5	0.5
% extreme poor	33.9	0.5
% urban	36.5	0.5
% access to electricity	38.1	0.6
% access to piped water	59.1	0.6
Nr. Household members	4.7	0.03
Nr. Income earners	2.0	0.01
Distance to Cajamarca city (km)	97.0	0.7
Firm data N=10		
Wage bill	42.3	27.7
Local purchases	55.5	33.9
Gold production	2.2	0.8
% local purchases	12.5	5.1

Notes: The mean and its standard error are calculated using sample weights and clustering by primary sampling unit. Income, consumption and poverty line are measured in Nuevos Soles. The value of wage bill and local purchases is measured in million of US$ while the quantity produced is measured in millions of ounces. In the period of analysis, the average exchange rate was 1 US dollar=3.2 Nuevos Soles.

previously mentioned, this growth was driven by the increment on gold extraction and implementation of mine's policies directed at increasing local procurement and employment.

Second, we exploit the household's distance to Cajamarca city as a source of heterogeneous exposure to the demand shock from the mine. This measure of distance ranges from 0 to 400 km with an average value of around 97 km. In the main specification, we round the average distance and use 100 km as the threshold to divide the districts in two categories: far and close to the city (see Figure 2).[26]

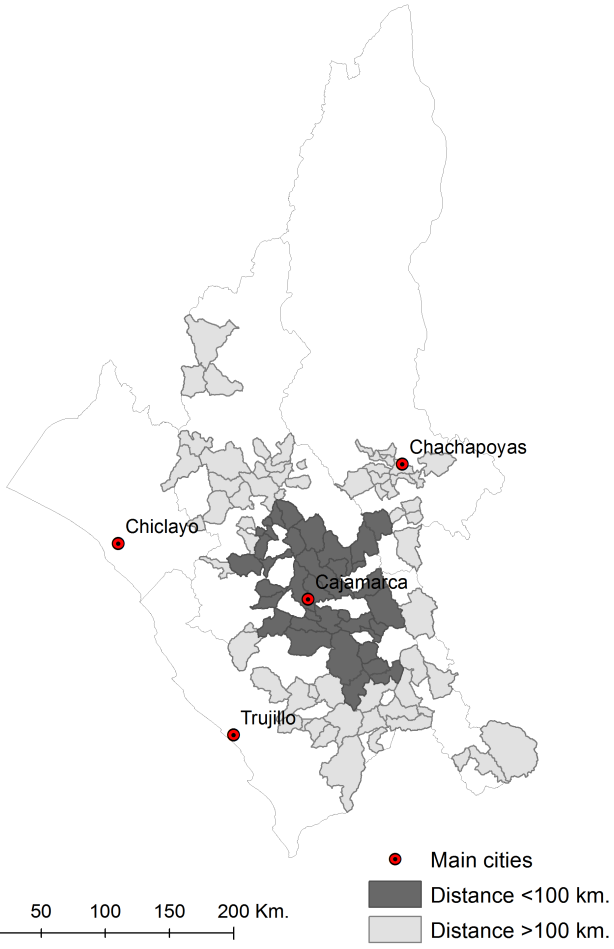

Figure 2. Districts in sample, by distance to Cajamarca city

[26]Results are similar using alternative thresholds such as the median value of 89 km.

Our identification strategy is basically a difference in difference procedure that uses the expansion of the mine as the treatment, and compares households located close to Cajamarca city to households farther away. The validity of the empirical strategy relies on the assumption that the effect of the mine declines with distance, and that the evolution of outcomes in areas far and close to the city would have been similar in the absence of the mine expansion.

Figure 3 illustrates the basic idea behind the identification strategy. It plots the conditional mean of real income per capita for households located within 100 km from the city and those located farther away.[27] Note that until 2001 the real income follows similar trends in both locations. After that, it diverges and shows a relative increase in areas located closer to the city.

The similarity of trends in both areas before the expansion of the mine is a necessary condition for the validity of our difference in difference strategy. There may be, however, other unobserved time-varying factors correlated with the expansion of the mine and affecting differently areas closer and farther from the city, which would invalidate our identification assumption. We address these concerns in more detail in Section V.

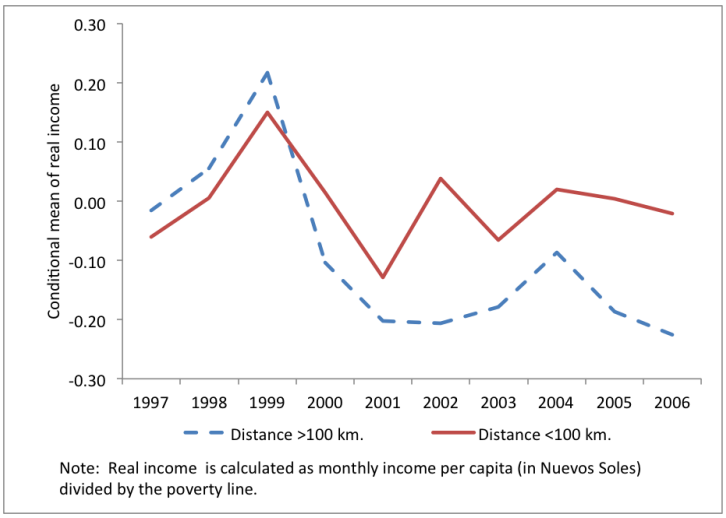

FIGURE 3. CONDITIONAL MEAN OF REAL INCOME

To formally evaluate the effect of the mine, we estimate the following regression:

$$y_{hdt} = \alpha_d + \eta_t + \beta(\ln M_t \times distance_d) + \mathbf{X}_{hdt}\gamma + \varepsilon_{hdt}, \quad (1)$$

where y_{hdt} is the outcome variable of household h in district d in year t. The

[27] The mean is conditional on schooling, age and gender of the household head, and access to piped water and electricity.

outcome variable could be the log of real income, measures of living standards such as consumption or poverty, or proxies of nominal prices.

M_t is a measure of the mine activity, lagged two periods to allow adjustments in markets.[28] In the baseline specification we use the mine's demand for local inputs as a measure of activity. This variable is the sum of the mine's wage bill and local purchases. We also check the robustness of the results using alternative measures such as the number of workers or quantity of gold produced. $distance_d$ is the measure of distance which is a dummy equal to one if the district where the household lives is within 100 km of Cajamarca city, and zero otherwise. We also use more flexible definitions of $distance_d$, such as a spline or the continuous measure, to explore the heterogeneous effects. In this specification, the parameter of interest is β which captures the effect of the mine expansion.

All regressions include year (η_t) and district (α_d) fixed effects, and a vector of household characteristics $\mathbf{X}_{hdt}$ (see footnote of Table 2 for details). We estimate the regressions using sample weights and cluster the standard errors at district level.[29] We cluster the errors at this level for two reasons: (i) to take into account possible spatial correlation between households, (ii) to reflect the fact that the variation in the expansion of the mine is at district level.[30]

IV. Main Results

In this section we report the main empirical results, following the analytical framework discussed in Section II. Here, the expansion of Yanacocha's demand for local inputs acts as a labor demand shock to the local economy and generates two effects. First, an increase in nominal income that affects all workers in the area, driven by the expansion of labor demand in the services sector. Second, an increase in the price of goods traded only locally, such as housing and local agricultural goods. As in Moretti (2010, 2011) real effects on income are present if the supply of local goods is upward sloping and labor is not perfectly mobile.

A. Effect on income

Table 2 reports the estimates of β, the parameter associated with the interaction of the mine activity and distance, using household income per capita as the outcome variable.

Column 1 presents results using the log of nominal income in the left hand side, while in columns 2 to 5 we use the log of real income, defined as the nominal income divided by the poverty line. Columns 1 and 2 use the demand for local

[28] We also estimate the baseline regression with different lags. The results are similar with longer lags (3 or 4 years). With shorter lags (contemporaneous value or 1-year lag) the results are qualitatively similar, but insignificant.

[29] See Magee, Robb and Burbidge (1998) for a discussion on the use of sample weights with complex survey data.

[30] There are 102 districts. The results are similar when we aggregate the annual data at district level. See Section B.4. of the on-line appendix.

inputs as a measure of the mine activity. This is our preferred indicator of the mine activity since it reflects the market interaction between the mine and the local economy better than other variables. The estimate of β is positive and significant, suggesting that the expansion of the mine is associated with an increase in nominal and real income in households close to Cajamarca city, relative to households further away. The results are robust to alternative measures of the mine's local procurement such as total number of workers and quantity of gold produced (Columns 3 and 4).[31]

Under the assumption that the evolution of real income in locations far from and close to the city would have been similar in the absence of Yanacocha, we can interpret these results as evidence of a positive effect of the mine on income. The magnitude of the effect is economically significant: the smallest estimate suggests that a 10 percent increase in the mine's activity is associated with an increase of 1.7 percent in the real income of households located closer to the city. Note that the evolution of Yanacocha implies large changes in household incomes since, by any measure, the activity of the mine has multiplied by at least a factor of two.

Heterogeneous effects by distance. — The identification strategy relies on the effect of the mine declining with distance to Cajamarca city.[32] We evaluate this feature in two ways. First, we use a spline of distance instead of the dummy variable. In particular, we divide the households in six groups according to the distance to the city. The categories start with households living in Cajamarca city and then group them in blocks of up to 50 km, with the last category containing all households located at least 200 km from the city. Then, we estimate the baseline regression (1) using real income as a function of the demand for local inputs interacted with each of the distance dummies.

Figure 4 shows the estimates of β for households located at each of the distance brackets, as well as the 90 percent confidence interval. The estimates are positive and significant for households located within 100 km of Cajamarca city, but become insignificant for households located in farther locations. These results support the assumptions such as imperfect inter-regional labor mobility, that imply that a shock to the labor demand shock has real effects in the city and surrounding areas, but not beyond. Empirically, they also provide a basis for using the dummy variable of distance (as in Table 2) and reduce concerns that the observed average effect is being driven exclusively by city residents.[33]

Second, we run a regression on the interaction of the measure of the mine's activity and the continuous measure of distance expressed in hundreds of kilometers. The results are displayed in column 5 of Table 2. Note that the estimated

[31] We also estimate the baseline regression using the quantity of gold as an instrument for the mine's demand for local inputs and obtain similar results.

[32] This could be due to transportation costs, for example.

[33] For example if the distribution of household income improvements was only concentrated in Cajamarca city, the reduced form estimates would be just averaging out large positive effects in the city and negative or zero effects in the vicinity.

Table 2—Effect of Yanacocha's expansion on real income

	Ln(nominal income)	Ln(real income)			
	(1)	(2)	(3)	(4)	(5)
Mine activity × distance < 100 km	0.159**	0.169**	0.234*	0.305**	
	(0.077)	(0.077)	(0.140)	(0.124)	
Mine activity × continuous distance					-0.115**
					(0.053)
Measure of mine activity	Demand for local inputs	Demand for local inputs	Total Nr. of workers	Gold production	Demand for local inputs
Observations	7,738	7,738	7,738	7,738	7,738
R-squared	0.568	0.524	0.526	0.525	0.524

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects. The full set of control variables includes: household head's education, age, gender and dummies indicating her industry of occupation and type of job, plus household access to water, electricity, number of household members and income earners, and an indicator or urban household. Gold production is measured in million of ounces. Demand for local inputs is the sum of Yanacocha's wage bill and local purchases. Column (5) uses a measure of continuous distance, expressed in hundreds of kilometers.

parameter is negative and significant.[34]

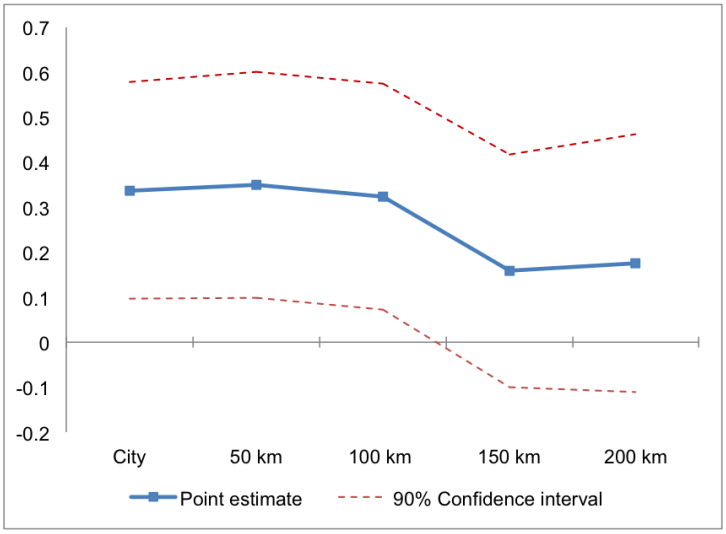

Figure 4. Effect of Yanacocha's expansion on real income, by distance to Cajamarca city

Other measures of well-being. — A main limitation of the previous analysis is that income may fail to fully capture the net effect on household welfare, even in the short run. This is particularly relevant since the operation of the mine has not been exempt of environmental concerns. The most serious incident occurred in 2000 with the spill of 150 kg of mercury on the road near Choropampa, a small town 85 km from the mine. There is also anecdotal evidence of concerns among the population regarding the risk of water pollution, due to the use of toxic chemicals in the mine, and discomfort associated with the perceived increase in prostitution and crime (Pascó-Font et al. 2001, p. 156).

To address this limitation, we first replicate the baseline results using other measures of well-being such as household real consumption and poverty[35]. Second, we test directly for the presence of some negative effects that could be associated with the expansion of the mine. In particular, we use data from the household survey to construct indicators of whether an individual had a health problem, or whether a household member was victim of a criminal activity.[36] Then, we

[34]These results are robust to the use of alternative measures of distance and non-linear effects of distance, see Section B.1. of the on-line appendix.

[35]Real consumption is defined as total expenditure divided by the value of the poverty line.

[36]The survey questions are "In the last four months, have you felt sick, suffered a chronic disease or an accident?" and "In the last 12 months, has any member of the household been affected by a criminal act?".

use these dummies as the dependent variables in the baseline regression (1) and estimate it using a linear probability model. As control variables we use an indicator of whether the household lives in a urban or rural area, has access to water, sanitation and electricity, the number of members and income earners in the household, and the individual's age and gender[37].

Table 3 displays the results. Columns 1 and 2 use the household's real consumption and a poverty dummy as outcome variables. In both cases, the expansion of the mine is associated with an increase in consumption and poverty reduction. Columns 3 to 5 explore the effect on health and crime indicators. Column 3 uses the whole sample of individuals, including children, while in column 4 we restrict the sample to children under the age of five, who may be more vulnerable to negative health spillovers. Note that in both cases the incidence of self-reported health problems has actually decreased with the expansion of the mine, although this effect is only significant in column 3. Column 5 shows that there is no apparent increase in crime associated with the expansion of the mine.

Nonetheless, we need to interpret these results with caution. They only suggest that there is no evidence that individuals in the area directly influenced by the mine have suffered more occasional illnesses, which could be a result from a more polluted environment. However, we cannot say anything about long run effects, such as a general deterioration in health, or chronic afflictions that could result from exposure to the activities of the mine. Similarly, the measure of crime informs us only about the perceived level of crime, and may fail to account for other forms of social disorder or crimes within the household.

These results do not rule out the presence of negative externalities. However, they suggest that their magnitude, at least as perceived by the residents, may not be too important.

B. Effect on local prices

The analytical framework predicts that general equilibrium effect of the mine's demand shock should be observed in the value of goods whose price is determined locally. In this section, we explore this by focusing on the price of housing and of main local agricultural goods, such as potatoes and maize.

The rationale for studying price of local crops in this context is twofold. First, due to high transportation costs in the Peruvian highlands, low value locally-produced goods are not generally traded outside a region. Hence their prices would be affected by local market conditions only. Second, the population in the area of study is mostly rural and dedicated to farming.[38] In this context, regional incomes in rural areas are directly link to changes in agricultural prices and production.

[37] The results are robust to the exclusion of these covariates.

[38] For example, around 74% of households live in rural areas, while 72% of the employed labor force works in the agricultural sector.

Table 3—Yanacocha's expansion and other measures of well-being

	Ln(household consumption)	Poor	Health problems		Crime
	(1)	(2)	(3)	(4)	(5)
Demand for local inputs	0.144***	-0.106***	-0.087**	-0.002	0.001
× distance < 100 km	(0.043)	(0.037)	(0.040)	(0.060)	(0.010)
Sample	households	households	all individuals	children age < 5	households
Observations	7,717	7,738	39,674	4,189	6,663
R-squared	0.589	0.406	0.076	0.157	0.047

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. *Poor* is a dummy equal to 1 if household is poor. *Health problems* is a self-reported measure of whether an individual was sick in the recent past, while *crime* is a self-reported measure of anyone in the household being victim of a crime in the recent past. Columns (2) to (5) are estimated using a linear probability model. All regressions include year and district fixed effects. Columns (1) and (2) use the same controls as the baseline regression (see notes of Table 2). Columns (3) and (4) include as control variables an indicator of urban household, access to water, sanitation and electricity, number of household members and income earners, and individual's sex and age. Column (5) uses similar controls but excludes individuals' age and sex.

Housing prices. — To measure the price of housing, we use self-reported house rental prices.[39] We use self-reported values, instead of actual land and rental prices, due to lack of data. The main limitation of using this measure is that open-ended stated preferences, like the self reported prices, may underestimate the true willingness to rent.

We estimate a hedonic regression with the log of the willingness to rent as dependent variable and the measure of the mine expansion and distance as explanatory variables. As control variables, we include year and district fixed effects, as well as dwelling and household characteristics (see notes of Table 4 for further details). The rationale for including these covariates is to account for determinants of the rental price and for systematic biases in the self-reporting of prices.

Column 1 in Table 4 presents the results. Note that there is a significant increase in housing prices in areas closer to the city. In Moretti (2011) this increase in housing prices can be interpreted as welfare gains for home owners. A positive shock to the local labor demand is associated with an increase in the demand for housing. With relatively inelastic housing supply, this translates into higher housing prices and welfare gains for home owners. In practice, since more than 80% of households are also home owners, this increase in housing prices implies an increase in the median household's wealth.

Price of agricultural goods. — To test whether prices of local agricultural goods have increased, we start by identifying the main crops in the area of study. We use information from the household survey about agricultural production and rank the crops according to their contribution to the regional agricultural gross product.

In our sample, the two most important crops are potatoes and maize. Together they account for almost half of the agricultural gross product.[40] These results are consistent with the data from the 1994 Agricultural Census. This census records that potatoes and maize are the most widespread crops in the region's highlands and represent more than 50 percent of the cultivated land.

For each crop, we calculate the unit value paid by consumers using information about total expenditure and quantity purchased. This variable is a proxy of the actual consumer price.[41] Then, we estimate the baseline regression (1) using the log of the measure of nominal prices as dependent variable. As control variables we include district and year fixed effects, plus non-parametric trends interacted with district characteristics such as altitude, population size, density and urbanization. These control variables account for heterogeneous market trends associated with district initial conditions.

[39]The survey question is: What is the minimum amount you would require for renting this property? In strict sense, this is a measure of willingness to rent.

[40]In the period 1997 to 2006, they represented 30 percent and 16 percent of the value of agricultural production, respectively. Their contribution remained relatively constant over the period of analysis.

[41]The unit values do not correspond exactly to market prices because they are also affected by the household's quality choice.

Columns 2 and 3 in Table 4 display the results. In both cases, the estimates suggest that the relative prices of local crops in areas closer to the city increase relative to prices in markets located in farther locations.

We replicate the exercise using the price of other food items, such as rice, sugar, and cooking oil that are mostly produced elsewhere (Columns 4 to 6).[42] In contrast to the price of local food crops, the price of these goods is not affected by the mine's activity. These results reduce the concern that the increase in price of potatoes and maize are simply reflecting a general increase in food prices[43].

C. Who benefits from the mine expansion?

We have shown that the expansion of the mine's demand for local inputs is associated with an increase of nominal and real income, and price of local goods, in areas closer to Cajamarca city, as predicted in Section II.

An important question that follows is who benefits from the mine expansion. We answer this question in several steps. First, notice that there is an increase in both workers' income and house prices. As in Moretti (2011), these results can be interpreted as evidence that both workers and home owners benefit from the mine expansion. The creation of these rents is possible because labor is not perfectly mobile.[44]

Second, we explore heterogeneous effects by sector. Ideally we would like to distinguish between tradable and non-tradable industries. However, this is not possible due to the above-mentioned data limitations.[45] Instead, we explore the effect of the mine expansion on households employed in the two main sectors in the region (services and agriculture) that represent around 90% of the labor force. There is also geographical specialization, as services are located in Cajamarca city, while agriculture is more important in the surrounding hinterland.[46]

To explore these heterogeneous effects, we estimate the baseline regression (1) splitting the sample between service workers and agricultural producers. In order to reflect the pattern of geographical specialization, we interact the mine's demand for local inputs with an indicator variable for households located Cajamarca city, and another for those located in the city hinterland (i.e. area outside the city, but within 100 km). As in the baseline regression, the omitted category includes households located farther than 100 km.

[42]For instance, rice represents only 1.6 percent of the agricultural product in the sample, while sugar and cooking oil are processed food stuff traded at national level.

[43]Further to this point, when we run a regression using the poverty line as the outcome variable, we fail to find any significant changes in areas close and far to Cajamarca. As discussed in on-line Appendix III.A, the poverty line is a basket of consumption that includes traded and non-traded goods.

[44]With perfect labor mobility the rents are fully capitalized by land values. This result features in the Rosen-Roback model of spatial equilibrium, widely used in economic geography.

[45]In particular, our data includes only a small sample size of workers in tradable industries, such as manufacturing.

[46]In Cajamarca city 48% of workers are employed in the service sector (retail, hotels and restaurants, and transport being the most important), while 15% work in agriculture. In contrast, in the city's hinterland the employment shares of both sectors are 18% and 75%, respectively.

Table 4—Effect of Yanacocha's expansion on prices

		Local food prices		Non-local food prices		
	House rents	Potatoes	Maize	Rice	Sugar	Cooking oil
	(1)	(2)	(3)	(4)	(5)	(6)
Demand for local inputs	0.247**	0.096*	0.076*	-0.010	-0.035	-0.022
× distance < 100 km	(0.105)	(0.051)	(0.046)	(0.019)	(0.030)	(0.021)
Prices reported by:	home owner	consumer	consumer	consumer	consumer	consumer
Observations	7,076	4,072	4,000	5,174	5,520	2,349
R-squared	0.690	0.598	0.303	0.414	0.421	0.460

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects, non-parametric trends interacted with district characteristics, and controls for head of household age, gender, schooling, number of household members and income earners. Column (1) also includes dwelling characteristics such as type of urban settlement, wall and floor materials, number of rooms, and access to utilities (water, sewage, electricity and telephone). All prices are in logarithms.

Column 1 in Table 5 displays the estimates using the whole sample. Columns 2 and 3 show the results when restricting the sample, first to service workers and then to agricultural producers. We find that there is an increase in real income among service workers in Cajamarca city, and among agricultural producers in the hinterland.

These results are consistent with the labor demand shock from the mine creating positive indirect effects in other non-tradable industries. Service and agricultural workers could benefit from a rise in wages. For agricultural producers, an additional channel could be the increase in local agricultural prices that would result in higher profits[47].

Finally, we explore the differences between skilled and unskilled workers. Recall that the mine's demand for local inputs targeted mostly unskilled workers. To the extent that both types of labor are imperfect substitutes, we could expect the benefits to be concentrated among unskilled workers. We study this issue by estimating the baseline regression by household head's skill level. We define skilled workers as the ones with years of education above the sample median. The results, displayed in columns 4 and 5 in Table 5, show that the increase in real income is much stronger for unskilled workers[48].

[47] In the sample, the majority of households engaged in agriculture are both producers and workers, so their income reflect both changes in agricultural wages and profits.

[48] Additionally, we also check how the effects on income are distributed at different points of the conditional income distribution, using quantile regressions. We find that the positive effects were evenly distributed across income deciles, even among the poorer households.

Table 5—Effect of Yanacocha's expansion by occupation and education

	Ln(real income)				
		By industry		By education	
	(1)	(2)	(3)	(4)	(5)
Demand for local inputs	0.178***	0.172*	0.122	0.318***	0.027
× Cajamarca city	(0.061)	(0.092)	(0.086)	(0.099)	(0.071)
Demand for local inputs	0.167*	0.158	0.204*	0.231*	0.033
× city hinterland	(0.085)	(0.110)	(0.112)	(0.125)	(0.084)
Sample	All	Service workers	Agricultural producers	Unskilled workers	Skilled workers
Observations	7,738	1,339	5,456	3,939	3,799
R-squared	0.524	0.603	0.419	0.432	0.649

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects and the same control variables of the baseline regression (see notes of Table 2). Cajamarca city is a dummy equal to 1 if household lives in Cajamarca city. City hinterland is equal to 1 if household lives outside Cajamarca city but within 100 km. The omitted category is households living further than 100 km. Skilled workers are defined as workers with schooling greater than the median of 5 years.

V. Alternative Explanations

We interpret the previous results as evidence that the local population benefited from the expansion of the mine due to the presence of backward linkages. This section explores whether alternative stories, different from the expansion of local procurement, could explain the same results. In particular, we focus our attention on two mechanisms: fiscal revenue windfalls and selective migration.[49]

A. Fiscal Revenue Windfall

As mentioned in Section I, local governments receive a mining transfer funded with a share of the corporate taxes paid by the mine. This source of local revenue grew in the last years following the expansion of the mine and represented a substantial revenue windfall for local governments. For instance, between 1997 and 2006 the total amount of mining transfers paid in the area increased by a factor of seven and its contribution to the municipal budget increased from 8 to 25 percent.

This revenue windfall, and the subsequent increase in public spending[50], may explain the observed relation between the mine expansion and real income. For instance, local wages could have increased due to the expansion of public employment, or due to the demand shock from additional public works.

There are two features of the canon allocation formula that are relevant for our analysis. First, the canon is distributed exclusively among local governments in the department where the mine is located.This implies that the canon funded with Yanacocha's taxes is distributed only among municipalities in the department of Cajamarca.

Second, the canon is distributed among district municipalities in three sequential rounds. First, a portion is distributed between the districts where the mine is located (producer districts). Second, another portion is distributed among the districts in the province where the mine is located including the producer districts (i.e. province of Cajamarca). Finally, another part is allocated to all the districts in the department, including the ones that receive canon in the previous two rounds.[51] In each round, the distribution of canon is a function of population, poverty and indexes of needs. This sequential distribution implies that the producer district and municipalities in the province of Cajamarca receive a larger share of the canon bursary relative to the rest of municipalities in the

[49] We present further checks to the robustness of the results in Section B.3 of the on-line appendix. In particular, we find that our results hold when controlling for heterogeneous trends (e.g. for more educated or more densely populated districts), when we exclude potential direct beneficiaries from the sample and when we control for distance to other cities in the region. Furthermore, we also show that household income in Cajamarca city increases relative to household income in these other cities.

[50] Using data at the municipal level, we find that increases in mining transfers are associated with greater levels and shares of capital expenditures.

[51] The remaining funds are allocated to the regional government, with jurisdiction over the whole department, and public universities.

department[52].

Figure 5 illustrates these features of the canon allocation formula. It depicts the evolution over time of the average canon per capita (in Nuevos Soles) for municipalities in Cajamarca province, the rest of Cajamarca department, and in other departments in areas closer and further than 100 km from Cajamarca city.[53]

There are three important observations to make. First, there is a timing difference between the increase in household income (i.e. from 2001) and the increase in canon per capita (that started in 2003 and became much steeper for Cajamarca province only, from 2005). Second, there is virtually no canon distributed in municipalities outside Cajamarca department. Finally, for those municipalities inside the department but outside Cajamarca province, the canon per capita has increased in a similar way regardless of proximity to Cajamarca city.

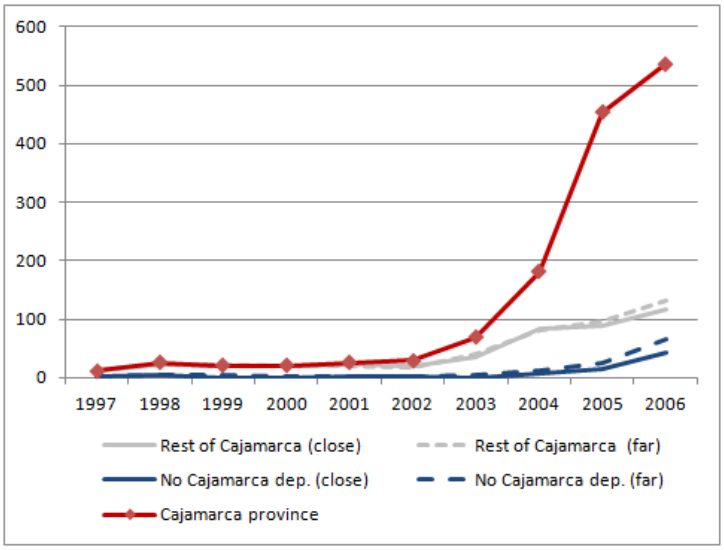

Figure 5. Average canon per capita by location (in Nuevos Soles)

To formally rule out that fiscal revenues are driving our results, we present three additional regression results. In Column 1 in Table 6 we add the log of the canon per capita received by the local government where the household resides to the baseline regression and find that that the relation between the mine's demand for local inputs and real income remains positive and significant.[54]

[52]Additionally, in 2005 the distribution of transfers was changed to benefit even more producer districts. As a consequence, the amount of canon received by municipalities in the province of Cajamarca has grown *faster* than in the rest of the department.

[53]All districts in Cajamarca province are within 100 km of the city.

[54]Results hold when using measures of total public spending and revenue and when instrumenting the transfer received using the sequence of rules described above.

Columns 2 and 3 exploit in more detail the features of the canon allocation formula. Column 2 adds a non-parametric trend interacted with an indicator of being in Cajamarca province to control for the faster growth in canon among these districts. Column 3 excludes all districts in Cajamarca department. This procedure effectively shuts down the possibility of canon from Yanacocha affecting the results, since this revenue accrues only to local governments in the department of Cajamarca.

These results have to be interpreted with caution. We should not interpret them as evidence that the canon has no effect in real income.[55] Instead, we interpret them just as a check that the observed effect of the mine's demand for local inputs on income is not driven by the revenue windfall to local governments.

The lack of a positive effect of the revenue windfall is surprising. A first explanation, beyond a possible attenuation bias, is the need of a longer period for public projects to mature [56]. An alternative explanation is that public spending increased well-being through better public good provision, but not through income gains. Finally, it could be that the additional public spending had very small social returns.[57].

B. Selective Migration

There is some evidence that areas close and far from Cajamarca city have experienced different population growth.[58]

A main concern with migration is that the observed increment in real income may be just reflecting compositional changes on the labor force. For example, if only the most productive agricultural workers migrate to the city, the increase in real income would be driven by higher productivity not by the demand shock from the mine.

Ideally we would like to identify migrants in the sample and check whether the results are driven by this sub-population. Unfortunately, that information is not available. Instead we address this concern indirectly by evaluating whether the expansion of the mine has lead to changes on observable characteristics of the labor force in areas closer and farther from the city. In particular we focus on different measures of human capital such as years of education, an indicator of having completed primary school, and an indicator of the worker being a male in prime age (between 20 and 40 years old).[59] We also explore characteristics of

[55]One concern is that even after controlling for district and year fixed effects, canon may still be correlated to unobserved district heterogeneity. For example, relatively poorer districts may receive a larger share of canon and also experience a long-term decline in economic activity. In that case, we may underestimate the relation between canon and real income.

[56]Note that using lagged values of the transfer does not change the results.

[57]Anecdotal evidence suggests that some recipients of mining transfers embarked in unproductive projects such as refurbishing the town main square or erecting monuments.

[58]See, for example, INEI (2009, p. 75). Between the 1993 and 2007 censuses, the region grew at an annual rate of 0.7 percent, below the national average of 2 percent. Cajamarca city, however, experienced a faster growth, with population increasing at a rate of 3.4 percent per year.

[59]In the baseline regressions we control for education and age. However, these controls may be insuf-

TABLE 6—EFFECT OF YANACOCHA'S EXPANSION ON REAL INCOME, CONTROLLING FOR THE REVENUE WINDFALL

	Ln(real income per capita)		
	(1)	(2)	(3)
Demand for local inputs	0.174**	0.166*	0.112*
× distance < 100 km	(0.082)	(0.089)	(0.065)
Ln(canon per capita)	-0.073	-0.194	0.943
	(0.209)	(0.303)	(0.644)
Non-parametric trends × Cajamarca province	No	Yes	No
Sample	All	All	No Cajamarca department
Observations	7,738	7,738	2,853
R-squared	0.524	0.525	0.623

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects and the same controls as the baseline regression (see notes of Table 2). *Yanacocha canon* is the total amount paid by Yanacocha as canon in US$. Column (2) adds year fixed effects interacted with an indicator of household living in Cajamarca province. Column (3) uses only households living outside Cajamarca department.

the agricultural unit such as number and concentration of crops. In all cases, we estimate the baseline regression (1) with year and district fixed effects as the only control variables.

Table 7 shows the results. Note that there are not significant changes in observable characteristics. Taken together, these results reduce concerns that the increase in real income is driven by migration of more productive workers or farmers to the city.

Table 7—Changes on characteristics of labor force and agricultural activity

	Years of education (1)	Complete primary (2)	Male in prime age (3)	Number of crops ()4)	Crop HH index (5)
Demand for local inputs	-0.684	-0.059	0.009	-0.165	0.021
$\times$ distance $<$ 100 km	(0.422)	(0.040)	(0.011)	(0.392)	(0.062)
Observations	31,255	31,255	34,159	5,582	5,582
R-squared	0.106	0.064	0.011	0.340	0.230

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects. Regressions in Columns (1) to (3) use the sample of individuals in working age, while columns (4) to (5) use the sample of households with some agricultural production. Complete primary is equal to 1 if individual completed primary school. Prime age is equal to one if worker is a male between 20 and 40 years old. Crop HH index is the Herfindahl-Hirschman concentration index of the value of agricultural production.

VI. Conclusion

This paper investigates the effects of a large mine's interactions with a regional economy. We find robust evidence that the mine has generated a positive effect on real income for residents in the city and in the surrounding rural hinterland. These results are generated by the expansion of local procurement.

The main contribution of the paper is to improve the understanding of the mechanisms through which natural resource extraction can foster local development. In particular it shows that, in the presence of backward linkages, the expansion of extractive industries can generate a positive demand shock and increase the real return to local factors of production, such as land and labor. In turn, this translates into better living conditions for local residents.

ficient to account for compositional changes in the presence of human capital spillovers or complementarities.

A main limitation of the paper is that we only observe events occurring over the span of a decade during the mine operation. This means that we are unable to explore whether the welfare gains are a short-term effect or part of sustainable development that would persist after the mine closure. For the same reason, we can say little about relevant long-run phenomena such as specialization, technological progress, or agglomeration economies. Though beyond the scope of this paper, these phenomena warrant further research.

In the case we study, the positive effects seem to come from a market channel rather than from the revenue windfall to local governments. This suggests that, in a context of weak governments, policies that promote local procurement and employment may be more beneficial to local residents than increased public spending, at least in the short run.

This policy implication depends, however, on the presence of upward sloping supply of local goods and labor, and the degree of inter-industry mobility of local workers. In the absence of migration costs, for example, the benefits could disappear since the increase in real wages would be offset by increasing labor supply. Similarly, if the mine demands very specialized work, not substitutable by local workers, the benefits would be confined to the mining sector.

The availability of natural resources in the developing world is often seen as a hindrance to economic development. In most cases, institutional failures such as conflict, mismanagement or corruption, are at the heart of this inability to transform natural wealth into better standards of living. This paper suggests, however, that in the presence of strong enough backward linkages natural resources have the potential to be more of a blessing than a curse.

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