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The Local Economic Impacts of Natural Resource Extraction

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Abstract Whether it is fair to characterize natural resource wealth as a curse is still debated. Most of the evidence derives from cross-country analyses, providing cases both for and against a potential resource curse. Scholars are increasingly turning to within-country evidence to deepen our understanding of the potential drivers, and outcomes, of resource wealth effects. Moving away from cross-country studies offers new perspectives on the resource curse debate, and can help overcome concerns regarding endogeneity. Therefore, scholars are leveraging datasets which provide greater disaggregation of economic responses and exogenous identification of impacts.

This paper surveys the literature on these studies of local and regional effects of natural resource extraction. We discuss data availability and quality, recent advances in methodological tools, and summarize the main findings of several areas of research. These include the direct impact of natural resource production on local labor markets and welfare, the effects of government spending channels resulting from mining revenue, and regional spillovers. Finally, we take stock of the state of the literature and provide suggestions for future research.

Keywords: survey, mining, Dutch disease, identification, spillovers

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1 Introduction

The relationship between natural resource abundance and economic performance has been the subject of a long and rich tradition in the literature. Some of early pioneers of modern economics such as David Ricardo and Adam Smith were concerned by both the positive and negative potential of resource wealth. More recent scholars have revisited this topic and sought to understand the ways in which natural resources can positively and negatively impact on national economic performance (Auty, 2001; Sachs and Warner, 1995; and for a recent survey see: Van der Ploeg, 2011).

The *resource curse* hypothesis that resource abundance is negatively associated with long-term economic growth has been scrutinized in great detail and linked to a wide-range of economic and political phenomena. The literature has examined a range of potential mechanisms including appreciation of the real exchange rate and de-industrialization, volatility, and consequences related to institutions, such as deterioration in governance, corruption, rent-seeking and conflict (Van der Ploeg, 2011). The final strand posits that resource rich countries are unable to convert their depleting resource into other productive assets for reasons of policy failure, myopia and time-inconsistency.

Whether it is fair to characterize natural resource wealth as a curse is still debated. Most of the evidence for the above mentioned channels derives from cross-country and macroeconomic analyses, providing evidence both for and against a potential resource curse. Fuelling this debate is not only the mixed evidence, but also concerns for endogeneity around the relationship between observed resource wealth and economic or political factors at the cross-country level. Therefore, scholars are increasingly turning to within-country studies for greater disaggregation of economic responses and exogenous identification of impacts.

This paper surveys the literature on the local and regional effects of natural resource production. Although the local environmental costs of mining can be large, this survey focuses on the economic impact. We discuss data availability and quality, recent advances in methodological tools, and

summarize the main findings of several areas of research. These include the direct impact of natural resource production on local labor markets and welfare, the effects of government spending channels resulting from mining revenue, and regional spillovers and mitigation. Finally, we take stock of the state of the literature and provide suggestions for future research.

While much of the attention for the last three decades has been focused at the national aggregate and cross-country level, it is not just methodological or identification concerns that have motivated a shift of focus. The within-country effects are thought to be at least as important, and may constitute important transmission mechanisms for the macro "resource curse" symptoms. Examples include the possibilities for resource wealth in concentrated geographical locations to drive divergent regional economic performance, allocating the costs and benefits of extraction asymmetrically. Furthermore, governments may choose to allocate the costs and benefits differently within countries, such as through revenue sharing rules or expenditure programs. This may further exacerbate regional inequalities. Finally, many of the hypothesized channels of resource benefits and costs are contingent on factors at the subnational level: rent-seeking by local politicians, regional favoritism, real exchange rate appreciation and price differences across space, as well as uneven investments in infrastructure, can all add up to a positive or negative national level experience. While some of the causes of the resource curse may be avoidable via actions by the national government, other factors arise locally or as a consequence of local government's actions.

The rest of this paper is organized as follows. Section 2 and 3 discuss methodologies and data sets. Section 4 reviews recent research into the direct local effects of natural resource production such as the effect of mines, oil fields or fracking sites either opening, closing, expanding or receiving some price or policy shock that propagates to the local or regional economy. In Section 5 we focus on windfall revenue which may or may not be channeled back to producing regions through government spending or transfers. Section 6 reviews evidence for regional spillovers from producing to other regions, including infrastructure and other supply-side responses to resource wealth. Finally, Section 7 concludes and provides avenues for future research.

2 Methodologies

Until recently the study of the effects of natural resource extraction within countries has been focused predominantly on case study evidence (ICMM, 2007). This approach has included detailed examination of individual projects, a cluster of sites, or comparison of sites. Methodologically this approach has deployed a variety of tools, from descriptive statistics and correlations, to the analysis of qualitative evidence and stakeholder interviews.

In the last decade the increased availability of large-scale socio-economic survey data, geographic identifiers (such as GPS coordinates of projects and survey respondents) and increasing availability and quality of government data at the subnational have all transformed the possibilities for researchers. While many of the new applications using spatially identified information have been focused on natural resources, important contributions have applied this to other questions, including examination of long-run effects of forced labor (Dell, 2010), the impacts of natural disasters (Kirchberger, 2010) and the effects of institutional variation on economic activity in developing countries (Michalopoulos and Papaioannou, 2013).

The particular trend in the local impacts literature has been towards econometric techniques deploying identification strategies that exploit spatial or temporal variation within countries and therefore facilitate causal inference. Researchers have increasingly sought to move beyond

estimating structural models or correlations in within-country data. Identification strategies now seek to isolate exogenous variation in policy and governance, and in the discovered resource wealth, production activity or revenues. These treatment effects facilitate causal inference around total effects as well as potential transmission channels.

Notable examples include a study of the Yanacocha goldmine in Peru (Aragon and Rud, 2013) which uses mine output and company procurement practices over time to estimate the welfare effects of the mine on its hinterland. A study of offshore oil production in Brazil (Caselli and Michaels, 2013) allows the authors to isolate the oil windfall effect on municipalities benefiting from fiscal sharing rules applied to oil revenues.

More recently work has expanded the scope to examine the labor market footprint of many mines (Cust, 2014), or their implications for conflict (Berman et al., 2014). With rich census and household survey data, a variety of new research questions can be possible, including implications for women (Kotsadam and Tolonen, 2014), the implications for the environment (Aragon and Rud, 2012), and the role of oil drilling and mining in agglomeration economies and long-run structural change (Michaels, 2011).

Reflecting the new approaches to this empirical work, a variety of units of analysis are now employed across the range of studies. At the more granular spatial dimension, spatial grid cells (Berman et al., 2014) as well as individual households or villages surveyed in panel data (Cust, 2014; Kotsadam and Tolonen, 2014) can be used to link spatially to resource extraction sites. Firm-level surveys offer similar levels of spatial disaggregation, though are currently less-widely used (exceptions are Allcott and Keniston, 2014, and De Haas and Poelhekke, 2014).

At greater levels of aggregation, a large number of studies use information collected at the district, county or municipality level, typically in panel form (Aragon and Rud, 2013; Caselli and Michaels, 2013). The final strand of within-country analysis uses state or province level information to build a panel dataset to investigate variation in regional performance and economic responses (Papyrakis and Raveh, 2014).

3 Data

To support the new methodological approaches being applied in the resource literature, new datasets have been sought. These new datasets typically seek to combine information on resource extraction, or fiscal information associated with resources, with other socio-economic variables.

For petroleum a range of data sources are now being used. The first example are regional statistics, either reporting extraction activities like volumes or investments at the state or district level, and fiscal information such as government revenues and expenditures associated with resource wealth. This information is typically sourced from national governments (for example in Brazil by Caselli and Michaels, 2013, or in Canada by Papyrakis and Raveh, 2014). Such data can be difficult and costly to assemble. It may need conversion from paper or pdf format, translation, and its acquisition may be preceded by negotiation with government agencies and officials to obtain access for research. The global trend toward public disclosure of petroleum information – and in a digital format – is increasing but remains incomplete.

The second type of petroleum data is micro-data at the level of companies, project or even wellhead. Examples include the Horn (2004) dataset of giant oilfields, which includes information on location, historic production and discovery year. PRIO produce the Petrodata dataset for researchers

(Lujala et al., 2007) which contains extensive field-level coverage for onshore and offshore activity. Various studies are also utilizing commercial data sources such as the Wood Mackenzie PathFinder database (Wood Mackenzie, 2011)[1] (used in Cust and Harding, 2014) for exploration wells and field production. The Wood Mackenzie PathFinder database represents the most extensive global coverage and accuracy used to date, as well as being regularly updated, access however remains limited to mostly commercial subscribers.

For solid minerals the sources of data are equally diverse. Aggregate government statistics at the subnational level are used in countries including for the US coal industry (Black et al., 2005). Micro-data at the company or mine-level includes the USGS database for the world, the Raw Materials Database (InterraRMG, 2013), and the PRIO dataset on diamonds (Gilmore et al., 2005). These data sources typically include information on mine location as GPS coordinates, historic production volumes and status, and levels of reserves. Challenges associated with these data are significant; the USGS dataset contains information on ore and geology, with very limited and patchy coverage on actual mining activity. Furthermore, the data quality can be lower- the USGS dataset for example categorizes mines simply as “small”, “medium”, or “large” without defining the categories. Indeed these datasets share a sample selection process that is unclear and undocumented, introducing potential bias that may affect empirical work. The RMD is more comprehensive in coverage of mine projects, including production volumes and status, however coverage is patchy and location data can be very inaccurate where available. Since the primary function of the RMD has been as a database of ownership, its use for economic and econometric analysis at the mine level can be challenging. It does not, for example, have systematic data on inputs, costs, investment, prices, labor or capital. Researchers have typically relied on mine status, volume or inferred revenue for analysis. Estimating the rents however would require cost data that is typically absent.

Many studies use world price shocks, exogenous changes in policy, or simply changes in production or revenues in a panel data setting for identification. Endogeneity remains a perennial problem in micro-econometric studies as it has for cross-country analysis. In particular any extraction activity is conditional on knowledge of where resource deposits reside, and new research suggests that the exploration process – at least in the petroleum sector – may be subject to strong effects from institutional quality (Cust and Harding, 2014). If governance indeed plays a critical role in choice of exploration location, any inference based on the presence of extraction activity may also be subject to these same effects. The Horn database (2004) has the advantage over many of the other resource datasets survey, via its appeal to the size of oilfields used. By including only “giant oilfields” – those exceeding ultimately recoverable reserves of 500 million barrels – whose global economic importance is clear, authors such as Lei and Michaels (2011) argue that their discovery is a plausibly exogenous event compared to specific country characteristics. However this too may suffer from the strong apparent influence of institutions and technology on choice of exploration location and therefore discovery location.

The data landscape has changed dramatically in the last decade making studies of the subnational effects of resource extraction possible. However the data remains patchy and few datasets used have been prepared and collected with researchers in mind. As the research agenda develops further, there will be important work to collate resource data more systematically, with better documentation and review to ensure quality and coherence. The global trend towards increased public disclosure of information about the mining and petroleum sectors, started by the Extractive

[1] The PathFinder database is a proprietary database available from Wood Mackenzie. More information can be found at: http://public.woodmac.com/public/industry-views/content/11703479

Industries Transparency Initiative in 2003, continues to gather pace. As new data, such corporate disclosures under Dodd-Frank Act 1504 begin to be made, new project level information will become available, opening up new avenues for work and interesting new research questions.

4 Local impacts of projects – direct channels

The local impacts of resource extraction has been subject to extensive study via case study analysis, often by companies or governments seeking to understand and manage the spillover consequences are mining or drilling. Such case studies are now ubiquitous, having become a required part of doing business in the form of environmental, social and economic impact assessments.[2]

Case studies have been completed in a wide-variety of contexts, for example for minerals in countries such as Chile (ICMM, 2007). Australia is probably the country where the largest number of case studies assessing the impact of different projects at the local level has been developed over the past decade (Rolfe, Ivanova, and Lockie, 2006; Rolfe et al, 2007; Franks et al. 2010; Mayes, 2008; Evans and Sawyer, 2009; Fleming and Measham, 2013). These studies also provide evidence of both positive and negative socio-economic effects of extraction, via increases in local income and employment, increased dynamism of small businesses, housing related problems and health issues, among others.

While case studies have provided a rich source of descriptive statistics and qualitative evidence, they are ill-suited to causal inference and external validity. To achieve a deeper understanding of the consequences of resource extraction, economists have deployed new data and new econometric methods to identify and disentangle the various the effects on the local economy.

As a branch of the resource literature, these studies typically examine the proximate effects from mining or drilling on the surrounding region - this may take the form of households, firms, districts, municipalities or states. Much of this work has helped document the economic consequences of extraction, such as job creation and welfare effects. In contrast to subsequent sections of this paper, here we focus on those studies that examine the *direct channels* of effect; namely the spending effects and demand for inputs from mines or oil fields, such as arising from their capital and operating expenditures. In subsequent sections we examine the role of government windfalls arising from resource revenues, and from infrastructure spillovers arising from resource-related infrastructure investments.

The direct channels by which extraction can affect the economy are of particular interest. The development of mines or oil and gas fields can constitute significant shocks to a regional economy, generating jobs and drawing in capital from other regions and countries. Both the development of a project and the subsequent operations can generate large local spending effects, both through local employment and through sourcing non-labor inputs. These backward linkages – to use the language of Hirschman (1958) relate to how these projects connect to the local markets. For people living proximate to resource extraction these backward linkage channels may be the main, and sometimes the only channel whereby resource wealth benefits livelihoods.

Studies of the local direct effects of natural resource extraction come from an established strand of the economic literature seeking to understand the labor market effects of demand shocks, often studied in the form of large scale investments. The recent trend in this literature has been to identify

[2] See for example the impact assessment for the Simandou iron ore mine done by Rio Tinto (2013).

specific shocks and hence identify spillover effects using causal inference. Notable contributions include the examination of large-scale construction projects (e.g. the US inter-state highway, Michaels (2008), the Alaskan oil pipeline, Carrington (1996)). These studies have documents the observed positive effects on employment, wages and house prices – as would be expected from a major localized increase in investment and demand for inputs. More recent developments have provided theoretical foundations for this work (such as work on local multiplier effects in Moretti, 2010) and a broader empirical literature has pioneered innovative identification strategies and use of spatial data in other settings (for the effect of dams see Duflo and Pande, 2007; for rural electrification: Dinkleman, 2011; and for rail privatization: Lowe, 2014).

In contrast, there is some evidence that local projects can have harmful effects too; the study of Enterprise Zones is one example where a variety of authors have documents neutral and even negative effects on local firms (Bartik, 2004). Other studies of local economic damage include a study of the effects of military base closures in the US (Hooker and Knetter, 2001).

The welfare implications of resource extraction at the within-country level are not clear *a priori* since extraction is generally considered an enclave activity (Hirschman, 1958) with limited linkages to the regional economy. This poses an important question for the literature, of whether there is evidence for the resource curse at the subnational level, as opposed to more intuitive welfare and labor market spillovers generated by a local demand shock.

A key contribution to the literature on local direct effects of extraction was made by Aragon and Rud (2013) who conducted an econometrics study of the Yanacocha gold mine in Peru. This study, focusing on a single mine, utilizes an exogenous expansion of the mine and change in procurement policies by the mine owner Newmont, to examine the local effects of a change in spending patterns. They find a strong positive relationship between the change in policy and real income levels of the local population that lives within 100km of the mine; they identify the mine's demand for local inputs as the main transmission mechanism for these welfare effects. They argue that for their short-run analysis, the backward linkages channel, such as the demand for local inputs, can be a more effective transmission mechanism for local benefits than government spending of revenues. However this is predicated on a mining region already having developed markets for goods and services, a prerequisite for the hinterland being able to respond to increased demand for inputs.

The Yanacocha gold mine is special, in that it represents the second largest goldmine in the world and in the fact that its local procurement policy was instated by one of its shareholders, the International Finance Corporation of the World Bank Group. An important question, therefore, is how externally valid these findings may prove to be. Other studies have followed, extending the Aragon and Rud analysis to different countries and multiple mining projects of differing sizes. Cust (2014) for example, examines the labor market effects of various industrial mines in Indonesia. He finds a small average footprint, of around 15km, within which most labor market effects are felt. Inside the typical mine footprint, his study documents a significant shift of employment from the traded manufacturing sector to the non-traded services sector, with no significant shift of local labor into mining. This effect appears stronger for foreign-owned mines versus domestic ones. In analogy to this, De Haas and Poelhekke (2014) find in a broad sample of emerging economies[3] that traded sector firms that have no direct link to the extraction sector report more constraints to doing business if they are located within 20km of active mines. These constraints, measured by the Business Environment and Enterprise Performance Survey, include transportation bottlenecks, electricity provision, access to educated workers, crime, and financial constraints. In turn, these

[3] The sample includes Brazil, Chile, China, Kazakhstan, Mexico, Mongolia, Russia, and Ukraine.

constraints tend to stunt firm growth in terms of employment and sales. Firms outside of mining areas report fewer constraints. This constitutes a local variant of the Corden and Neary (1982) resource movement and spending effects.

Backward linkages may constitute the main, and in some cases only means by which the economic benefits of resource extraction are felt by those living proximate to resources. Lippert (2014) studies the extent to which Zambian's have benefitted in the copper belt region. He look at the effect of the Zambia copper boom using exogenous variation in copper production at the mine level between 1996 and 2010. His study draws upon repeated cross-sectional data drawn from the Living Standard Measurement Survey (LSMS) to create a constituency-level panel. The central result of this paper suggests that an increase in local copper output improves measures of living standards in the respective constituencies via the mines' backward linkages. In particular Lippert estimated an increase in real household expenditure of 2 percent associated with 10 percent increase in copper output at the constituency level. Lippert's study makes the claim of estimating the pure project effects – i.e. the backward linkages – isolate from any government spending mechanism by reference to the very small revenues accruing to the government during the copper boom.

A similar study by Loayza et al. (2013) uses variation in mining across Peruvian districts to investigate the impact of mining activity and government transfers on local socioeconomic outcomes. The analysis uses a district level dataset that merges administrative data on local mining production, transfers from central to local government, and census and survey-based measures of households' average consumption, poverty, and inequality. The authors are able to trace the positive impact of mining on local communities with the strongest effects in producing districts- who benefit from both the mine and government transfers. However, their findings do suggest that mining is exacerbating inequality across districts in Peru- even beyond producing regions. This may be drive by a policy of returning a disproportionate share of resource revenues to the local district, at the expense on non-mining districts.

The documented positive, but modest gains from resource extraction projects challenge some narratives of enclave development, dating back to Hirchsman (1958). However, there remain concerns that the gains may be distributed unevenly or asymmetrically. These heterogeneous effects are also being examined in recent studies. Kotsadam and Tolonen (2014), for example, use data from the Demographic Health Survey for various countries in Africa to examine the effect of mine opening. They use the RMG Raw Materials Database for information on mine location and opening year, and combine it with DHS clusters using GPS coordinates and straight-line distances. Their study is concerned with the gender impacts of mining, finding evidence for increase female employment from mine opening. Furthermore they find evidence for a shift of women into the service sector, while the effect decays over distance. They find an asymmetric effect for mine closure and suspension with women not fully returning to the agricultural sector, whereas overall employment levels remain low.

The finite nature of resource extraction means that all projects will eventually end and closure prompts concerns of job losses and reversal of economic gains that might have accrued during operations. A study of the coal 'boom and bust' in north-eastern United States (Black et al., 2005) measures the employment spillovers of both mine opening and closure. The authors find a modest number of non-coal jobs created by the boom. During the bust, the spillovers are bigger and more persistent than the boom. This asymmetry of effect is being taken up by other more recent papers (for example, by Toews et al. (2014) for the coal mines closures in the United Kingdom, by Cust (2014) for mines in Indonesia, and by Kotsadam and Tolonen in Africa for women and mining, 2014).

Studies of the relationship between resources and economic development at the macroeconomic and cross-country level have highlighted the importing mediating effect of political institutions. These importance seems to be replicated at the subnational level. Libman (2013), for example, uses variation in institutional quality across Russian regions to examine the relationship between resources and governance at the *within-country* level. His empirical work supports the cross-country hypothesis, that the economic effects of the resource curse are mediated the level of institutional quality (see for example Collier and Goderis, 2007). Libman finds that resources have a negative association with growth if the quality of regional governance is low. On the other hand, increasing levels of democracy also have negative consequences for regions with substantial resources. However, as the author notes, these estimates cannot be interpreted causally and constitute a very short (seven year) timespan.

Finally, local effects studies are also concerned with the negative potential of resource abundance. The clearest evidence for a *resource curse* factor being observed at both the cross-country and the local level is that of conflict. Various authors, including Dal Bo and Dal Bo (2011) show theoretically that positive shocks to capital intensive industries like mining may increase the risk of conflict - a prediction empirically confirmed by Berman et al. (2014) for mining in Africa and Dube and Vargas (2013) in their case study of oil windfalls in Columbia. Berman et al. (2014) utilized mine location data for Africa combined with the ACLED conflict dataset. This allows them to examine the relationship between world price shocks to minerals and subsequent conflict incidents. They find evidence to suggest increases in mineral prices trigger increased violence close to mine sites- measured both in terms of riots and unrest, and in terms of battles. Furthermore their evidence suggests that access to mines supports the ability of armed groups to perpetuate violence and this can drive secessionist violence. Oil can be a driver of internal conflict too. Using the Horn (2004) dataset on giant oilfields, Michaels and Lei (2011) find that on average discoveries increase the incidence of internal armed conflicts by about 5-8 percentage points within 4-8 years of discovery, compared to a baseline probability of about 10 percentage points.

Related studies use within-country variation to document the adverse effect of oil windfalls on corruption in Brazil (Caselli and Michaels, 2013), on crime (James and Smith, 2014) or the adverse environmental impact of Gold mining in Ghana (Aragon and Rud, 2012).

The various studies examining the direct effects of resource extraction share many findings in common. Through backward linkages to the local economy, projects can have significant positive welfare effects. Indeed there is evidence to suggest this may be the most effective channel, versus say local government spending. This stands in contradiction to the claims that such projects act as enclaves with very limited ties to the local economy. The magnitude however can be small, and is conditioned on the policies of resource projects as well as the availability of local markets for goods and services. On the other hand, there is evidence that resource projects can fuel internal conflict- both from petroleum and solid mineral production. Extraction can increase and exacerbate inequality, with asymmetric effects on men and women, and there is some initial evidence that now suggests that mine closure or a "bust" can be more painful than the welfare gains during mine opening or the "boom".

5 Government spending channels

The previous section examined the local impact of mines in terms of direct channels of effect- most often via backward and forward linkages to the economy. A relatively recent development is that

natural resource revenues have directly benefited local government budgets and the producing administrative units. Resource extracting firms are typically taxed by the national government or they are state owned, resulting in resource rents accruing purely to the national government. However, several countries have seen a move to the decentralization of executive and fiscal powers to local administrative units to foster regional autonomy, improve service delivery, and improve accountability of government. To some extent, this was driven by a process of democratization and the wish of (ethnic) minorities to have more say in political decisions. In addition, resource extraction itself created demand for decentralization. Observing steeply rising natural resource revenues during the 2000s, local governments demanded a larger say in the way in which revenues were spent and a larger stake in the revenues themselves. The combination of these trends resulted in a higher impact of mines on their region, through the revenue channel.

However, the size of this impact depends on the sharing rules between regions and the way in which local governments spend the revenue. On the one hand, there is relatively little research that compares sharing rules and fiscal arrangements making it unclear what the optimal policy should be. On the other hand, the available evidence suggests that, for a given degree of revenue sharing, the impact of resource rent transfers to local governments has resulted in mixed blessings.

In theory, rent transfers to local governments have the potential to generate more public support for mining by compensating environmental costs. Moreover, the classic case for fiscal federalism (Stigler, 1957; Tiebout, 1956; Oates, 1972) is that local (elected) governments are better informed of local needs and ways to spend the rents effectively, although public goods provision such as infrastructure that transcends local boundaries should be provided by higher layers of government. Countering this argument is that local governments may not have the capacity to administer the rents, and fragmentation of rents across many executive powers may result in ineffectively small amounts being made available for investment. At the same time, public investment may not be effective at a local level due to absorptive capacity constraints. Finally, the different layers of governments may have different priorities: local development needs (such as water provision) are not necessarily in line with national development goals (such as higher education). These differences may also result in political conflict over what is considered to be the more equitable division of resource wealth.

Recently, a small literature has emerged on the effectiveness of rent sharing with local governments. For Brazil, Caselli and Michaels (2013) show that, unfortunately, corruption and embezzlement drive a wedge between the amount of fiscal transfers or royalty payments received and local outcomes. They find that municipal revenues increase with royalties from oil production, which amount to roughly 3% of gross oil output. To identify the effect of this on socio-economic outcomes, they compare coastal municipalities with no oil to those with *only* offshore oil. The reason is that offshore oil, as opposed to onshore oil, is shown to have no systematic effect on non-oil GDP, suggesting that the effect of oil works through revenues only and not through spillovers from extraction activity. The main result is that municipal spending increases much less than what can be expected from the increase in royalty payments. Spending does increase, but, on average, survey reported measures of real outcomes do not improve, nor do oil municipalities attract migrants, suggesting that welfare does not increase. They argue that the lack of a positive effect cannot be accounted for by offsetting reductions in taxation or federal spending in municipalities, neither of which takes place. They suggest that mayors use money to create fictitious public employment for certain groups to improve reelection chances. Also, mayors of municipalities with oil income are found to be more commonly mentioned in the news in relation to corruption. An open question however, is whether in this respect natural resource windfalls are different from other windfalls such as aid or federal transfers.

The former may be worse because there tends to be less transparency over the amount of revenue involved.

In addition to corruption, Arrellano-Yanguas (2011) show, based on field research in mining regions in Peru, that redistribution of natural resource rents to regional and local levels of government can create new problems. On the one hand, it increases public support for mining because revenues no longer 'disappear' to the national government. However, it may also fuel new forms of conflict. Where previously typical conflicts involved the mining company and the local community over issue such as land ownership, access to water and pollution, new forms of conflict involve access to natural resource revenues and their use. Partly, the issue is that the streams of revenues increased quickly during 2005-08 without increased administrative capacities in government, such that corruption and absorption capacity constraints led to inefficient spending. Disagreement between levels of government on how the revenue should be spent could for example be paid off by raising public salaries. Also, the structure of governance is poorly equipped to execute development strategies due to fractured mandates, overlapping jurisdictions, and high staff turnover. Other forms of conflict involve the rules of allocation which result in political conflict over territorial boundaries or fights over the criteria themselves, fueled by increased inequality between mining and non-mining regions. The basic message is that decentralization of revenue spending can only work if government capacity is improved simultaneously.

This latter view seems consistent with the experience in Colombia, which divides oil and coal royalties between the national government, departments, and local municipalities. Unlike federal transfers, royalty payments are not earmarked specifically although education and health has priority over other public investment. Nevertheless, in a panel of Colombian departments, Perry and Olivera (2009) find that high oil production and high royalty payments correlate negatively with GDP per capita growth. Royalties only appear to increase income in departments which already have a strong capacity to generate tax income. Possibly, departments with governments able enough to raise revenue through taxes are also better equipped to spend royalties relatively wisely.

In contrast, Cust and Rusli (2014) find evidence for Indonesia that fiscal transfers related to oil production boost local GDP, while the direct effect from project investments is more attenuated. Transfers increased markedly after 1999, when the fiscal system was decentralized to give local governments more autonomy over spending, and resulted in larger disparities between producing and non-producing districts. As in Brazil, this has led to the endogenous creation of more local (and even provincial) administrative units to carve out larger local shares of the revenue. Direct local elections foster accountability over spending, but have also led to increased patronage and collusion with businesses. Moreover, smaller administrative units may not have the capacity to spend revenue effectively. In Kazakhstan, Toews (2013) finds that oil windfalls can lead to increased dissatisfaction, however this may be driven by inflated expectations rather than simply government underperformance.

Finally, in Chile rent transfers are aimed at decreasing inequality between provinces. However, Aroca and Atienza (2011) make a case that the mining region of Antofagasta loses more potential mining related wage income through commuting than the region receives in the form of fiscal transfers through the regional development fund. The reason is that reductions in travel costs have allowed city-mine commuting to replace the creation of traditional mining towns close to mines, especially for more remote areas. These allow the wage income earned by labor to spread further from the mine. Naturally, this reduced the scope for local spillovers. For the case of Chile, which has 44 percent of workers concentrated in the capital city, leaving rest of the country fairly empty, he finds

that regions that send workers are the main beneficiaries of mining in the region of Antofagasta, where 10 percent of the workforce commutes from out of the region.

The evidence suggests that positive local outcomes as a result of revenue sharing with local government are possible but in no sense are they guaranteed.[4] Further research is warranted on how to distribute rents in the best way and how to equip local governments with the capacity to spend them effectively. For this reason, none of the papers above allow strong welfare statements, because no benchmark exists. Optimal fiscal policy design with resource rents has been analyzed at the national level, but has been under-researched at the local level.

6 Regional spillovers, mitigation, and infrastructure

The recent shift from cross-country data to subnational data sets has also led to improved identification of 'Dutch disease', one of the main macroeconomic mechanisms behind a resource curse. Moreover, subnational and micro units of observation allow identification of spillover effects across (local) industries and also across regions. For example, the recent shale revolution has increased interest from policy makers (who decide on drilling licenses) on the costs and benefits of local resource booms on the environment, on employment and on growth. Such local booms may result in migration which mitigates Dutch disease effect. Furthermore, extraction typically requires extensive investment in infrastructure with potentially important side effects on trade and investment.

6.1 Spillovers and mitigation of local resource booms

Allcott and Keniston (2014) examine county-level data for the US to investigate the local and spillover effects of boom-bust cycles in natural resource production.[5] Several US counties experienced two oil and gas booms – after the oil crisis in the 1970s and recently during the shale revolution – and one bust – during the 1980s – and were treated with sizeable changes in natural resource employment.[6] Other counties with less or no initial resource endowments did not experience these cycles directly. However, the high degree of disaggregation allows identification of spillover effects across industries and counties. Their findings suggests pro-cyclical performance of the aggregate county economy: a doubling of resource sector employment predicts a 2.9 percent rise in total employment. In addition, manufacturing employment increases, even though manufacturing wages also rise. The latter reflects imperfect elasticity of labor supply despite significant migration to booming counties which mitigates the rise in wages. Since many manufactures link to the resource sector as up or downstream industries, or produce locally traded goods, these findings are in line with the classic Dutch disease models (i.e. Corden and Neary, 1982). However, they find only weak evidence that non-linked traded manufacturing firms suffer, which goes against the predictions of Dutch disease. A related paper on the local effect of the coal boom in the 1970s and bust in the 1980s in coal producing counties of four US states found similar albeit small employment and wage effects across sectors (Black et al., 2005). In addition, and consistent

[4] See for another case study: Obeng-Odoom (2013).

[5] James and Aadland (2011) and Domenech (2008) also test for a resource curse in US counties and Spanish provinces respectively, but they do not test for spillovers. A related emerging literature examines the US shale revolution specifically, see for example: Weber (2013), Fetzer (2014), James and Smith (2014), Muehlenbachs et al. (2014), and also Gilje et al. (2013) on the effects on local finance.

[6] For further reading on the causes of these commodity cycles, see: Carter et al., 2011.

with the relatively low-skill intensity of coal mining at the time, they documented positive effects on poverty during the boom period, suggesting that existing residents benefited from the boom.

Interestingly, one of the main ideas of how Dutch disease may reduce aggregate growth is also not supported by the data in Allcott and Keniston (2014). In Van Wijnbergen (1984), learning by doing which may mainly take place within the traded sector would also suffer from a resource boom, thereby reducing productivity growth. The paper finds neither contemporaneous nor long run evidence that revenue based TFP of non-linked traded firms relatively declines in booming counties. In addition, none of the positive contemporaneous TFP effect on the other industries hold in the long run. This contrasts the idea – based on Chinitz (1961) – that mining towns may specialize in heavy industries with large scale economies which in turn crowds out entrepreneurship by reducing access to inputs, capital and investment in skills. Glaeser et al. (2014) show that this reduced employment growth in such cities.

These results may depend on how resource, tradable and non-tradable sectors are defined. As long as a firm sells some of its output locally, it will also benefit somewhat from the local increase in demand. A narrower definition of non-linked sectors may result in stronger negative spillovers from the resource boom: these firms pay higher wages but cannot benefit from local demand. Alternatively, there may be limited substitutability between the traded and resource sectors, at least in the short run. Another potential explanation is that any negative effects are cancelled by other unobserved positive effects, such as from local infrastructure provision or local tax cuts.

In addition to looking across sectors, Allcott and Keniston (2014) also find evidence for considerable regional spillovers: less resource abundant counties experience positive spillovers from resource abundant counties. Although they may lose population to the higher wage offers in resource counties, their industries also supply more goods and services to meet the increase in regional demand.

Michaels (2011) examines US counties in the South and compares the long run economic outcome of oil rich versus oil scarce counties. He finds mostly positive effects however: oil rich counties have higher population density, higher per capita income and higher manufacturing employment density despite inflated factor prices. While he cannot rule out that this may be due to linked industries, the paper also finds that investment in infrastructure has been higher in oil rich counties, which may have led to positive agglomeration externalities and can explain the positive spillover effect on the agricultural sector. This suggests that a local boom can be sustained if local revenues also translate in local investment in public goods, providing another channel of positive spillovers. Such a beneficial public policy may be lacking in less developed countries.

Notwithstanding the clean identification of the results in Allcott and Keniston (2014), Michaels (2011) and Black et al. (2005), the question arises how specific these results are for the US case. One can imagine that in other countries, with fewer up or downstream industries (for example because there is no local refining capacity), a larger share of the manufacturing sector may suffer from Dutch disease effects. Furthermore, the high degree of internal migration limits the rise in wages, which, as the paper notes, explains the relatively small magnitudes of the effects. In contrast, Caselli and Michaels (2013) found no evidence for interregional migration flows as a result of oil booms. Also, the US is a net importer of hydrocarbons, which limits upward pressure on the exchange rate and reduces electricity prices[7], further limiting the negative spillovers on the traded sector. Another consideration is that in the US case a large share of resource sector revenues may be spent locally in

[7] See also Fetzer (2014) on US local electricity prices in this context.

the form of wages from resource sector workers, but also by land owners whom hold ultimate title to the land and subterranean natural resources and thus receive royalty payments. In other countries, such royalties typically accrue to the national government, and wage earners in the resource sector are not necessarily hired locally. Future research at a similarly disaggregated level from less developed countries may shed more light on these considerations.

A related paper uses provincial level data for Canada (Beine et al., *forthcoming*) to investigate how large the mitigating effect of labor mobility are on Dutch disease dynamics. Without internal and international migration, competition for workers would lead to a larger relative change in the size of the non-traded sector (as proxied by the services sector) versus the manufacturing sector in booming regions. Identification comes from the boom in Alberta's tar sands oil production and the discovery of oil fields off the coast of Newfoundland. They find that a local resource boom increases the share of the non-traded sectors in the provincial economy, while mainly temporary immigration reduces it. On the other hand, the resulting interprovincial outmigration in non-booming regions leads to negative spillovers in the form of an increase in the share of the non-traded sector.

Further evidence for Canada provided by Papyrakis and Raveh (2014). They find that a provincial boom in natural resources leads to higher local prices and a decline in the share of employment in the tradable sector, although the share of capital in the traded sector increases, thereby also increasing the capital intensity of the traded sector. By estimating a spatial lag model based on distance between the largest cities of each province, they find that a boom in neighboring regions conversely increases the share or labor in the traded sector, while the share of capital in the traded sector decreases, such that capital intensity decreases. Since they make no distinction between linked up and downstream industries and unrelated traded manufacturers, it may be the case that the increase in capital intensity is due to capital intensive linked sectors drawn into the booming region. Alternatively, the positive effect on capital may be due to lower capital taxation which may be financed by resource revenues in the booming province (Raveh, 2013). In addition they find that non-resource exports suffer as a result of a local boom in natural resource production, consistent with Dutch disease. Interestingly, only international exports suffer, while national trade remains unaffected, reflecting the appreciation of the real exchange rate, and the possibility that international trade may have been substituted by national trade to meet increased local demand.

6.2 Mining infrastructure

While Michaels (2011) documented the positive effects of oil-financed general purpose infrastructure on local economic development, Bonfatti and Poelhekke (2014) have looked at potential side effects of purpose-built mining infrastructure. Especially in Africa, the predominant pattern of road and rail infrastructure is that it connects the interior with the coast, rather than with neighboring countries. In many cases, such infrastructure was constructed with the purpose of unlocking inland mineral deposits and exporting these via ports to world markets. While many such infrastructure was built in colonial times, most of it is still maintained or newly constructed in later decades with the same purpose. To the extent that such infrastructure can be used to import as well, Bonfatti and Poelhekke (2014) hypothesize that mine-to-coast infrastructure decreases trade costs with world markets relative to trade costs with neighboring countries. They find evidence in a cross-section of bilateral trade flows that countries with more mines trade relatively less with neighboring countries. The effect is stronger the closer mines are located to city-to-port roads. In contrast, and consistent with the theory, landlocked countries trade more with at least one (transit) neighbor, while no effect is found for oil and gas extraction, which is typically piped and does not reduce import costs. However, an open question is what the aggregate welfare effects of mining

infrastructure are, since such construction can be efficient from the perspective of comparative advantage.

Finally, a related literature examines the labor demand and spillover effects of infrastructure construction. For example, Carrington (1996) examines the impact of the construction of the Trans-Alaskan Pipeline System (TAPS) between 1974 and 1977. This led to large swings in labor demand relative to the local economy which were large enough to identify in state level statistics over time. The evidence suggests strong positive spillovers on related sectors. Less related sectors experienced only little upward pressure on wages suggesting that cross-sector labor substitutability was limited, possibly due to the high skill intensity of the construction. Instead, labor was provided by seasonal and temporary in-migration. Manufacturing and the public sector are unaffected, which may be due to the geographic remoteness of these sectors to the TAPS sites.

7 Conclusions: what we know and future avenues for research

This paper provides a survey of the literature of the within-country effects of natural resource abundance. A growing body of theoretical and empirical literature has shifted-attention from examination of the "resource curse" hypothesis across countries, to exploring the potential dynamics at the local and regional levels. In particular, new datasets and empirical methodologies have allowed researchers to conduct causal inference of the effect of resource projects, revenue windfalls, and infrastructure associated with resource abundance. These studies find strong evidence for impacts – positive and negative – extending beyond the project "enclave".

Through backward linkages to the local economy, projects can have significant positive welfare effects. Indeed there is evidence to suggest this may be the most effective channel, versus local government spending. The magnitude however can be small, and is conditioned on the policies of resource projects as well as the availability of local markets for goods and services. On the other hand, there is evidence that resource projects can fuel internal conflict - both for petroleum and solid mineral production. Extraction can increase and exacerbate inequality, with asymmetric effects on men and women, and some initial evidence suggesting that mine closure or a "bust", can be more painful than the welfare gains during mine opening or the "boom".

While mines and oil fields appear to generate positive labor market and welfare effects on the surrounding economy in the short run, the magnitude is possibly only large in developed countries such as the US, which have more potential for developing local up- and downstream industries. Also, internal migration can limit Dutch disease effects. There is some evidence that developed countries are better able to prolong boom periods by investing in local infrastructure and other public goods.

Many resource-rich countries face pressure to decentralize spending and distribute the proceeds of resource extraction disproportionately in favor of resource rich regions. It is therefore of great relevant to study the cases where developing countries have already undertaken local revenue sharing. The literature suggests they have had mixed success. Early evidence suggests that local government spending, in particular where the capacity of local government is limited, can crowd out private sector activity through a burgeoning public sector. More research on how sharing rules and spending policies should best be designed and administered, in addition to the capacity constraints and pre-requisites for effective administration could provide significant benefits for countries following this path.

Finally, more research is warranted on a variety of fronts. The first is to look at an even finer spatial scale, such as artisanal mining, which in many rural areas may cause severe environmental and health risks, conflict and generally few economic benefits. Second there is a need to better understand the relative magnitudes of local impact versus the benefits accruing to the whole country via government revenues. This can help contextualize the policy challenge faced by governments who seek to balance national economic development with benefits to local groups.

The final area for development is a methodological one. Many of the early studies have deployed innovative techniques and new datasets. Future work should continue the careful attention to identifying assumptions such as exogenous discovery and seek improvements in data quality. This will allow authors to test earlier findings and evaluate external validity, while identifying key transmission channels and policy levers.

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