The Local Economic Impacts of Resource Abundance: Theory and Evidence*

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Abstract

What are the socio-economic impacts of resource abundance? Are these effects different at national and local level? How could resource booms benefit (or harm) local communities? This paper reviews a vast literature examining these questions, with emphasis on empirical works. We start by discussing the evidence and theoretical arguments behind the so-called resource curse, and other impacts at country level. Then, we develop a simple analytical framework to understand how resource booms could impact local communities, and examine the available empirical evidence. This emerging literature exploits within country variation and is opening new ways to think about the relation between natural resources and economic development. Finally, we discuss issues related to fiscal decentralization and provide ideas for future research.

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1 Introduction

The literature studying the impact of resource abundance starts with the puzzling observation that some resource-rich economics tend to have worse economic performance than resource-poor countries. This phenomenon, the so-called natural resource curse, has dominated the debate on the economic impact of natural resources in developing countries. For instance, compare resource-rich Congo and Nigeria to resource-poor Singapore, Korea and Taiwan. A telling example is Venezuela, a primary beneficiary of the increases in oil prices in the 1970s, which suffered a decline in per capita output of 28 percent from 1970 to 1990 (Lane and Tornell, 1996, p.216). Similarly, from 1965 to 2000, oil revenues in Nigeria increased almost ten-fold. In that period, real income stagnated and both poverty and inequality increased (van der Ploeg, 2011, p.367).

The exceptions to this rule of resource curse have, naturally drawn attention. For instance, in the modern age Botswana, Chile, and, Norway have been successful in transforming their resource wealth into economic prosperity. Moreover, resource abundant countries, such as the United States, Canada, and Sweden, which are now high income countries, were long ago able to diversify their economies and reduce their dependence on natural resources.

In this paper, we review the literature on the economic effects of natural resource abundance. We focus on non-renewable resources such as oil, gas and minerals, although we also discuss some work that refers to a wider definition of natural resources. We start by reviewing the literature that motivates the natural resource curse and evaluates the impact of resource abundance at country level (Section 2). This literature is well developed and has been reviewed extensively.[1] The main contribution of this paper is reviewing the literature on the local impact of natural resource abundance (Section 3). This emerging literature reflects an active area of research and is currently shedding new light on mechanisms through which resource abundance can affect local communities (Section 3). The works reviewed define local community in a broad way as any sub-national jurisdiction. This includes major sub-divisions such as in federalized countries with states or provinces and lesser sub-divisions such as counties, districts or even municipalities. The important feature is the use of within country

[1] For additional literature reviews, see Stevens (2003), van der Ploeg (2011), Frankel (2011), Rosser (2006) or Deacon (2011).

variation as a basis for undertaking empirical analysis. Given the importance of resource fiscal windfalls and their distribution, we also discuss issues related to fiscal decentralization of mining revenues (Section 4). Finally, we provide some ideas for future work (Section 5).

2 Impacts at country level

In this section, we first discuss an analytical framework to think about how resource abundance could have negative economic effects. Then we examine the evidence available in the literature. Finally, we discuss the policy implications and main limitations of country-level studies.

2.1 Analytical framework

The theoretical explanations for the resource curse can be, roughly, grouped in three categories. First, a boom in extractive industries can crowd out other industries, such as manufacturing, that are more conducive to long-term economic growth. This is the Dutch disease argument. Second, dependence on primary sectors could leave an economy over-exposed to changes in commodity prices, which may be more volatile. Finally, the windfall from natural resources can exacerbate rent-seeking, corruption and conflict in a society. These phenomena can lead to bad economic policies, deterioration of institutions, and lower income and growth.

2.1.1 The Dutch disease

The Dutch disease is one of the earliest arguments linking resource abundance to lower economic growth (Corden and Neary, 1982; Corden, 1984). Dutch disease models usually consider an economy that produces traded and non-traded goods (we can think of them as manufactures and services), and treat a boom in export of natural resources as an income windfall.[2]

This windfall increases aggregate demand, which in turn increases the price of non-traded goods relative to traded goods.[3] This is effectively an appreciation of the real exchange rate. In the short run, this change in relative prices triggers several adjustments in the economy. First, output of the non-traded sector expands while the traded-sector contracts. Second, consistent

[2] See van der Ploeg (2011, section 3.1) for a formal exposition.

[3] This happens because price of non-traded goods prices is set domestically, while price of traded-goods is set in international markets.

with this change in output, production factors (such as labor and capital) reallocate from the traded sector to the non-traded sector. Finally, the economy fills its increased demand by importing more traded-goods. In the long run, the effects on output and import are similar, though there would also be changes in the wage-rent ratio. The effect depends on labor intensity of the non-traded industry. In particular, if this industry were more labor intensive, the wage-rent ratio would increase.[4]

The argument above assumes that the extractive sector does not use any production factor. In that case, the effects are driven exclusively by changes in aggregate spending. A more realistic model would assume that the extractive sector also employs labor and capital. In that case, in addition to the short-run changes in relative prices and crowding out of the traded sector (the spending effect), there would also be a reallocation of resources to the extractive sector, with negative effects on both traded and non-traded sectors. This is called the resource movement effect (Corden and Neary, 1982). The effects in the long run are more nuanced. If the resource sector is labor intensive and manufacturing is capital intensive, a resource boom could actually lead to more industrialization. On the contrary, if the resource sector also uses capital, then the traded sector would decline, and labor would reallocate to the non-traded sector. In turn, this may lead to a depreciation of the real exchange rate.

In sum, under reasonable assumptions, Dutch disease models suggest that resource booms would lead to: (1) an appreciation of the real exchange rate, and (2) reduction in output from traded sectors, such as manufacturing.

These effects by themselves are not negative. They are a market response to a revenue windfall, and reflect the adjustments of an economy to exploit its comparative advantages.

To explain why resource booms may reduce economic growth, we need to assume that the traded sectors crowded out by extractive industries (like manufacturing) are somehow special: they are the engine of growth. Models usually attain this by assuming that traded sectors benefit most from learning by doing and other positive externalities, such as human capital externalities (Krugman, 1987; Matsuyama, 1992; Sachs and Warner, 1995; Torvik, 2001). In standard endogenous growth models, these positive externalities determine technological progress, and long-run economic growth. In this view, by reducing investment and employment in the traded sector, resource booms could reduce technological progress and have negative, long term, effects

[4] Note that in this context, short-run and long-run refer to whether capital is fixed or not

on growth and welfare.

Similar results could be obtained if trade sectors exhibit increasing returns to scale, as in big push models (Murphy et al., 1989). In these models, the economy could make the transition from low-productivity cottage industry to high-productivity factory production if the size of the manufacturing sector is large enough. In that case, a resource boom that diverts resources away from manufacturing could frustrate or even reverse industrialization (Sachs and Warner, 1999).

2.1.2 Exposure to changes in commodity prices

A second argument relies on the observation that commodity prices tend to be more volatile and, until early 2000, exhibited a long-term decline. Thus, economies with high dependence on natural resources may be exposed to higher volatility of terms of trade.

The uncertainty stemming from this volatility would reduce investment in physical or human capital. For instance, Aghion et al. (2009) argue that with imperfect financial institutions, firms exposed to exchange rate fluctuations are more likely to hit liquidity constraints and be unable to invest. Gylfason et al. (1999) propose a model in which price volatility deters firms from moving towards high-skilled tradable sectors, which demand investments in human capital, and instead keep them producing commodities.

The link with growth is similar to the Dutch disease argument. It is assumed that technological progress is driven by learning by doing or human capital externalities. Thus, the decline of investment associated to price volatility can hinder economic growth.

Price volatility can also affect growth by making it more difficult to implement sound, prudent, policies. For instance, a resource boom may make a government more willing to increase spending and borrowing, using future resource revenue as collateral. If it fails to anticipate a decline in commodity prices, this can leave the country with high debt and a low flow of foreign resources to service it. Thus, a resource boom could generate a debt-overhang problem (Manzano and Rigobon, 2001).

2.1.3 Rent-seeking, corruption and conflict

The third set of explanations emphasizes political economy channels. The key idea is that resource abundance creates rents that, in the absence of good institutions, can be easily appropriated. The rents may foster rent-seeking behavior, increase corruption and erode

quality of institutions. In extreme situations, competition for these rents can generate violent conflict.

The existing literature discusses, at least, five political economy channels through which resource abundance can hinder economic growth and welfare. First, resource abundance may increase costly rent seeking and reduce net return to investment. For instance, Lane and Tornell (1996) and Tornell and Lane (1999) develop a model in which multiple powerful groups can appropriate resources via production taxes and targeted transfers. Note that the tax rate can be thought as, effectively, the expropriation rate. In this scenario, a resource boom increases demand for transfers, which lead to an increase in the tax rate and a reduction in the net return to investment. This discourages investment and, through the reduction of learning by doing and capital externalities, has a negative effect on growth.

Second, resource windfalls can divert entrepreneurial talent away from productive activities towards, unproductive, rent seeking. This idea is formalized in Torvik (2001) and Mehlum et al. (2006). In these models, there are a fixed number of individuals with entrepreneurial skills. These skills can be used in two activities: a modern sector, or in unproductive rent-seeking. It is assumed that the modern sector generates positive growth externalities, either through human capital externalities or demand complementarities, as in big push models (Murphy et al., 1989). A resource boom makes rent-seeking more profitable and attracts more entrepreneurs to the rent-seeking sector. While this is optimal from an individual perspective, it is socially inefficient. In particular, the loss of positive externalities in the modern sector can lead to an overall negative impact on income and growth.

Third, resource windfalls can increase political corruption and, more broadly, hinder quality of governance. For instance, Brollo et al. (2013) develop a model in which resource abundance increases corruption. The main idea is that the increase in government revenues, and spending, makes it easier for politicians to grab rents without disappointing voters. Thus, corrupt incumbents can still be re-elected.[5] Furthermore, the increase in rent-grabbing possibilities attracts other corrupt individuals to a political career, so the quality of the political elite deteriorates. In this view, resource booms can exacerbate the political agency problem and

[5] This results hinges on the assumption that voters are rational, but imperfectly informed. In that case, voters use spending as a signal of politician's quality. With higher revenue, a corrupt politician can disguise as an honest one by increasing public spending.

deteriorate political selection. Similar arguments have been proposed by political scientists. For example, Ross (2001) discusses several reasons why some natural resources, such as oil, may undermine democratic institutions.

Fourth, resource rents can fuel armed conflict. The key idea is that resource windfalls increase the "war chest" that organized groups can appropriate by fighting. This increases the returns to predation and promotes rapacity over these resources (Hirshleifer, 1991; Grossman, 1999; Collier and Hoeffler, 2005). Resource booms, however, do not necessarily increase violence. In some cases, they could actually reduce it. This can happen if resource booms increase the returns from productive activities and thus, the opportunity cost of participating in violence (Dal Bó and Dal Bó, 2011). This is the so-called opportunity cost effect. For instance an increase in agriculture prices may lead to higher rural wages, discourage workers to become warriors, and reduce intensity of social conflict.

The role of resource on conflict may be facilitated by ethnic diversity. In this view, ethnic differences allow the formation of stable coalitions necessary to engage in civil conflict (Caselli and Coleman, 2013). Resource-fueled conflict can have a negative effect on a country's income and growth, by destroying capital and discouraging investment. It can also have deeper, more damaging effects by reducing effectiveness of property right institutions (Hodler, 2006), and weakening incentives to invest on state capacities. State capacity refers to the ability of the state to implement a range of policies such as raising taxes, enforcing contracts, and supporting markets through regulation or otherwise. Besley and Persson (2010) propose a model in which dependence on natural resources triggers a higher propensity towards conflict. The resulting political instability discourages political elites to invest on legal and fiscal capacities.

It is important to remark that all these political economy explanations rely on the assumption that institutions are weak. In particular, they assume that institutions are unable to constrain expropriation and discretionary redistribution by interest groups.

2.2 Country-level evidence

This section discusses some of the empirical evidence on the socioeconomic impacts of resource abundance using country-level data. First, we examine the evidence on the resource curse. Then, guided by the analytical framework discussed in the previous section, we explore evidence on the possible explanations. Finally, we discuss the importance of institutions to understand the

impact of natural resources.

2.2.1 Natural resource curse

Sachs and Warner (1995) and Sachs and Warner (2001) were among the first to formally explore the relation between resource abundance and economic growth. Using a cross section of countries, they find that resource abundance (measured as the relative size of primary exports) is negatively correlated to GDP growth. Other studies, using similar methodology, also document similar negative correlation between measures of resource abundance and growth (Leite and Weidmann, 1999; Gylfason et al., 1999; Sala-i-Martin, 1997).

The evidence of the natural resource curse is, however, far from conclusive (Lederman and Maloney, 2007; Lederman and Maloney, 2008). Recent empirical work questions the robustness of the results to alternative specifications and measures of resource abundance. For instance, Alexeev and Conrad (2009) depart from the growth regression approach and use, as an outcome, income per capita. They show that abundance of oil and mineral resources is associated with higher income per capita. They also fail to find support for a deterioration of institutions due to natural resources.

A fundamental critique is that the measure of resource abundance (usually the relative size of commodity exports) is endogenous. For instance, there may be other confounding factors, such as quality of institutions, which may affect both growth and size of commodity exports. In that case, the resource curse would just reflect the fact that countries with bad institutions have lower growth and are less industrialized, thus more dependent on primary sectors.

For instance, Sala-i-Martin and Subramanian (2003) and Bulte et al. (2005) find that when adding measures of institutions as additional controls, the relation between resource abundance and growth disappears. Brunnschweiler and Bulte (2008) and Brunnschweiler (2008) go a step further by arguing that the usual measures of resource abundance are actually a measure of resource dependence. They treat this variable as endogenous and find that the negative relation between resource dependence and growth disappears. Moreover, they find a positive relation between growth and alternative measures of resource endowment, such as value of natural wealth and subsoil assets. van der Ploeg and Poelhekke (2009, 2010) also find similar results when controlling for measures of output volatility.

A possibility is that effects of resource abundance on growth may be heterogeneous; in

particular, it could depend on quality of institutions. For instance, the effect could be negative in a country with bad institutions, but positive when institutions are good (Robinson et al., 2006). Failing to account for this heterogeneity may lead to the wrong conclusion that the effect is insignificant.

Most of the country-level literature focuses on the effect of resource abundance on growth. There are, however, some studies focusing on other outcomes, such as inequality. For instance, Leamer et al. (1999) and Fum and Hodler (2010) find that resource abundance is associated with more inequality, especially in ethnically polarized societies. In contrast, Goderis and Malone (2011) find that inequality falls immediately after a resource boom, and returns to its previous level in the long-run.

2.2.2 Possible explanations for the resource curse

The debate of why the natural resource curse occurs is not yet settled. Cross-country empirical evidence offers mixed support for the Dutch disease and increase of terms of trade volatility as explanations for the resource curse. A more robust body of evidence points instead to the relevance of institutions. This suggests that rent-seeking and deterioration of governance may play an important role.

Several studies find strong evidence that resource booms are associated with the sectoral reallocation predicted by Dutch disease models, i.e, reduction of the manufacturing sector and increase of imports (Stijns, 2003; Ismail, 2010; Harding and Venables, 2010). This evidence provides support to the first part of the Dutch disease argument, i.e. that resource windfalls would lead to de-industrialization. These studies, however, fail to show evidence of the second part of the argument, i.e. that real appreciation and the subsequent de-industrialization would reduce growth or income. For instance, Sala-i-Martin and Subramanian (2003) do not find a significant relationship between overvaluation of the exchange rate and economic growth.

There is also mixed empirical support for the hypothesis that terms-of-trade volatility is the main culprit. Using cross-sectional and panel regressions, Gylfason et al. (1999) do not find a negative relationship between volatility of the real exchange rate and growth. Sala-i-Martin and Subramanian (2003) document a significant, but not robust, relation. In contrast, van der Ploeg and Poelhekke (2009) find a negative and significant relation and argue that volatility is

the key channel for the resource curse. The main differences between these studies are the set of control variables, measures of volatility, and sample of countries used.

Three sets of results point to the importance of institutions to understand the natural resource curse. As previously discussed, with weak institutions, resource windfalls can fuel opportunistic behavior such as rent-seeking. In turn, this may lead to deterioration of governance, corruption, and even armed conflict.

The first set of results suggests that the resource curse seems to be associated with the so-called "point source" resources. These are resources (such as oil, minerals, and plantation crops) whose production is concentrated in few geographic or economic areas. This concentration makes it easier for interest groups to control and capture their rents. For instance, Isham et al. (2005) and Bulte et al. (2005) find that point-resources are associated with worse political institutions and lower growth. Boschini et al. (2007) extends this analysis by interacting the type of resource with quality of institutions. They find the combination of abundance of point source resources with low-quality institutions is detrimental for economic growth.

The second set of results suggest that resource abundance seems to be associated with increase in corruption, deterioration of democracy, and armed conflict, especially in countries with weak democratic institutions. These results are consistent with the rent-seeking explanation of the resource curse. For instance, using a cross section of countries, Ades and Di Tella (1999) find that natural resource wealth is correlated with worse subjective measures of political corruption. Bhattacharyya and Hodler (2010) use a panel data of countries and find that natural resource abundance is associated with perceived corruption only in countries with a history of non-democratic rule. They interpret this as evidence that resource rents lead to corruption if the quality of democratic institutions is poor.

Several empirical studies argue that resource abundance hinders democracy, and fosters authoritarian regimes, especially in African countries (Ross, 2001; Wantchekon, 2002; Jensen and Wantchekon, 2004). Early evidence was based on cross-sectional analysis and case studies and its internal validity is open to debate. A recent paper (Tsui, 2011) uses a more convincing identification strategy exploiting a panel data of countries and oil discoveries. He finds that oil discoveries indeed reduce quality of democratic institutions, but only in already non-democratic regimes. Oil does not seem to affect institutions in countries with established democracies.

A large body of cross-country evidence points out to a positive relation between resource abundance and civil war (Fearon and Laitin, 2003; Collier et al., 2004; Ross, 2004; Fearon, 2005; Humphreys, 2005; Lujala, 2010). This relation seems to be driven by point-source resources, such as oil, diamonds and narcotics. These results, however, may not be robust to including country fixed effects, which accounts for several time-invariant unobserved omitted variables. In a recent study, Cotet and Tsui (2013) use a panel data of countries and include country fixed effects. In that case, they fail to find a significant effect of oil discoveries on conflict. Using a similar approach, however, Lei and Michaels (2011) do find a positive relation between oil and conflict. The main difference between these studies is that Lei and Michaels focus on large oil fields while Cotet and Tsui examine all fields, including small ones. This evidence is suggestive of non-linearities in the relation between resource abundance and conflict.

Finally, the negative relation between resource abundance and growth seems to be present only in countries with already bad institutions. In an influential paper, Mehlum et al. (2006) show that the resource curse is essentially driven by countries with low-quality institutions. In contrast, in countries with high-quality institutions, resource abundance does not affect growth. Using a panel dataset of countries, Collier and Hoeffler (2009) find similar results. In particular, the resource curse seems to be avoided in countries with strong democratic checks and balances. Boschini et al. (2007) extend these results by adding differences in the type of resources. They find that the curse is present only in countries with low quality institutions and easily appropriable resources, such as precious minerals and diamonds.

2.3 Lessons, limitations, and policy implications

The literature examining the impact of natural resource abundance at national level is ample and quite mature. So, what have we learnt? First, natural resources, by themselves, do not seem to be bad for economic growth. But they do become a problem in the absence of good institutions. Second, the problem is bigger for some type of resources that are easily appropriated (such as oil, minerals and diamonds). Finally, de-industrialization and price volatility may also matter, but not as much as we initially believed.

What are the policy implications? Resource economists have long been studying how to best use scarce, non-renewable, resources. The key insight is that a fraction of rents from a non-renewable resource should be saved and invested (Hartwick, 1977). This is the so-called

Hartwick rule.[6]

In this view, the policy recommendation for a resource boom is quite straightforward: invest the resource rents in other forms of productive capital, such as public infrastructure, education and health, or financial assets. In practice, this recommendation has translated into establishing commodity funds or sovereign wealth funds. Originally set by a handful of oil-rich countries, such as Norway, UAE, Saudi Arabia and Kuwait, these funds have been increasingly adopted by other resource-rich countries such as Kazakhstan, Nigeria, Papua New Guinea, and Ghana.[7] An alternative, suboptimal, policy has been simply to accumulate foreign reserves.

There are also several macroeconomic policy alternatives that could mitigate the side-effects of commodity price volatility. For instance, producers could reduce their exposure by hedging in commodity future markets, or governments could negotiate debt to be indexed to commodity prices. In terms of monetary policy, a country could reduce the impact of term of trade shocks by adopting a managed floating exchange rate regime or pegged exchange rates within target bands. Countries could also implement countercyclical fiscal rules that would force it to save export-earnings during boom years (for instance in a commodity or stability fund) in order to fuel spending during commodity busts. A good example of such an institutional arrangement is the case of Chile's budget rules (Frankel, 2011).

The country-level empirical evidence, however, suggests that the main challenge is not to identify the right policies, but to make societies willing (or able) to adopt them.[8] This goes back to having the right institutional environment. Hence, the main policy recommendation from this literature is that resource-rich countries should improve their institutions in order to make the best use of a resource boom, and avoid its more deleterious effects.

This insight underpins the current advice given to resource-rich countries of the need to improve public accountability and transparency, enhance democratic checks and balances, and limit rent-seeking behavior. This recommendation is echoed by a vast literature in

[6] The fraction saved should be such that genuine savings are zero (Asheim et al., 2003). Genuine savings, also known as adjusted net saving, take into account, national savings, investment in human capita, depletion of natural resources, and damage caused by pollution.

[7] Note, however, that having a commodity fund by itself does not guarantee that the country is adhering to an optimal saving policy, or that an interest group will not capture the rents.

[8] For instance, van der Ploeg (2011, section 4.2) documents that many resource-rich economies actually have negative rates of genuine saving, i.e., they seem to be wasting or consuming their resource rents, rather than reinvesting them.

development economics that highlights the importance of institutions (especially the ones that improve property rights) for economic development (Acemoglu et al., 2005; Nunn, 2009; Acemoglu et al., 2012).

This literature, however, suggests that core institutions, such as the ones needed to avoid the resource curse, are in part shaped by profound historical events. Recent theoretical work also points out to fundamental factors, such as external threats and distribution of political power, as important drivers of state building (Persson and Besley, 2009). Given these antecedents, it is not clear whether short-term policies could significantly improve the quality of these core institutions.

The use of country-level data has significantly advanced our knowledge on the impact of resource abundance. This literature, however, has several limitations. First, there are still relevant concerns regarding the causal interpretation of results. The presence of omitted variables, reverse causality, and measurement error are important empirical challenges in this literature. (van der Ploeg, 2011, p. 381) Scholars have tried to address them by including richer set of covariates, exploiting panel datasets, and using instrumental variables. These solutions, however, still fall short relative to experimental and quasi-experimental approaches currently used in applied economics.

Second, the impacts (positive or negative) of resource abundance are unlikely to be uniformly distributed in a country. For instance, many negative spillovers (such as pollution and population displacement) have a local geographical scope. Distribution of resource rents usually targets certain populations. Similarly, the impact of extractive industries demand for inputs may be felt more intensively in specific local markets. These local phenomena cannot be studied by looking at cross-country variation.

Finally, the main policy implication, i.e., that countries need to improve institutions to benefit from a resource boom, may be of limited applicability to several stakeholders, such as extractive firms, local communities, or funding agencies. An unsolved question is what these groups could do, short of fostering an institutional reform, to ameliorate the negative effects of resource abundance and enhance its potential benefits. Exploring the local impacts of resource abundance may shed some light on this question.

3 Impacts at the local level

In this section, we examine the potential economic impacts of resource abundance from a local perspective. In contrast to the country-level literature, which focuses on the country as a unit of observation, we instead focus now on subnational units such as states, counties or municipalities. By exploiting variation *within a country*, this literature is able to improve the empirical strategy and explore novel mechanisms. There are, however, new empirical challenges that need to be taken into account, in particular confounding changes in prices and population that may affect the interpretation of results.

First, we develop an analytical framework for understanding how a resource boom can impact local communities. Second, we present the available empirical evidence using within-country variation. Finally, we discuss whether there is a local resource curse and point out to some policy recommendations to mitigate negative effects of resource abundance at the local level.

3.1 Analytical framework[9]

The existing economic literature highlights at least four possible ways to analyze the local economic impact of natural resources and resource booms.

3.1.1 Resource endowments and specialization

First, resource abundance can be analyzed as a change in local endowments. If we treat local areas as small open economies, then we can study this change in endowments within the framework of the standard Hecksher-Ohlin model of international trade.

Within this framework, this change in endowments will imply a change in comparative advantages. This will lead to specialization in primary sectors at the expense of other traded sectors, such as agriculture and manufacturing. The reallocation of inputs towards the primary sector would require an increase in input prices, such as wages. In turn, this would increase the cost, and price, of non-traded goods relative to traded goods. This argument is basically an application of the Dutch disease models discussed in the cross-country literature.

[9] See diagrams in Appendix A for a graphical representation of the analytical framework.

In a similar way, the link between specialization and long-term outcomes is given by potential learning by doing or human capital spillovers associated with traded sectors. If these sectors experience faster productivity gains, then specialization in natural resources would hinder long-term economic growth and local income (Michaels, 2011). Note that this argument assumes that population is fixed, thus excludes possible migration that could occur as a response of a resource boom. Later we discuss models that relax this assumption.

Models stressing this specialization mechanism have several testable empirical predictions. First, they suggest that resource abundance would be associated with a reduction in the size of industries producing nationally traded goods. At local level, these industries are usually considered to be manufacturing and agriculture. Some of the measures of industry size used are: employment shares, share in wage bills, or share in local income. Second, they suggest that resource abundance could have a negative impact on economic growth and income. Finally, they also predict a change in relative prices. In particular, the price of non-traded goods would increase relative to traded goods. This result is equivalent to the real exchange appreciation predicted by Dutch disease models.

3.1.2 Fiscal revenue windfall

A second way to analyze the local impact of natural resources is to consider them as a source of fiscal revenue to local communities, i.e., a fiscal revenue windfall. This windfall could have both positive and negative effects on economic welfare.

A positive effect can be generated by the increase in the budget constraint of local governments and subsequent increase in public spending. This could potentially translate into better public good provision and better local infrastructure. In some cases, extractive firms directly improve local infrastructure and provide public services, such as roads, hospital, schools, and housing, or contribute to local development projects. By improving quantity or quality of local public goods, these interventions have the potential to improve human welfare outcomes, such as health and education. Moreover, to the extent that these public goods are productive inputs or create positive spillovers (as in the case of transport infrastructure), a resource boom could also increase local income and growth.

This argument, however, relies on several assumptions. First, it requires that local politicians are responsive to demands from the broad population. In turn, this requires well-functioning

local institutions and a healthy degree of political competition (Besley and Burgess, 2002). In the absence of good democratic checks and balances, the revenue windfall can fail to significantly improve public good provision (Caselli and Michaels, 2013) and lead instead to corruption and worsening of political selection (Brollo et al., 2013), Second, even if local politics made politicians responsive, it requires that local bureaucracies have the technical capacity to provide those public goods and services. This is not necessarily the case (Aragón and Casas, 2009). Not surprisingly, practitioners usually highlight the need to develop managerial and planning skills when implementing decentralization processes (Litvack et al., 1998).

These two factors, lack of political responsiveness or lack of technical capacities, may undermine the positive effect of revenue windfalls on public good provision, and local living conditions. A similar negative effect on living conditions can occur due to violent conflict. A resource windfall can foster conflict by increasing the benefit interest groups could obtain with violence. This is the so-called rapacity effect discussed in the country-level literature. Note that this argument relies on the assumption that local governments, in control of the revenue windfall, are unable to commit to redistribute these resources (Lei and Michaels, 2011). Resource booms, however, may also reduce conflict if they increase the opportunity cost for participants. This is the so-called opportunity cost effect.

In this case, the distribution and type of natural resources can be important. The important distinction is the degree of appropriability of the resource (Boschini et al., 2007).[10] For instance, booms associate to point resources such as oil and gold, may be more prone to generate a rapacity effect, since they mostly increase appropriable rents, but may have a relatively smaller impact on local wages. On the other hand, booms associated with dispersed agricultural resources, such as coffee, banana, and tobacco, may have a greater effect on local wages, and thus increase the opportunity cost of conflict participants (Dube and Vargas, 2013).

An additional source of conflict, complementary to the rent-seeking argument, is the change in land use (Hilson, 2002). For instance, some modern open pit mines may require land or access to water previously used for agriculture. This may create competing claims with existing local populations that may be already using those resources. Change in land use could also displace

[10] For analytical purposes, resources are classified as point and dispersed resources, the former being the most easily appropriated. In practice, the degree of appropriability is a continuum and depends of specific technological and institutional features. For instance, in some contexts, artisanal mining is a hybrid with dispersed activity high labor participation but commercial structures that make rents easily appropriated.

local populations and disrupt other activities such as hunting, fishing and gathering. In the absence of adequate reallocation and compensation policies, this competition for resources can have negative re-distributional consequences and lead to civil unrest and violence.

This discussion highlights the importance of local institutions. There are two sets of institutions that might be particularly relevant at local level: political institutions and fiscal decentralization arrangements. In contrast to the institutions studied in the cross-country literature, these institutional arrangements are usually defined by national legislation and thus are, in principle, more susceptible to policy interventions.

Political institutions comprise the rules to select politicians, re-elect incumbents, and restrict an incumbent's power. Similarly, they include the procedures citizens may need to take to become eligible voters, the set of electoral rules, among others. The theoretical political economy literature has emphasized the importance of political institutions, such as electoral rules and the form of government (Persson, 2002; Lizzeri and Persico, 2001).

Sub-national evidence is consistent with these predictions. For instance, Besley and Case (2003) find that different political institutions between U.S. states such as voter registration procedures, use of primaries, restrictions to campaign contributions or super-majority requirements affect the degree of political competition and representativeness of elected authorities. In turn, this translates in differences in spending and taxation. In India, Pande (2003) finds that political reservation (wherein some seats in state legislatures are reserved to candidates from minority castes) affects the size of public transfers to some disadvantaged groups. In China, Zhang et al. (2004) find that the use of elections to select local authorities (instead of appointment by the Central government) was more conductive to a better allocation of public expenditures. Similarly, Besley and Coate (2003) find that elected utility regulators implement more pro-consumer policies than appointed ones.

A second set of institutions includes fiscal decentralization arrangements. These are rules that define how fiscal revenue will be collected, distributed and used at subnational level. We will discuss in more detail the literature on fiscal decentralization in Section 4.

3.1.3 Local demand shocks

The previous two analytical frameworks are closely related to mechanisms already studied at country level. A more novel approach relies on thinking of resource booms as an increase in

the demand of local goods and inputs, i.e., a positive demand shock (Aragón and Rud, 2013b). This is plausible in contexts in which extractive industries use locally supplied inputs, such as labor or intermediate materials--i.e., in cases when extractive industries have strong enough backward linkages.[11]

A useful framework to examine the general equilibrium effect of such localized demand shocks is provided by models of spatial equilibrium. These models, originally developed by urban economists, are increasingly used to analyze local housing and labor markets.

The most widely used model is the Rosen-Roback framework. This model considers a country composed by several local economies or cities. Every city produces a single internationally traded good using labor, land, and a local amenity. Workers utility depends on nominal wages, cost of housing and local amenities. Labor is homogeneous and perfectly mobile. Land is the only immobile factor and its supply is fixed.

The key insight of this model is that, due to perfect mobility, utility of workers in every city should be the same. Thus, any local shock to the demand of labor is fully capitalized into land prices. In equilibrium, shocks to the local economy (such as a resource boom) benefit mostly the owners of immobile factors, such as landowners. In this case, while the national real wage may increase (depending on the relative size of the local shock), there is no difference in real wage between locations. This extreme result, however, is driven by the assumption that the elasticity of housing supply is limited while local labor supply is infinitely elastic.

Greenstone et al. (2010) and Moretti (2011) extends this framework by considering a more general case in which the supply of housing is not necessarily fixed and workers mobility is not necessarily infinite. In this framework, a shock to the demand of labor has more nuanced effects. In particular, a positive shock in the local demand for labor would first increase nominal wages. This would attract workers from other cities. Migration would increase labor supply, push down wages and increase housing costs. The net effect, however, depends on the elasticity of supply of both labor and housing. In particular, if both supplies are upward slopping (i.e. housing supply is not fixed and labor is not perfectly mobile) then the demand shock can lead to an increase in real wages, and welfare, of workers.

This benefit could accrue not only to workers in the affected industry, but, to workers in other

[11] Similar effect could occur if rents of extractive industries are transferred directly to the local population. Examples of such policies are the impact benefit agreements in Canada and the permanent fund dividend in Alaska.

industries. This can occur to the extent that workers in different industries are substitutable. Similar arguments can be made for workers of different skill level or within commuting distance of the city. Thus, a demand shock can have spillovers effect across industries and space.

The increase in real income is driven by the relative inelasticity of supply of factors used in production of non-traded goods (such as housing and services). In Moretti's model, these two factors are land for housing and labor, which is used to produce a traded manufacturing good and non-traded services. This argument, however, can be easily extended to other inputs used in production of goods that may be costly to trade, such as agricultural land used to produce perishable food.

An interesting prediction of spatial equilibrium models is that local demand shocks would attract workers and increase the local population. Population growth may create increase congestion and additional pressure on local services, such as education and health. However, the additional population could also generate positive effects in the form of agglomeration economies, i.e., gains in productivity associated with the clustering of economic activity. There is a growing body of evidence, mostly from the U.S., suggesting that the magnitude of agglomeration economies, in manufacturing and high-tech industries, is not trivial.[12] There is, however, not yet evidence on the magnitude of agglomeration economies generated by extractive industries. Moretti (2011) also points out to heterogeneous effects across tradable and non-tradable sectors. In particular, the model predicts that the demand shock would benefit mostly the non-tradable sector, such as services. The effect on tradable sectors is ambiguous. On the one hand, it may be negative due to the increase in wages and land rents. On the other, it may benefit from increasing agglomeration economies associated with the larger population. Thus, it is not clear whether a resource boom would encourage or crowd out manufacturing. This prediction contrasts with the standard Dutch disease argument, which would predict de-industrialization.

This framework provides several empirical predictions of the effect of resource booms, such as opening or expansion of mines and oil fields, in the case when *they have strong enough backward linkages*.

[12] See Moretti (2011, section 4.1) for a review of the evidence.

1. They suggest that resource booms would have a positive effect on nominal wages and labor outcomes, such as participation rate, number of hours worked, or employment rates.

2. Under plausible assumptions on housing supply and labor mobility, resource booms could increase real wages, and real income, of local populations. This could translate in reduction of poverty and increase in welfare. Note, however, that many extractive operations, especially in rural and less developed areas, resemble economic enclaves. They hire few local workers, do not redistribute profits locally and most of their production is exported. In these cases, we should expect positive economic impacts to be negligible.

3. There may be positive spillovers workers in several industries, not directly linked to the extractive activity, and surrounding localities within the hinterland of the affected city.

4. Resource booms will be associated to migration of workers and an increase in price of non-traded goods, such as housing.

These predictions have important implications for empirical analysis. First, migration induced by the resource boom may change the spatial distribution of a population's productivity. This could happen, for instance, if high-productivity workers are more able to benefit from the boom or face lower migration costs, or if low-productivity workers are displaced away from resource-rich areas. The worry is that an increase in local real income would just reflect the change in population composition, not real improvements in economic wellbeing. The importance of these compositional effects is case specific. Some empirical strategies to address this concern include using individual panel data, focusing on sub-populations that reside in the locality before and after the resource boom, and examining observable population characteristics (such as measures of human capital) that may be indicative of the importance of compositional changes.

Second, the predicted increase in non-traded prices, and cost of living, implies that changes in nominal variables (such as income, wages, and household expenditure) are not informative of the effect on purchasing power and welfare. Increments of these nominal variables may just reflect local inflation. To address this concern, researchers should deflate nominal variables using local price indices that take into account possible changes in local housing costs. Moretti

(2013) discusses several methodologies to construct such local price indices.

Similar concern arises when using other measures of wellbeing based on income or expenditure, such as poverty. The main issue is that in many cases poverty lines reflect the cost of a minimum consumption basket using prices at national level. In that case, they may fail to take into account changes in the local cost of living. To avoid this, researchers should adjust poverty lines using measures of local inflation.

While this framework predicts a possible positive impact of resource booms on real income, it is less clear what would be the effect on other measures of human wellbeing, such as education and health. On the one hand, education and health outcomes could improve due to an income effect. In addition, if the resource boom is biased towards high-skilled workers it could increase the returns to education. On the other hand, the increase in wages could increase the opportunity cost of education and discourage it (Atkin, 2012). A similar effect can occur if the extractive industry demands low-skilled workers and thus reduces the skill-premium. In terms of health, environmental pollution can reduce, or offset, the benefits from higher income. Below, we discuss in more detail the role of pollution.

3.1.4 Pollution

Extractive industries, such as mining and oil extraction, have the potential to pollute the environment. For instance, large-scale mining and mineral processing can generate significant amounts of air pollutants such as nitrogen oxides (NO_x), sulphur dioxide (SO_2), ozone and particulate matter. The main sources of these air pollutants are petrol engines of heavy machinery, fumes from smelters and refineries, and dust from blasting and earth moving operations. These air pollutants can be carried away over larger distances. At low concentrations, air pollutants are short lived: they are dissipated or absorbed by the environment. However, if toxic emissions are relatively large, they can deposit on the ground as acid rain. Acid rain contributes to soil degradation and can have cumulative negative effects (Menz and Seip, 2004).

Mining activities can also release industry-specific pollutants, such as cyanide, sulfuric acid, mercury, heavy metals and acidic drainages (Salomons, 1995; Dudka and Adriano, 1997). These pollutants can have negative, cumulative effects, on quality of soil and water sources. Similarly, small-scale and artisanal mining operations can pollute air and water.

The most notorious example is pollution from mercury used in gold amalgamation.

Environmental pollution creates several negative externalities. The one that has received most of the attention, in biological and social sciences, is the negative effect on human health (Graff-Zivin and Neidell, 2013; Currie et al., 2013).[13] There is also evidence that pollution can affect school and cognitive outcomes (Almond et al., 2009; Lavy et al., 2012), and increase school absenteeism (Currie et al., 2009; Gilliland et al., 2001; Park et al., 2002; Ransom and Pope III, 1992).

Recently, scholars have also started to examine other possible health-related effects, such as reduction on labor supply and labor productivity (Hanna and Oliva, 2011; Graff-Zivin and Neidell, 2012). This literature suggests that, by affecting health and human capital, pollution can deteriorate living conditions and hinder long-term development.

Another possible important pollution externality is the loss of agricultural productivity (Aragón and Rud, 2013a). The loss of agricultural productivity can have a negative impact on agricultural output, and, through that channel, affect income of farmers and rural population. This externality can be particularly relevant when extractive industries are located in the vicinity of rural areas, in which agriculture remains an important source of livelihood.

There are at least three mechanisms by which pollution can affect agricultural productivity. First, pollution can affect crops health and growth (Heck et al., 1982; Miller, 1988; Marshall et al., 1997). This translates in lower yields. Second, pollution can deteriorate quality of key agricultural inputs, such as soil and water (Menz and Seip, 2004; U.S. Environmental Protection Agency, 2012). For instance, deposition of air pollutants in the form of acid rain can lead to soil degradation. The increased acidity leaches nutrients from the soil, reduces plants' ability to absorb remaining nutrients, and releases toxic metals, like aluminum. Similar effects can be caused by acidic discharges from mining operations. Finally, air pollution can reduce labor productivity (Graff-Zivin and Neidell, 2012; Chang et al., 2014).

This framework has several implications for the empirical analysis. First, it suggests examining the effect of resource booms on indicators of human health, such as mortality and incidence of illness. This can provide a better picture of the effect on human wellbeing than simply observing income or poverty outcomes. Second, it points to other possible

[13] For example, in the economics literature, there are studies linking pollution to infant mortality (Chay and Greenstone, 2003; Jayachandran, 2009; Currie and Neidell, 2005), children hospitalizations (Lleras-Muney, 2010), low birth weight (Currie and Walker, 2011) and incidence of cancer (Ebenstein, 2012).

outcomes affected by resource booms such as workers' productivity, labor supply, and agricultural output. Finally, it highlights another channel, i.e. loss of agricultural productivity, through which resource booms could negatively affect local income, especially in rural areas.

3.2 Empirical evidence[14]

In this section, we discuss the empirical evidence on the local impact of resource abundance. We focus on quantitative academic studies.[15] In contrast to the country-level literature, the empirical literature exploiting within-country variation is more recent and less developed. There are, however, a growing number of studies already expanding this literature.

3.2.1 Impact on growth

A first group of studies replicate the growth regressions used in the cross-country literature, but with data at state, province or county-level. Similar to early work suggesting the presence of a resource curse, these papers also document a negative relation between measures of resource abundance and growth. For instance, using a cross-section of state-level data from the U.S., Papyrakis and Gerlagh (2007) find a negative relation between income growth and the share of primary sectors in local GDP. James and Aadland (2011) and Douglas and Walker (2013) use more disaggregated data from U.S. counties and find similar result. Outside the U.S., Zuo and Jack (2014) document similar negative relation using data from Chinese provinces.

It is, however, difficult to interpret these results in a causal way. These studies share many of the limitations of the cross-country literature such as omitted variable bias, reverse causality and measurement error.

3.2.2 Impact on employment and local living standards

Black et al. (2005) is one of the earliest studies departing from the cross-country growth

[14] See tables in Appendix B for a summary of the papers discussed in this section.

[15] There are, however, several case studies examining the role of extractive industries, such as mining, on local communities. See for instance McMahon and Remy, eds (2001) for a review of case studies in Latin America, Canada and Spain. There is also a growing body of work on local value added in extractives supply chains, which is informative of the potential impact of mining on local economies. This includes industry sponsored reports (ICMM) and work funded by the World Bank (Zambia, Zimbabwe, Burkina Faso, Liberia, Ghana, Tanzania, Central Asia). The latter has not yet been assessed but tentative conclusions are that in weak private sector environments there tends to be a very low proportion of manufacturing value added in supplying mines and a somewhat higher service value added. This is after excluding supply of locally produced fuel, electricity and cement.

regressions. They use county-level data from the coal-rich areas in U.S. Appalachia to examine the short-term economic impact of the coal boom in the 1970s and subsequent bust in the early 1980s. This study treats resource booms and busts as shocks to the local demand of labor. They find evidence of modest employment spillovers. The boom is associated with an increase in population, especially males in prime age, and in non-mining employment and wages. These effects are reversed during the bust. Their results, however, do not support the hypothesis that the coal boom crowded out other industries.

Using data from Western Canada, Marchand (2012) documents similar effects on local labor markets (i.e. modest employment spillovers, mostly in construction, services and retail) associated with the 1970s energy boom and bust. Fleming and Measham (2014) also find positive employment spillovers associated with the recent boom of coal seam gas in Australia.

In a related paper, Michaels (2011) examines the long-term economic impact of oil discoveries in Southern U.S. He uses county-level data covering the period 1940 to 1990 and exploits geological variation in oil abundance. He finds that discovery of oil increases specialization in oil production, but does not seem to have led to de-industrialization. There is, for instance, no change in the employment share of manufacturing. On the contrary, oil discovery increases the overall size of manufacturing (measured as number of manufacturing jobs per square mile). The increase in density of manufacturing employment seems to be associated with the increase in population size. These results are the opposite of what we could expect from the standard Dutch disease argument. Instead they are suggestive of agglomeration economies. The effect on real income is less clear. Michaels (2011) finds that nominal income increases, but this increase may have been offset by higher housing costs.

Allcott and Keniston (2013) extend Michaels (2011) study to rural counties in the entire U.S. They find similar results: oil discoveries increase population size, income growth and wages, but do not seem to negatively affect manufacturing. If anything, oil discoveries have a positive effect on manufacturing employment and output. Using rich data at firm level, they also evaluate the effect on total factor productivity, but find no significant increase. They interpret this evidence as suggesting that some manufacturing firms benefit from oil booms due to the increase in size of local markets and not due to productivity gains associated with agglomeration economies. This can happen, for instance, if manufacturing firms produce locally-traded goods.

More recently, Jacobsen and Parker (forthcoming) extend Black et al.'s (2005) study to Western U.S. They focus on oil and gas boomtowns created during the 1970s increase in energy prices. They also use county-level data but observe a longer time-span, i.e., 1969 to 1998. This allows them to explore the effect of a bust after a longer period.

Similar to Black et al. (2005), they also find evidence of improvement in several economic indicators during boom years (such as nominal income and wages, employment and population). Most of these effects are transitory and disappear after the boom. But, there are some long-lived negative effects after the bust: lower nominal income, lower profits and earnings, and higher unemployment compensation. The authors interpret these results as evidence that the bust created long-lasting economic hardships in the form of joblessness and depressed local income. In contrast to Michaels (2011) and Allcott and Keniston (2013), however, they find no evidence of any effect in manufacturing employment in either the short- or long-term.

These studies suggest that extractive industries (such as coal mining, oil and gas) do generate positive employment spillovers: booms seem to increase number of jobs and wages in other industries.[16] These spillovers are, however, modest in size.

These studies provide a less clear answer regarding the crowding out of manufacturing, which is a necessary condition for Dutch-disease arguments. While some studies find a reduction in relative size of manufacturing, others document an actual increase in manufacturing activity. A possible explanation is that resource booms may generate agglomeration economies that benefit local manufacturing firms. Similarly, part of manufacturing output is actually destined to local markets. Thus, some manufacturers could benefit from the growth of local demand. These factors may offset the increase in input prices associated with the resource boom. There is also not conclusive evidence on the long-term effects, at the local level, of resource booms. This is still an active area of research.

The studies discussed above have two important limitations. First, they are not very informative about the effects on real income or other measures of welfare. In particular, it is hard to assess how much of the increase in nominal income simply reflects the higher cost of living or changes in the composition of the local population. Second, these studies focus on developed economies such as U.S., Canada, and Australia. Thus they are not very informative

[16] Similar employment spillovers have been documented using other sources of demand shocks, such as construction of a pipeline (Carrington, 1996), closure of army bases (Hooker and Knetter, 2001), or opening of manufacturing plants (Greenstone et al., 2010).

of the local economic effects of resource abundance in less developed economies.

As discussed in the analytical framework, the economic effects at the local level depend on several factors, such as the degree of economic linkages of extractive activities (which determine the size of the local demand shock), substitutability of labor between industries, and labor mobility. These factors are likely to be very context specific.

Recent work has started to fill this gap in the literature. Caselli and Michaels (2013) examine the local economic effect of oil-based fiscal windfall in Brazil. Using data at municipality-level, this paper shows that oil production is associated with an increase in oil royalties paid to local governments, and reported public spending. However, the impact on provision of local public services is minimal. There is no significant improvement in housing quality or quantity, supply of educational or health inputs, or welfare receipts.[17] There is also a negligible effect on household income and population size. The authors interpret these findings as evidence that oil production has not been particularly beneficial to the local population. Instead, circumstantial evidence suggests that the oil revenues were used to fund patronage, rent extraction and officials' embezzlement. Brollo et al. (2013) provide further support to this interpretation. They also use municipality-level data from Brazil, but focus on all municipalities (not only the recipients of oil royalties). They find that fiscal windfalls are indeed associated with an increase in political corruption.

In the Brazilian case, the most important channel linking local economies to natural resources is through the fiscal windfall associated with oil royalties. This happens because in Brazil the extent of economic linkages between oil companies and local economies is very limited.

Aragón and Rud (2013b) examine the importance of these economic linkages. They use the case of Yanacocha, a large gold mine in the Peruvian highlands, and exploit a significant increase in the demand for local inputs. Their empirical strategy uses micro-data at household level and a difference in difference approach. They find that this increase in backward linkages had a positive economic impact on real income and poverty reduction. The benefit extends to local population not directly linked to mining, such as farmers and service workers. These results are consistent with the effects of a local shock to demand for labor in the presence of

[17] Using the same case but a different methodology, Monteiro and Ferraz (2010) also document that the oil windfall is associated to reported increases in expenses and size of the public sector, but no improvement in public services to the local population.

imperfect worker mobility. As suggested by Greenstone et al. (2010), in this case local shocks are not fully capitalized in land prices but can increase real wages.

Aragón and Rud (2013b) also examine the effect of the fiscal revenue windfall associated with mining production. In the Peruvian case, a share of corporate taxes from mining companies is transferred to local authorities. Similar to Caselli and Michaels (2013) they also find that increased local revenue, and public spending, associated with the resource boom does not translate into higher household income. The authors interpret these results as suggestive evidence that the market mechanism (i.e., increase in demand for local inputs) might be more effective in improving local living conditions than the fiscal channel (i.e., increase in local governments revenue and spending). These findings, both in Peru and Brazil, cast some doubts on the usefulness of revenue sharing schemes as a policy instrument for local communities to benefit from resource booms.

In a related study, Loayza et al. (2013), examines the socio-economic impact of mining in Peru using a rich dataset at the district-level that combines census and household surveys. Similar to Aragón and Rud (2013b), they find a positive relation between measures of living standards (such as poverty, consumption and literacy) and mining production, but not with government transfers associated to mining tax revenue. Moreover, they find suggestive evidence that mining is associated with an increase in inequality. The authors highlight that this increase in inequality, among other factors, may explain the opposition of local communities to mining projects.[18]

In one of the few studies focusing on Africa, Kotsadam and Tolonen (2014) examine the effect of mining on local employment. They use a rich dataset at the individual level for several Sub-Saharan African countries, and implement a difference in difference approach exploiting the opening and closure of mines. This study finds that mine openings seem to create new employment opportunities outside agriculture, and significant structural shifts. Interestingly, these effects are differentiated by gender. Women switch towards service sectors, while men move towards skilled manual jobs. Moreover, women's participation rate decreases with mine openings, while men's participation rate increases. These structural changes seem to persist after mine closures, at least for women. After a mine closure, men

[18] Similar relation between resource booms, income, and inequality has been reported in the case of Australia (Reeson et al., 2012). Interestingly, this study suggests that the relation between mining and inequality may have an inverted U-shape.

return to agricultural jobs, but women do not shift back to agricultural production. Instead, they leave the labor force. The authors interpret these findings as evidence that mining works as a boom-bust economy on the local level in Africa, but with permanent (negative) effects on women's labor market participation.

3.2.3 Impact on corruption and conflict

The within-country evidence linking resource booms to corruption and conflict is also quite sparse. As discussed above, evidence from Brazil (Caselli and Michaels, 2013; Brollo et al., 2013) suggests that the fiscal revenue windfall, associated with oil royalties, has increased corruption and rent seeking at the local level.

The revenue windfall is also associated with changes in political outcomes. For instance, Brollo et al. (2013) argue that the increase in public spending (allowed by the resource windfall) allows bad politicians to remain in office, despite extracting more rents. This translates in higher re-election rates of incumbents. Monteiro and Ferraz (2010) also document a similar increase in incumbency advantage, but only in the short term.

These studies examine the effect of a current resource windfall. Political behavior, however, could change in anticipation of a windfall, i.e., even before resources are actually extracted. This could happen because anticipated rents (from future resource extraction) increase the value of political positions. Thus, politicians may start competing for office now in order to capture future rents.

Vicente (2010) examines this issue in the context of Sao Tome and Principe's announcement of oil discoveries. He uses micro-data at the individual level with retrospective information on perceived corruption. He finds that oil discovery announcements are associated with an increase in perceived vote buying and corruption across a range of public services, such as customs, public procurement, state jobs, health care, and police.

The empirical study of resource abundance on local conflict has focused on exploring two possible mechanisms: the opportunity cost effect and the rapacity effect. As previously discussed, these mechanisms have different implications for the effect of resource booms on conflict, depending on the type of resource being exploited: resources that increase local wages (such as agricultural products) may decrease conflict, while resources that create appropriable rents (such as oil, diamond, and minerals) may encourage it.

For instance, Angrist and Kugler (2008) find that an increase in coca prices in Colombia led to modest local economic gains, but increased violence in rural areas. They interpret these findings as evidence that the financial opportunities provided by coca fueled internal conflict. Gawande et al. (2012) examine the Naxalite conflict in India. They find that negative agricultural shocks are associated with an intensification of conflict. This is consistent with the opportunity cost effect.

In a recent paper, Dube and Vargas (2013) provide convincing evidence that both the opportunity and rapacity effects are important. They use data at the municipality level from Colombia and exploit variation in commodity prices. The main idea is that some commodities, such as oil, are more likely to generate rents than changes in local wages, and thus affect conflict mostly through a rapacity effect. In contrast, agricultural commodities, like coffee, may have relatively more influence on wages than rents and thus mostly affect the opportunity cost of conflict. This study finds that increase in oil, coal, and gold prices are associated with an intensification of conflict. In contrast, the increase in international prices of agricultural products, such as coffee, banana, sugar, palm and tobacco, decrease it.

3.2.4 Impact of mining-related pollution

There is a vast literature highlighting the potential for extractive industries, such as mining, to pollute the environment. Similarly, there are several studies documenting the negative effect of pollution on human health and, through that channel, on labor supply and labor productivity (see references above). Despite these findings, there is little empirical work directly examining the socio-economic impacts of mining-related pollution.

Rau et al. (2013) examine the impact of mining-related pollution on educational achievement. They focus on a case of environmental negligence in northern Chile in which hundreds of houses were built in the proximity of a deposit of mineral waste. This mineral waste had hazardous levels of lead and other heavy metals. This study finds that children living in the proximity of the mineral waste had higher concentrations of lead in their blood, and worse academic performance. They estimate that this translates into a significant loss of earnings in adulthood.[19]

[19] The estimated figure is around USD 60,000 for the average affected individual.

Aragón and Rud (2013a) focus instead on the effect of pollution on agriculture using the case of large-scale gold mining in Ghana. This study is motivated by the existing evidence in biological sciences linking pollution to lower crop yields, and degradation of key agricultural inputs, such as soil and water. They find robust evidence that cumulative gold production (a measure of the stock of pollution) is associated with a significant reduction in agricultural productivity. The effects are concentrated within 20 km of mine sites and decline with distance. This loss of productivity is associated with an increase in rural poverty. Using satellite imagery, they also document an increase in concentration of air pollutants in the proximity of mines. They rule out alternative explanations, such as mines competing for local inputs (and increasing input prices), or changes in the composition of the local population, that may occur in the presence of selective migration. This study highlights the importance of a pollution externality (i.e. loss of agricultural productivity) that may occur when potentially polluting industries are located in the vicinity of rural areas.

Recently, van der Goltz and Barnwal (2013) examine the effect of mining on human health outcomes. They use a rich micro-dataset from 44 developing countries and a difference in difference approach. They find suggestive evidence that mining is associated with an increase in stunting and anemia among children and young women, respectively. The effects are localized in the vicinity of mines (i.e., within 5 km). These effects occur despite an increase in household wealth, which may attenuate the negative effects of mining on health. This paper raises an important debate about the trade-off between economic benefits and health costs that mining communities may face.

3.2.5 Input-output analysis

The studies described above are ex-post analysis of the effect of resource abundance, i.e., they observe the change on outcomes that takes place *after* a resource boom/bust takes place. A complementary approach consists on predicting what the effect of a mining project (or other extractive activities) would be. This is useful for ex ante impact evaluations (i.e., when the project has not been implemented yet) or for economic planning and analysis.

Some common tools to perform this type of analysis are input-output (I-O) models and social accounting matrices (SAM). The basic idea of these tools is to construct mathematical models of an economy and then calculate the change on economic outcomes associated with changes in some variables, such as the expenditure on a given basket of goods, or the

output of an industry. Depending on data availability, these models can be built to describe regional and local economies, and thus inform about impacts at the sub-national level.[20]

Some countries, like US and Canada, routinely use I-O models to assess the ex-ante economic impact of extractive industries.[21] These models have also been used to assess the impact of mining in a variety of contexts, such as north Chile (Aroca, 2001), North Sweden (Ejdemo and Söderholm, 2011), South Africa (Stilwell et al., 2000), Europe (San Cristobal and Biezma, 2006), among others.

Analysis based on I-O models and SAMs are useful for economic planning and ex-ante impact evaluation. Their predictions are informative of what the economic effect of a mining project could be. But a main limitation is that they do not tell what the effect actually is.

The actual effect could be different from the predicted one for several reasons. First, by construction, economic models cannot account for all the possible mechanisms through which resource booms affect outcomes, such as pollution spillovers, structural changes, and migration. These mechanisms may be important. Second, I-O models usually do not take into account price-adjusting behavior or substitution effects, and assume that there is no scarcity of resources. Finally, the model parameters (such as multipliers and technical coefficients) may change as a consequence of the resource boom itself and thus render the model predictions inaccurate. This is the standard Lucas critique.

3.3 Main lessons

The literature on the local impact of natural abundance is still at the early stages of development. Despite this, it has already provided some important insights.

First, similar to the country-level literature, it suggests that a local resource curse is not inevitable. On the contrary, there are some examples in which resource abundance does not have detrimental effects. A provocative idea is that what may matter is the channel through which resource rents reach a local economy. When resource rents are distributed using public channels (such as a revenue windfall to local governments), resource booms do not seem to improve living standards, and even foster negative side effects such as conflict, rent-seeking and corruption. In

[20] I-O models and SAMs are available for several developed and developing countries. For a list of SAMs for developing countries see http://www.ifpri.org/category/dataset-type/social-accounting-matrices.

[21] In Canada, the I-O analysis at national and sub-national level is performed by Stats Canada and provincial statistical agencies. In the U.S., there are commercial I-O models at national and regional level, such as IMPLAN and RIMS II.

contrast, when the resource rents are distributed through market channels (for instance as an increase in demand for local workers), resource booms may bring some benefits to the local population, at least in the short-term. The failure of fiscal channels can reflect pre-existing institutional factors that limit the responsiveness of local politicians and facilitate rent-seeking, as suggested by the country-level literature.

Second, there is no conclusive evidence that resource booms lead to de-industrialization, despite the increase in price of local inputs. On the contrary, in some cases, resource booms are even associated with an increase in manufacturing activity. This finding is the opposite of what we would expect from the standard Dutch disease arguments, and suggests that other effects, such as agglomeration economies, may also be relevant.

Finally, this literature highlights the importance of examining other outcomes besides income and growth. Evidence linking resource booms to local demand shocks, employment shifts and pollution, suggests that natural abundance may also affect other measures of human well-being such as inequality, education, and health. So far, there is paucity of empirical studies examining these possible impacts.

4 Fiscal decentralization arrangements

Mining, and other extractive activities, generate a substantial fiscal windfall from taxes, royalties, and fees. This windfall raises several important policy questions. First, which level of government (local, regional or national) should collect this revenue? Second, how should this mining revenue be shared with sub-national governments? Finally, to what extent do these institutional differences matter for economic performance? These questions relate to fiscal decentralization. Fiscal decentralization involves shifting some responsibilities for revenue collection and/or expenditure to lower levels of government.

In this section, we focus on fiscal decentralization of mining revenues.[22] We start by discussing the main theoretical arguments addressing the design of fiscal decentralization arrangements. Then we review the empirical literature on the effect of fiscal decentralization on economic

[22] The design of expenditure decentralization, i.e., which expenditures are the responsibility of each subnational level, does not distinguish the source of revenue. In that sense, the some general principles can be applied to both mining and non-mining cases. For a discussion on principles for expenditure decentralization, see World Bank (2014).

outcomes. Finally, we discuss some international practices.

4.1 What is the optimal level of fiscal decentralization?[23]

4.1.1 Revenue decentralization

Governments rely on several tax tools to collect revenues. In the case of mining, these tools include royalties, direct taxes (income, profit and property taxes), indirect taxes (such as VAT, sales and excise taxes, import and export duties and payroll-based taxes), surtaxes, and licensing and user fees. The policy question is which of these taxes should be assigned to sub-national governments. To inform this question, the literature on fiscal decentralization has already identified several principles for the optimal design of tax systems.

1. Economic efficiency: This requires that the tax system does not affect economic decisions such as how much or where to invest, produce or consume. Decentralized tax systems can interfere with economic efficiency in at least two ways. First, geographical differences in tax systems may distort locational decisions linked to mobile goods and factors, such as capital and tradable goods. For instance, a state imposing a high corporate tax rate may hinder private investment. Second, in the presence of mobile factors, jurisdictions could compete among themselves by reducing taxes to sub-optimal levels. This principle has an important implication. It suggests that taxes linked to mobile goods and activities should be decided centrally or at least coordinated among jurisdictions. Similarly, taxes linked to less mobile tax bases (such as property taxes) are more suitable to be assigned to local governments. Given the ex-ante mobility of mining, this principle suggests that mining taxes should be assigned to national and regional level governments, instead of local governments.

2. Equity: the tax system plays a crucial role in economic redistribution. This redistribution is politically feasible when both net payers and net receivers (the winners and losers of redistribution) are both represented by the government to whom the tax has been assigned. For that reason, a decentralized tax system can hinder the goal of national equity. For

[23] This section is partially based on World Bank (2014) and Otto (2001). For additional work describing fiscal tools and principles to decentralize resource rents, the reader can also see Clark (1999), Brosio (2006), or Morgandi (2008).

instance, a local government may be less interested than the federal government in using its tax revenue to fund a nationwide welfare program. In addition, local governments could use redistribution policies (such as less progressive taxes and transfers) to attract high-income persons and repel poorer ones. This can exacerbate the geographical differences within a country. Given the unequal distribution of mineral wealth, this equity principle supports assigning mining taxes to the national and regional level.

3. Administrative costs: the design of tax systems should consider the effect on collection and compliance costs. A decentralized tax system can increase these costs for several reasons. First, there are fixed costs associated with collecting taxes. This creates economies of scale, and scope, in tax administration. Second, the complexity of several local tax systems can increase opportunities for tax evasion and avoidance. Finally, local government may also lack the technical capacities to administer some taxes, thus facing higher costs, lower compliance rates and inefficient use of resources at least in the short run (Aragón and Casas, 2009). These additional administrative costs not only can erode the net tax revenue, but they can also distort local governments incentives. In particular, by increasing the cost of collecting taxes, it can reduce the local fiscal effort, leading to sub-optimal levels of tax collection (Aragón, 2013). In the case of mining, there are two other factors that may make local tax collection costly. First, in most jurisdictions there are few mines. Thus, there is limited scope to exploit economies of scale in tax collection. Second, in some cases mining activities straddle several jurisdictions. This can increase the complexity of assessing tax bases, and create incentives to free-ride on other local governments' monitoring, thus reducing overall monitoring effort.

4. Fiscal revenue should match spending needs: in order to guarantee accountability of local politicians, and sustainability and quality of local public goods, revenue means should be matched to revenue needs. Mining activities can potentially increase the pressures on local services and infrastructure due, for instance, to inflow of new workers and their families. This increase in revenue needs requires an expansion of fiscal revenue in the form of sub-national taxes or intergovernmental transfers.

In addition to these principles, mining has three features that should be taken into account in designing fiscal decentralization arrangements.

5. Mining extracts non-renewable resources: These resources are usually owned by the State, but in some cases, like in the U.S., the owners may be private individuals. In either case, the owner of these assets has the right to levy a compensatory royalty, in addition to usual income or profit taxes.

6. Mining is a risky and capital-intensive activity: One of the most risky aspects of mining is exploration. This activity involves significant investments and the rate of success is quite low. Mine development can also be lengthy thus creating a substantial time gap between expenses and revenues. Finally, once in operation, most of the costs are sunk. This creates the possibility of a hold-up problem: operating mines have less bargaining power to deter expropriation from the State, in the form of exceptional taxes or fees. This risk of expropriation can deter mining investment in the first place. These features provide the rational for creating tax incentives and guarantee stable tax treatment of mining companies (for instance in the form of tax agreements).

7. Mining can create localized negative effects: mining has the potential to generate local spillovers, such as pollution, migration and population displacement. In addition, mining can change land use and affect other economic activities such as agriculture, cattle husbandry or harvesting of wildlife. These factors can impose significant costs on local communities. These features raise two implications for the design of fiscal decentralization arrangements. First, the tax design should consider the use of Pigouvian taxes to reduce these spillovers to socially efficient levels. These taxes should be defined by the level of government more able to internalize these externalities. While in many cases this is the local government, it does not have to be always the case. Second, it provides the rational for some form of compensation to the local population. This compensation can take the form of payments by the mining firm to the community (such as impact benefit agreements or direct community contributions) or targeted intergovernmental transfers.

The above discussion points to a limited scope for decentralization of mining-related taxes. The main sources of mining revenue, such as corporate tax and royalties, may be better managed by higher government tiers (national or regional). There are, however, some tax tools that could be suitable to local governments, such as property taxes, surtaxes and land

use fees.[24] Importantly, it also points to the importance of intergovernmental transfers to match increased local needs and to compensate local populations.

4.1.2 Intergovernmental transfers and revenue sharing

In practice, intergovernmental transfers are important tools to redistribute mining revenue among local populations. Transfers can be classified into three types:

1. Non-matching unconditional transfers: the amount of the transfer does not have to be matched by local funds and there are no constraints on how it should be spent. Many equalization grants fall within this category.

2. Non-matching conditional transfers: the transfer does not have to be matched by local funds, but it has to be spent for a particular purpose, such as capital expenditure or specific projects.

3. Selective matching transfers: also called cost-sharing programs, require that funds must be spent for a specific purpose and that the recipient also match the funds to some degree.

From an analytical perspective, non-matching transfers create an income effect, while matching transfers change the relative price of public goods, thus also creating a substitution effect.

Another way to classify transfers is based on their source of funding. Some transfers are paid with funds from the national budget. Others are linked to a particular source of revenue or tax. This last type of transfer, also called revenue sharing or tax sharing scheme, is commonly used to distribute mining revenues. An example of a revenue scheme is the Peruvian *canon minero*. This transfer is funded with 50% of corporate taxes paid by mining firms. Revenue sharing schemes usually define the sharing rate and allocation procedure by law and thus are less subject to the uncertainties of annual budget negotiations. These schemes effectively give local recipients ownership over part of the stream of future fiscal revenue.

The main advantages of revenue sharing schemes are their simplicity and transparency. Furthermore, they give incentives to local politicians to support mining activities. But also

[24] Otto (2001, p.8) provides a detailed discussion on the suitability of different tax tools in the context of mining.

have several disadvantages. First, if they are based only on certain taxes, they may bias national tax policy. In particular, they may discourage national fiscal efforts to collect those taxes. This argument is related to the problems associated with multitasking studied in contract theory.[25] Second, if they share the revenue from origin-based production (as in the case of mining- related sharing schemes) they can break the link between revenue needs and revenue means at the local level. In other words, targeted localities may end up receiving too many resources. In turn, this can reduce accountability of local politicians and their incentives to spend public funds efficiently. Similar phenomenon can occur if the sharing rate is applied uniformly, and thus revenue is unrelated to actual spending needs. Third, if revenue sharing schemes depend on few taxes (such as mining firms corporate taxes) then their funding is exposed to industry shocks, such as changes in commodity prices. This can increase the volatility of local fiscal revenue. Finally, if tax collection is done locally and shared with the national government, then revenue sharing schemes can create perverse incentives among local authorities to reduce fiscal effort or under-report tax revenues.

4.2 Does fiscal decentralization matter? Empirical evidence

As previously discussed (Section 3.2), there is some evidence examining the link between mining revenue windfalls and economic outcomes. Overall, this literature suggests that mining-related transfers may fail to improve local living conditions. However, there is a lack of quantitative studies examining how different fiscal decentralization arrangements used to distribute mining revenues can shape the effect of this windfall.

The current literature on the impact of fiscal decentralization mostly focuses on examining how different degrees of decentralization affect income growth or corruption at the country or regional level. These studies use measures of expenditure or revenue decentralization, such as share of sub-national governments in tax revenues or public spending. While not aimed at understanding how decentralization of mining revenues affects local communities, this literature might be informative of the overall impact of fiscal decentralization.

[25] This argument is related to the problems associated with multitasking studied in contract theory. Multitasking refers to the case when an agent (such as a worker) is in charge of several tasks but her reward is based on the outcome of few tasks. In that case, the agent can exert more effort on the tasks she is rewarded for and neglect the others. For example, consider a teacher that can receive a bonus if her class average grade on a test exceeds certain score. In that case, the teacher may put more effort on preparing students for that exam and neglect other important aspects of teaching.

Early studies, using cross-country regressions find a negative, or insignificant relation between spending decentralization and growth (Davoodi and Zou, 1998). Similar results have been found using data of Chinese provinces and U.S. states (Zhang and Zou, 1998; Xie et al., 1999). Woller and Phillips (1998) also fail to find a statistically significant relationship between fiscal decentralization and economic growth for separate panels of developing countries

This result seems to be sensitive to the measure of decentralization used. In particular, when using measures of revenue decentralization, such as share of revenue collected by subnational governments, the relation becomes positive. For instance, using measures of revenue decentralization, Lin and Liu (2000) and Akai and Sakata (2002) find a positive relation between decentralization and growth in the Chinese and U.S. case, respectively. A concern is that spending decentralization may fail to reflect revenue autonomy of subnational governments. To illustrate this issue, Ebel and Yilmaz (2002) replicate the cross-sectional study of Davoodi and Zou (1998) using measures of revenue decentralization. In contrast to the original study, they find a positive relation.

It is hard to interpret these results as evidence of a causal effect of fiscal decentralization on economic growth. The positive (or negative) relation could be driven by omitted variables or confounding factors. The available studies do not satisfactorily address these endogeneity concerns. A conservative interpretation is that the evidence linking fiscal decentralization and economic growth is, at best, still inconclusive (Martinez-Vazquez and McNab, 2003).

Related work examines the link between decentralization and corruption. Based on cross-country regressions, Fisman and Gatti (2002a) find suggestive evidence that spending decentralization may be effective in reducing corruption. Fisman and Gatti (2002b) extend this result using data from the U.S. In that case, they study the effects of a mismatch between revenue generation and expenditure on corruption. Their results suggest that decentralizing government expenditures may not be beneficial unless accompanied by decentralization of revenue generation.

4.3 How are mining revenues distributed? Some case studies

In practice, the distribution of mining revenues varies across countries. In this section we discuss some case studies that fall within four commonly used approaches: no re-distribution, revenue

sharing, fiscal decentralization and direct contributions to communities.[26]

4.3.1 Chile - no redistribution

In contrast to most mining countries, Chile does not operate an institutionalized mechanism of redistributing revenue received from mining to sub-national governments. Instead, sub-national funding is allocated through the budget process managed at the central government level. In addition, almost all mining taxes and fees are collected by the central government.[27]

An important element of Chile's management of mining windfalls is its structural surplus rule. Under this fiscal rule, introduced in 2000, the government aims to achieve a structural surplus of 1% (0.5% effective since 2008) of actual GDP. This structural surplus considers, among other things, the copper revenue that could have been obtained using a long-term cooper price, instead of the actual price. In practice, this means that the government will save during copper price booms and increase spending during price busts.

4.3.2 Tanzania - no redistribution

In Tanzania, the majority of mining revenue (mostly from copper and gold) comes from just 6 out of 117 local districts. Similar to Chile, there are no specific arrangements to distribute mining revenue among mining regions. There are also no special mining compensation or development funds targeting these regions.

4.3.3 Peru - revenue sharing

The most important source of mining revenue in Peru comes from corporate income taxes paid by mining companies. These taxes are collected at the central government level. This mining revenue is distributed to mining localities via a revenue sharing mechanism called canon minero. Through this mechanism part of this revenue (50% since 2001) from a given mine is directly distributed to subnational governments (regional governments, provincial and district municipalities) in whose jurisdiction the mine is located. The allocation is based on a formula defined by law. The allocation is done in two stages. First, the canon is allocated between levels of subnational governments using the following participation rates: 10% for municipalities

[26] This section is based on ICMM (2006) and ICMM (2009).
[27] The only exception is the mining patent, an annual fee paid to the region to protect the mining title.

where mine is located, 25% for all municipalities in the province where the mine is located, 40% for all municipalities in the region where the mine is located and 25% for the regional government and public universities. Second, the amount in each category is distributed among municipalities based on population size, and poverty

Since 2005, mining companies are also required to pay a royalty tax. Similar to the canon minero, the revenue from this royalty is distributed among all tiers of subnational governments where a mine is located.[28] The majority of large mining companies, however, do not pay this royalty due to tax stability contracts that they have previously signed. These contracts lock-in each firm's tax status and thus protect them from new taxes, royalties and fees.

In response to this situation, the Peruvian government and mining companies negotiated a voluntary mining fund (VMF) in 2006.[29] Under this arrangement, mining companies contribute to a private fund to implement social development projects in mining localities. This fund is not distributed to local authorities, nor publicly audited. The use of the fund is decided by a committee composed of representatives of the firm and by local authorities.

4.3.4 Ghana - revenue sharing

The main sources of mining revenues in Ghana are corporate taxes and royalties. Most of this revenue is generated from large-scale gold mines in the Western, Central, Ahafo and Ashanti regions. Similar to Tanzania, revenue generation is highly concentrated: in 2004, half of all mining revenue was collected in two (out of 160) districts.

This revenue is distributed among mining regions using a revenue sharing mechanism: 20% of mining royalties are allocated to a Mineral Development Fund (MDF). The MDF is then distributed among mining sector institutions and local authorities with mines in their jurisdictions. The participation shares, defined in the Constitution, are: 50% to institutions and agencies that support mining at the national level (such as the Minerals Commission, Department of Mines and Geological Survey), 30% to district assemblies, 10% to traditional stools, and 10% to traditional authorities.

[28] The participation shares are also pre-defined by law: 20% to the district municipalities (of which 50% is given to the communities); 20% to the provincial municipalities; 15% to the regional government; and 5% to national universities of the region. The remaining 40% is distributed to the district and provincial municipalities of the departments where exploration has taken place.

[29] These funds are used to support the so-called *Programa Minero de Solidaridad con el Pueblo* - Solidarity Mining Program

In contrast to the Peruvian case, the participation of local communities in mining revenue is very small. Only 10% of mining royalties are distributed to local communities where mines are located. This limits the scope of development projects and mitigation activities that can be implemented at the local level.

Four additional issues weaken the effectiveness of this scheme. First, the amount of revenue is highly volatile. Second, there is lack of transparency on both the amount of royalties collected and payments made to local authorities. Third, there is no clarity on the purpose of this fund, especially for traditional stools. In this case, the law establishes that the MDF should be used to maintain the stool in keeping with its status. Finally, traditional stools and authorities are not elected, do not need to prepare budgets or financial statements, and are not subject to the oversight of national auditing authorities. This greatly reduces the accountability of local politicians and may facilitate diversion of resources and rent-extraction.

4.3.5 Australia and Canada - fiscal decentralization

Both countries have federal systems with a high degree of revenue and spending decentralization. Subnational governments (provinces and territories in Canada, states and territories in Australia) own mineral resources within their territory and have the power to raise mining taxes and royalties, in addition to taxes and fees collected by the federal government.

The high degree of fiscal decentralization guarantees that a large share of mining revenues remains within mining regions. This comes at the cost of increasing complexity of mining taxation: each province or territory imposes its own mining taxes, and the systems vary significantly.

4.3.6 Impact-benefit agreements - direct contributions to communities[30]

In the last 20 years, mining companies and Aboriginal communities in Canada and Australia have pioneered a new way to distribute mining benefits directly to communities using so-called Impact Benefit Agreements (IBA). These agreements are legally binding contracts between mining companies and aboriginal communities that specify the obligations of each party regarding mitigation actions, as well as the benefits to the local community (such as employment opportunities, training, or revenue sharing). These agreements are negotiated in

[30] This discussion is based on BC First Nations Energy & Mining Council (2010).

almost all new mining projects in Canada and are regarded as a best practice by the mining industry (Sosa et al., 2001).

The rise of this tool has been facilitated by the existence of Aboriginal rights over land. These rights recognize the ancestral occupation of the land. In the Canadian case, aboriginal rights are enshrined in the Constitution and, in many cases, defined and protected by treaties. The existence of these rights creates the duty to consult with aboriginal communities before any mining activity takes place. These features have greatly increased the bargaining power of aboriginal communities.

IBAs usually specify how Aboriginal communities can participate in mining benefits. For instance, they can include provisions to provide education and training to local workers, secure employment in the mine project, and maximize business opportunities to local firms. Importantly, they may also include provisions to set out financial benefits.[31] There are several contractual models to share financial benefits such as issuing shares or stock options on the mining projects, or giving the community a share in the mine's profits or revenues.

5 Ideas for future work

The research reviewed in this paper is starting to provide new insights on the local impact of natural resources and sharing of resource rents. First, similar to the cross-country literature, some of the research studies find that resource abundance may have negative effects by increasing corruption, conflict, or deteriorating local political processes. This evidence, however, is far from conclusive. Second, this work highlights the importance of studying other local phenomena such as the general equilibrium effects of local demand shocks, migration, and environmental pollution. These mechanisms may also affect living standards and make the impact of natural resources more nuanced. Finally, there is a well-developed literature discussing several tools to distribute resource rents, and the principles that guide fiscal decentralization. There are, however, still several limitations and unsolved questions. In this section, we identify some of these issues to suggest strands of future work.

First, a main limitation is the paucity of empirical evidence on the impact of resource

[31] The benefits specified in IBAs are in addition to federal and provincial taxes, and other compensation and mitigation actions required by Environmental Agencies.

abundance on local income, poverty, and employment, especially in less developed countries. The available evidence is sparse and focuses on a few countries, such as the U.S, Canada, Brazil and Peru. Research in other resource-rich contexts, such as Sub-Saharan Africa and Asia, is needed to increase the external validity of these results and to better inform policy-makers and practitioners.

Second, there is also paucity of quantitative studies exploring the effect of extractive industries on other outcomes such as health, education, and pollution externalities. The few existing studies suggest that these impacts (on health and agricultural productivity) can be economically important. However, additional studies are necessary to draw a better picture of the scope and magnitude of these negative spillovers, as well as to better understand the mitigation actions needed to ameliorate these potential negative effects.

Third, some research highlights the importance of market versus fiscal mechanisms to create positive local impacts. In this view, developing local supply chain linkages may be more effective in improving local living standards than sharing the revenue windfall with local governments. More research is needed, however, to confirm these initial findings and to evaluate the effectiveness of different policies in developing these local linkages.

Fourth, more quantitative research is needed to examine the effect of resource abundance on local conflict and political outcomes. The existing evidence, mostly from Latin America, already suggests that the revenue windfall associated with resource abundance may hinder political selection and increase corruption. There is paucity of evidence, however, from other regions with different institutional contexts, such as Sub-Saharan Africa. These different institutional arrangements may attenuate, or exacerbate, these negative effects. Similarly, there is lack of evidence examining the effect of resource abundance on less violent forms of conflict, such as riots and civil unrest.

Fifth, there is paucity of empirical evidence assessing the political economic impact of different fiscal decentralization arrangements. The existing evidence examines the effect of the overall degree of decentralization, but it is not informative of the importance of the specific institutional arrangements, such as type of transfers, type of revenue sharing schemes, or type of competences devolved. These features may affect the impact of resource revenues on local income, corruption or local political responsiveness. Similarly, there is not much evidence on which institutional factors contribute to the success (or failure) of fiscal decentralization.

Understanding these questions is crucial to inform the design of fiscal decentralization.

Finally, a related issue is the role of local technical capacities. Even if local governments have the political will to use a revenue windfall to promote local development, they may lack the capacity to identify and implement the necessary projects. Some studies, using the Peruvian case, suggest that lack of capacities may be important and affect local governments' spending ability (Aragón and Casas, 2009; Aragón, 2013). More research is needed, however, to understand the main technical constraints faced by local governments, their effect on communities' ability to benefit from a revenue windfall, and the best policies to alleviate them.

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A Graphical representation of analytical framework

Figure 1: Change in endowments

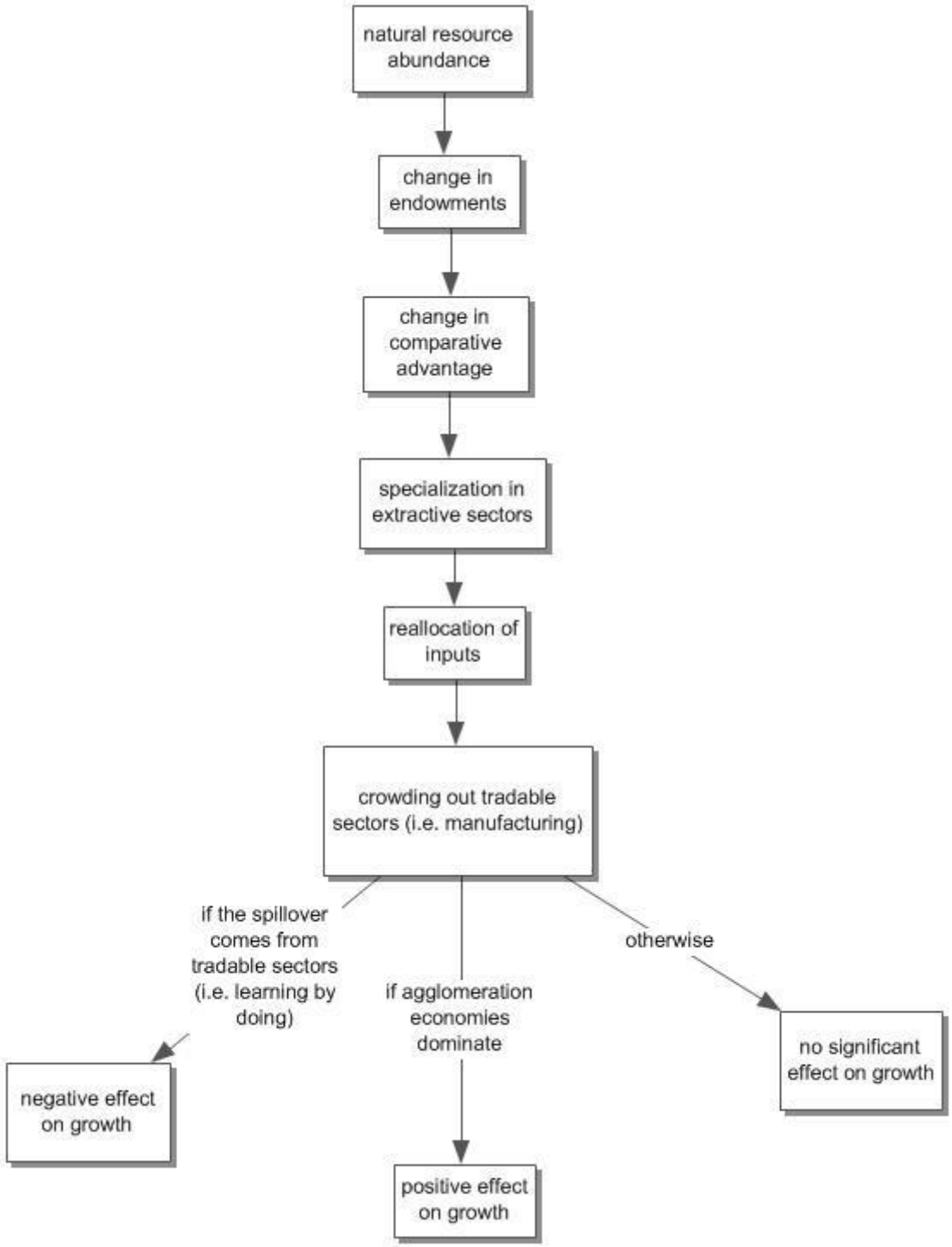


Figure 2: Revenue windfall

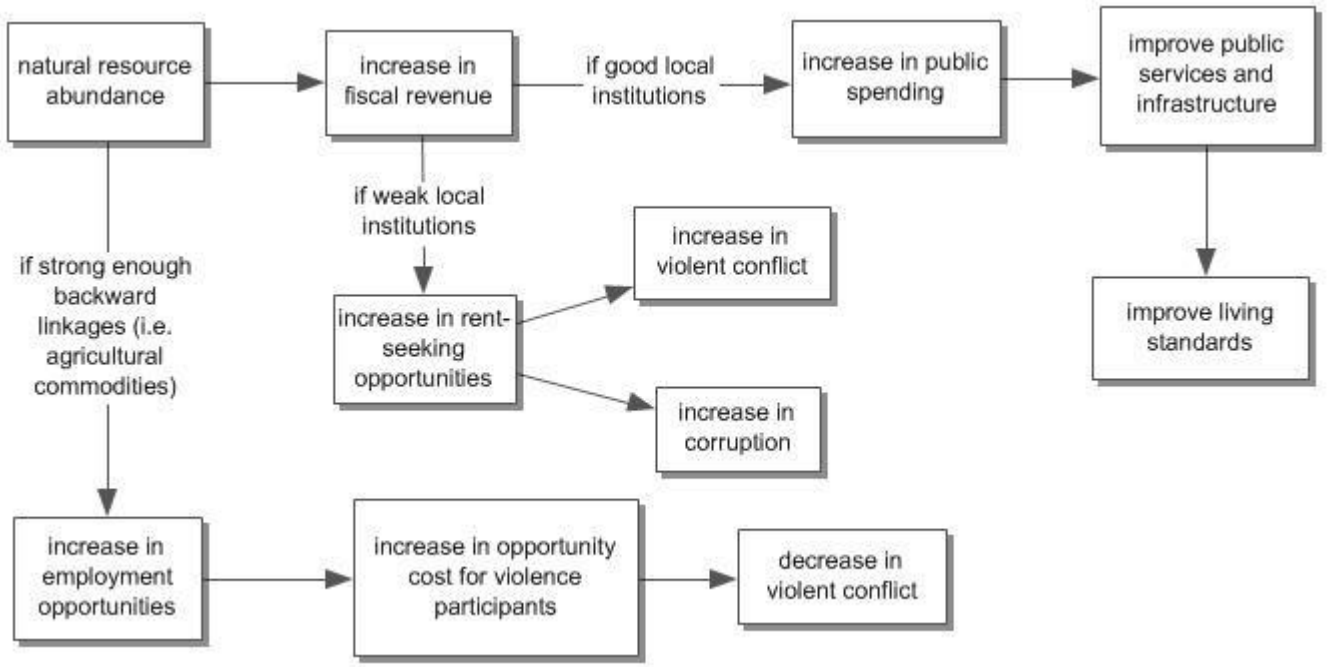


Figure 3: Local demand shock

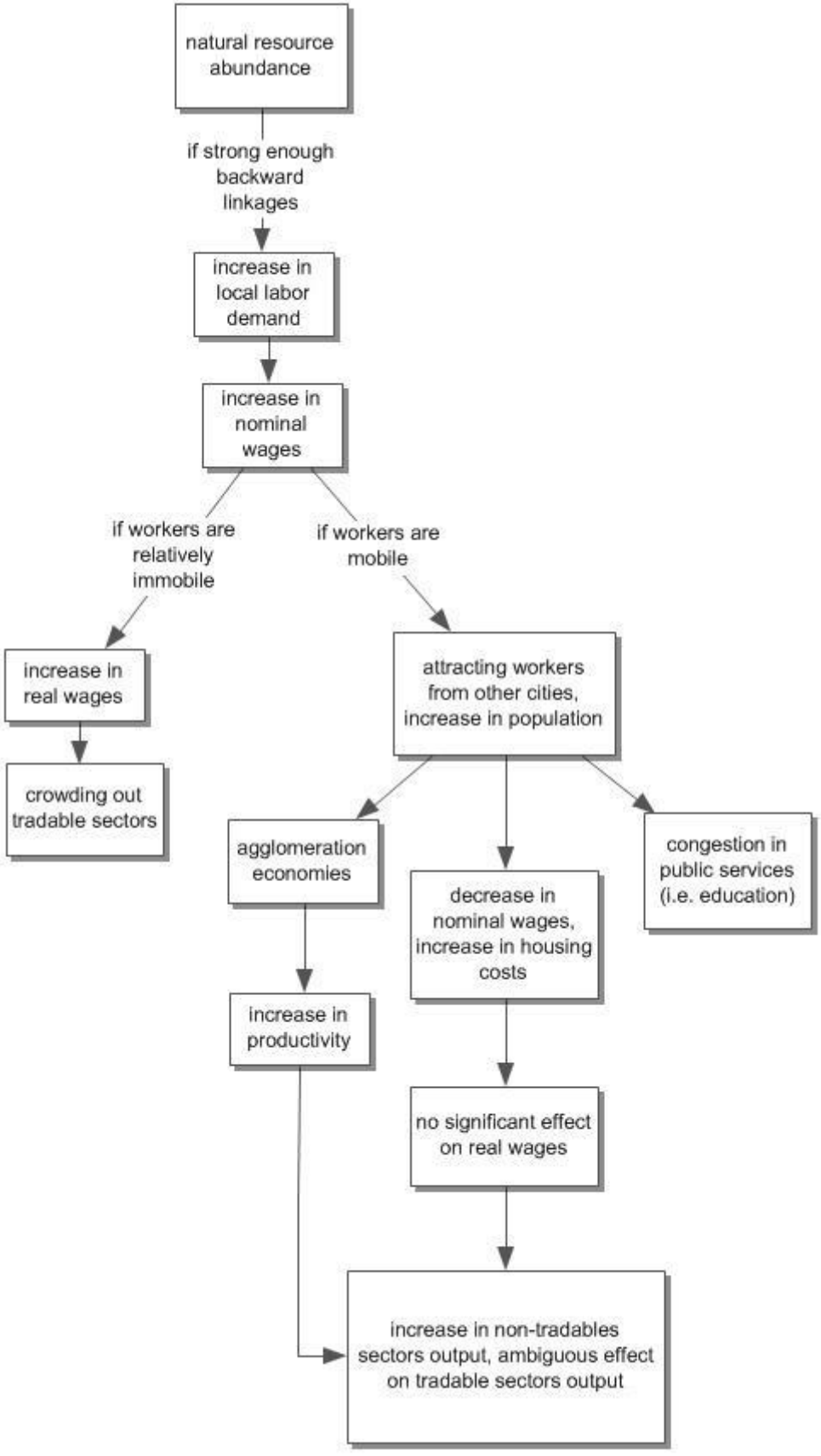
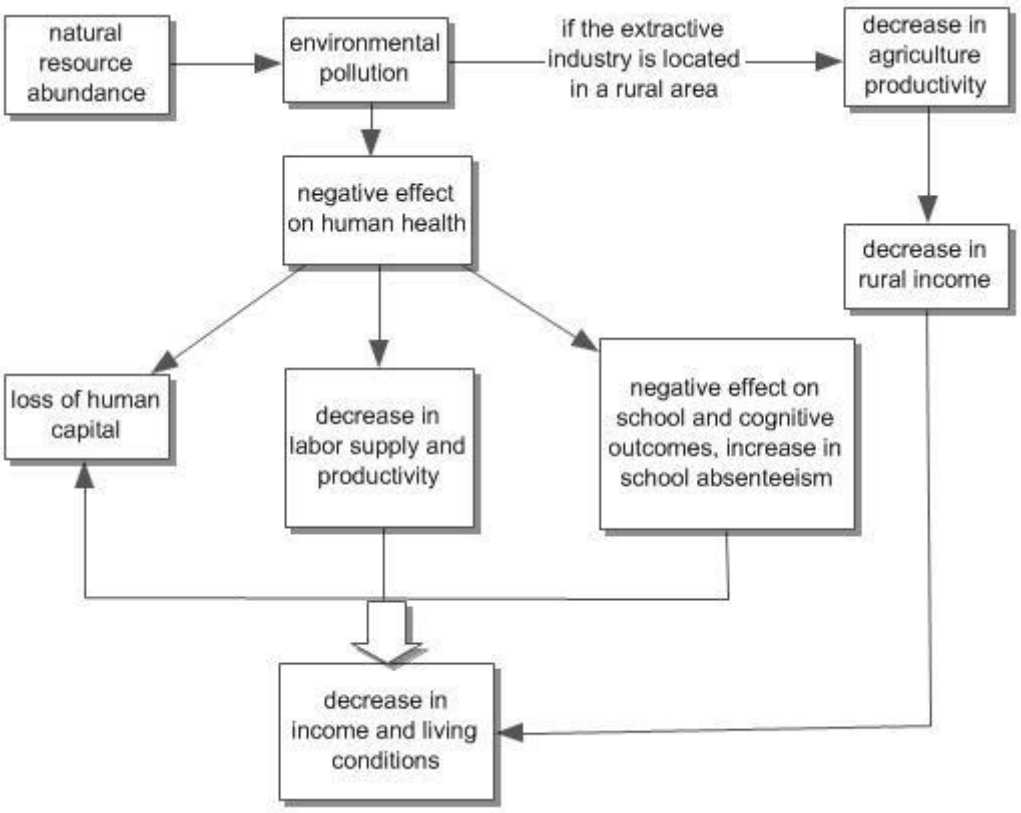


Figure 4: Environmental pollution



B Summary of empirical studies

Table 1: Impact on growth

Paper	Explanatory variable	Outcome variable	Sign	Country, data level	Identification strategy
Douglas & Walker (2013)	share of coal revenue in total county personal income	income growth rate	-	U.S., county level	cross sectional OLS
James & Aadland (2011)	share of earnings in resource-extraction industries			U.S., county level	cross sectional OLS
Papyrakis & Gerlagh (2007)	share of primary sector in local GDP			U.S., state level	cross sectional OLS
Zuo & Jack (2014)	provincial annual energy production per capita, or provincial annual energy production, or ratio of the regional energy production over GDP			China, province level	fixed effect panel model

Note: +, positive relation, -, negative relation, 0 statistically insignificant

Table 2: Impact on employment and local living standards

Paper	Explanatory variable	Outcome variable	Sign	Country, data level	Identification strategy
Allcott & Keniston (2013)	whether the county produces any oil or gas in any year after 1969	income growth rate, wages	+	U.S., county level	difference in difference
		manufacturing employment and output	+		
		factor productivity	0		
Aragon and Rud (2013b)	gold mine production	household income	+	Peru, household level	difference in difference
	mining transfer	municipality revenue and expenditure	+		
		household income	0		
Black et al. (2005)	whether the county is the coal boom county	employment and wages	+	U.S., county level	instrumental variables
Caselli & Michaels (2013)	oil output	local government revenues	+	Brazil, municipality level	instrumental variables
		local government spending	+		
		local public service	0		
		household income	0		
Fleming & Measham (2014)	indicator of having a coal seam gas operation	income growth, employment	+	Australia, individual level	cross sectional OLS

Note: +, positive relation, -, negative relation, 0 statistically insignificant

(cont. next page)

Table 2: (Continued from previous page)

Paper	Explanatory variable	Outcome variable	Sign	Country, data level	Identification strategy
Jacobsen (2013)	whether the county is the oil and gas boom county	nominal income, wages, employment and population	+	U.S., county level	fixed effect panel model
		manufacturing employment	0		
Kotsadam & Tolonen (2014)	mine openings	service sector employment	+	Sub-Saharan Africa, individual level	difference in difference
		agriculture employment	-		
		women--service sector employment	+		
		men--skilled manual jobs employment	+		
	mine closings	women--agriculture employment	0		
		men--agriculture employment	+		
Loayza et al. (2013)	mining production	household consumption, literacy	+	Peru, district level	matching and propensity score
		poverty rate	-		
		consumption inequality	+		
Marchand (2012)	indicator of having 10% or more of their total earnings from the energy extraction sector.	employment and earnings	+	Canada, province level	difference in difference

Note: +, positive relation, -, negative relation, 0 statistically insignificant

(cont. next page)

Table 2: (Continued from previous page)

Paper	Explanatory variable	Outcome variable	Sign	Country, data level	Identification strategy
Michaels (2011)	Indicator of whether the county is located above an oil fi ld or part of an oil fi ld (or multiple oil fields) that contains at least 100 million barrels of oil before any oil was extracted	employment share of mining	+	U.S., county level	fixed effect panel model
		employment share of agriculture	-		
		employment share of manufacturing	0		
		stock of educated workers	+		
		nominal income	+		

Note: +, positive relation, -, negative relation, 0 statistically insignificant

Table 3: Impact on corruption and conflict

Paper	Explanatory variable	Outcome variable	Sign	Country, data level	Identification strategy
Angrist and Kugler (2008)	coca prices	violent conflict	+	Colombia, individual level	difference in difference
Brollo et al. (2013)	oil royalty revenue	political corruption,	+	Brazil, municipality level	regression discontinuity
		quality of political candidates	-		
Dube and Vargas (2013)	oil, coal, and gold prices	conflict	+	Colombia, municipality level	difference in difference
	international prices of agricultural products		-		
Monteiro and Ferraz (2010)	oil royalty revenue	incumbency advantage	+	Brazil, municipality level	instrumental variables
		public employment	+		
		educational and health supply	0		
Vicente (2010)	oil discovery announcements	perceived vote buying and corruption on public services	+	Africa individual level	difference in difference

Note: +, positive relation, -, negative relation, 0 statistically insignificant

Table 4: Impact of of mining-related pollution

Paper	Explanatory variable	Outcome variable	Sign	Country, data level	Identification strategy
Aragon and Rud (2013a)	cumulative gold production	agricultural productivity	-	Ghana, household level	difference in difference
		poverty	+		
		respiratory diseases among children	+		
Rau et al. (2013)	distance to the mineral waste site	academic performance, earnings in adulthood	-	Chile, individual level	two sample instrumental variables
Van der Goltz and Barnwal (2013)	indicator of whether the cluster is within five kilometers of the nearest mine	stunting and anemia among children and young women	+	44 developing countries, individual level	difference in difference

Note: +, positive relation, -, negative relation, 0 statistically insignificant