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Local Labor Markets and Natural Resources: A Synthesis of the Literature

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Abstract

A primary way that natural resources affect a locality is through the demand for labor, with greater extraction requiring more workers. Shifts in labor demand can be measured through changes in employment and earnings, the main labor market outcomes, or through changes in the population and income, more generally. These changes may spillover into the non-resource economy, leading to greater overall effects or possibly crowd out; be spread unequally across the population, thereby altering the distribution of income and the poverty rate; or influence educational attainment, as people choose between additional schooling and work. In this review, the literature linking natural resources to local labor markets is synthesized by organizing existing studies according to their resource measurement and the outcomes that they consider. This synthesis provides an accessible guide to a literature that has boomed in recent years. It also identifies promising avenues for future research and lays a foundation to further generalize the evidence through an eventual meta-analysis.

JEL codes: J20, J40, Q23, Q33, R23.

Keywords: local labor markets, natural resources, resource booms.

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1 Introduction

The economics literature contains many studies that enhance the understanding of what happens to a local economy following a large labor demand shock. One strand of literature focuses on the introduction of a major establishment into a local labor market, with prominent examples including casinos, in the U.S. and Canada (Cotti, 2008; Humphreys and Marchand, 2013); large retail stores, using the example of Walmart (Basker, 2005; Neumark et al., 2008); large manufacturing plants, such as those of the "million dollar" variety (Greenstone and Moretti, 2003; Edmiston, 2004; Greenstone et al., 2010; Adams, 2016); professional sports facilities, both old and new (Coates and Humphreys, 1999, 2003; Siegfried and Zimbalist, 2000); and the hosting of a large event, such as the Olympics (Rose and Spiegel, 2011; Billings and Holladay, 2012; Baade and Matheson, 2016). Another strand of literature studies the effects of expansions or contractions of broad sectors within a local labor market, using external shocks that differentially affect states or counties based on their initial characteristics (Topel, 1986; Bartik, 1991; Blanchard and Katz, 1992) or particular shocks to an entire sector (Autor et al., 2013, 2016; Acemoglu et al., 2016).

Labor market shocks linked to natural resources in particular have gained considerable attention, with numerous studies linking natural resources to a range of labor market outcomes proliferating in the last decade. As with the previous examples, although natural resources can affect a locality in many ways, a primary way is through the demand for labor. During a boom in energy prices, greater extraction requires additional labor, thereby attracting people from elsewhere and raising earnings and income. In the presence of spillovers, greater labor demand from extraction may also affect other individuals and firms across the local economy who have no direct connection to the natural resource sector. In addition, this greater labor demand can alter the distribution of income and the poverty rate, as well as influence decisions about staying in school or what types of education to pursue.

The literature on the local labor market effects of natural resources has several intertwined origins. Economists interested in local labor markets realize, in general, that natural resource industries can bring about labor demand shocks that are large, sudden, and geographically focused, three characteristics that contribute to more credible and precise empirical estimates. At the same time, economists and others particularly interested in the economic effects of natural resources shifted attention from studying cross-country variation in resources (e.g. Gylfason, 2001) to sub-national variation, which allows for more credible empirical analyses by holding country-specific conditions constant. Concurrent with both shifts in attention, the widespread development of unconventional oil and gas resources in the U.S. and Australia provided opportunities for new empirical work, while increasing its timeliness.

In this review, the recent literature linking natural resources to local labor market outcomes is synthesized. This recent proliferation of research has led to the emergence of several recent reviews (or review-like papers), although none have focused exclusively on local labor markets. Focused on the national level, van der Ploeg (2011) was the first to comprehensively review the cross-national literature and provide an overview of the causal channels linking resource abundance to various economic outcomes. Soon after, Fleming and Measham (2013) developed a conceptual framework for the linkages between resources and socio-economic outcomes and, in doing so, reviewed many studies.

Most recently, Fleming et al. (2015) review the literature on the effects of unconventional fossil fuel development by looking at its effects on employment and income, population and housing values, and human and social capital. More narrowly focusing on shale gas development, Mason et al. (2015) quantify the economic costs and benefits of development and review the related research on unconventional fossil fuel development. Aragon et al. (2015) consider non-renewable resources in general and review the cross-country and within-country literature, looking at an array of socio-economic, environmental, and public finance outcomes. Lastly, van der Ploeg and Poelhekke (2017) offer a broad review of cross-country and within-country studies linking natural resources to a variety of economic outcomes.

Distinguishing the current review from related reviews, a typology of studies is introduced based on the measurement of natural resources that each paper uses. This resource typology includes: *dependence*, such as the share of earnings accounted for by the oil and gas sector; *endowments*, such as oil and gas reserves; and *extraction*, such as the number of wells drilled. The literature has many examples of each type of measurement. While much of the earlier research of natural resources focused on measuring dependence and testing the so-called "resource-curse hypothesis", many of the newer studies instead use endowments, or extraction, or some combination of the two, as their resource measure.

After introducing this resource typology, the literature linking natural resources to local labor markets is further synthesized by considering the estimated effects on aggregate labor market outcomes, beginning with employment and population, and then moving on to earnings and income. Regarding employment and population, all of the studies found positive employment effects from extraction during a boom, and most additionally showed greater population growth. Unsurprisingly, the studies examining earnings and income also generally showed positive effects, with more studies looking at income rather than earnings.

Estimates involving related labor market outcomes are then explored, namely spillovers (from natural resource-based industries to other industries), the distribution of income (relating to inequality and poverty), and education (primarily through high school graduation rates). Several studies documented positive spillover effects, attributing an additional one to two jobs in other sectors of the local economy for every resource sector job created. While the evidence linking resources to inequality remains mixed, the majority of studies in both developed and developing countries shows that resource booms lower the poverty rate. And, several educational studies indicate that booms generally increase high school dropout rates, due to the increased wages of low-skilled workers relative to skilled ones.

As for future research, much uncertainty surrounds the long-term effects of resource extraction. Are busts generally worse for the local economy than booms are good? What happens when economically attractive resources have been largely exhausted? The sparseness of the literature in answering such questions makes them a promising avenue of further research, especially given that many existing studies document economic gains from extraction booms. Estimates of the educational effects of resources are also scarce and inconclusive, despite their relevance for the long-term effects. As such, the link between natural resources and human capital accumulation is an additional area ripe for more research.

2 Resource Measures and Empirical Approaches

Studies of natural resources can differ by the types of resources that they analyze. Resources may be energy-related, such as oil and natural gas, or be non-energy minerals, such as metals and stones. They may also differ by whether they are non-renewable, like all of the preceding examples, or renewable, like the energy of the sun, water, and wind. A less obvious difference between studies, however, is in how they measure their resources. Studies may look at the effect of being economically dependent upon the resource industry, the effect of having certain endowments of these resources, or the effect of their scale of resource extraction. The literature is therefore organized by these measures (dependence, endowment, and extraction) and variations in the empirical approaches that use them to link resources to labor market outcomes are described.

Each study is situated within the resource category that best matches its approach, while recognizing that a study could overlap one or more of the typologies. Black et al. (2005a) illustrate the challenge of cleanly categorizing the literature, as their empirical analysis employs all three of these measures to varying degrees. They use the initial share of earnings from coal mining beyond a certain threshold to represent a county's dependence on the industry, which then serves as a proxy for coal endowments. Changes in coal prices are then interacted with this coal-county status and linked to changes in employment, with the assumption that booms or busts in coal prices will have a greater effect on extraction in coal-dependent counties.

2.1 Dependence

Economic dependence on natural resources, which is often measured by the share of an economy's total employment or total earnings accounted for by the resource sector, has been used by many studies, as shown in the first column of Table 1. One motivation for using the resource share of the economy as the variable of interest is to examine the so-called "natural resource curse": a hypothesis that resource-abundant economies tend to have slower economic growth. Unsurprisingly, the studies in this review that use a dependence measure often focus on testing this resource curse hypothesis, such as Papyrakis and Gerlagh (2007) and James and James (2011), which look at U.S. states, and James and Aadland (2011), which looks at U.S. counties. More recent studies using dependence measures continue this pattern, while either mentioning the resource curse within their title (Partridge et al., 2013; Betz et al., 2015) or using it to frame and motivate the empirical analysis (Deaton and Niman, 2012; Haggerty et al., 2014). To test the resource curse hypothesis, researchers often estimate the relationship between resource dependence in an initial year and economic growth over the subsequent decade or similar length of time.

Another motivation for using the resource-dependence measure is to capture an economy's exposure to particular external shocks, which then allows researchers to study the effect of a shock by comparing more and less-exposed economies. This use of dependence measures has roots in the broader economics literature on the effects of expansions or contractions of broad sectors within a local economy (Topel, 1986; Bartik, 1991; Blanchard and Katz, 1992). More recently, the local labor market effects of increased Chinese imports have been examined through a locality's exposure to competition from Chinese imports, as measured by a county's specialization in goods exported by China, which were shown to significantly affect employment and wages in the U.S. over the 1990s and 2000s (Autor et al., 2013, 2016; Acemoglu et al., 2016).

An early study, Blanchard and Katz (1992), looked at long-run employment growth across various groupings of U.S. states to examine how regional labor markets differ in their response to macroeconomic shocks. One of their particular regional designations was "oil and mineral states," which they defined as states where oil, gas, and other minerals comprise two percent or more of total earnings. Two other within-country studies use a measure of resource dependence at a more local level to study the effects of booms and busts in energy prices, and therefore booms and busts in resource extraction. Black et al. (2005a) define their U.S. Appalachian coal counties as those where earnings from coal accounted for at least ten percent of total earnings prior to the boom in coal prices. Marchand (2012) similarly defines his treatment set of Western Canadian Census divisions, which is based on having at least ten percent of earnings coming from the energy extraction sector.

Although both studies use a dependence measure (a binary variable based on initial resource dependence), they seek to study the effects of changes in extraction, not necessarily their degree of dependence. This is done by interacting the binary dependence variable with variables indicating periods of high and low energy prices. The approach rests on the idea that areas with greater resource dependence have greater resource reserves and should therefore experience greater extraction growth (relative to less-dependent areas) during times of high resource prices. The empirical models then look at annual changes in outcomes over different price periods.

In general, dependence measures can be hard to interpret. The share of employment accounted for by the extractive sector will increase with the scale of extraction, as greater extraction requires a larger resource sector, but it also increases as the non-resource economy shrinks. The multiple sources of variation in this measure complicate its interpretation, because an economy could become more resource-dependent for reasons unrelated to the resource sector. For example, greater competition from imports could cause several local factories to close, thereby shrinking the non-resource economy and increasing local resource dependence. This makes linking initial dependence to subsequent economic growth problematic because greater dependence by itself may indicate deteriorating economic performance.

The link between dependence and subsequent economic growth will also be highly dependent on changes in resource prices observed over the study period. Explicitly incorporating changes in prices, perhaps by identifying the years of price increases and decreases or by interacting dependence with price changes, allows for a fuller explanation of the link between dependence and economic growth.

2.2 Endowment

There are also studies that look at the effect of the presence or quantity of a particular natural resource, regardless of whether or how much that resource has been exploited, which are listed in the second column of Table 1. Black et al. (2005b) classify mid-western U.S. counties based on low, medium, and high coal reserves. Michaels (2010) divides southern U.S. counties based on whether they are located above a major oil field. Emery et al. (2012) organize their data by province, with one province (Alberta) having abundant oil and gas endowments. More recently, Allcott and Keniston (2015) and Cascio and Narayan (2015) use a continuous measure of oil and gas endowments for the U.S., while Marchand and Weber (2017) use the variation in shale depth across Texas school districts, with deeper shale being associated with more oil and gas. Similarly, Bartik et al. (2016) use a geologically-based measure of shale prospectivity, comparing counties in the top-quartile of prospectivity with counties in lower quartiles.

Simply having resources, but not extracting them, should have little effect on the local economy. Studies using endowment-based measures, however, often look at economic outcomes across high and low-endowment localities during periods with widely differing extraction incentives. Black et al. (2005b), for example, look at the effect of having a high (or medium or low) coal endowment during periods of a boom, peak, and bust in coal prices. Alternatively, Michaels (2010) looks at the effect of oil abundance on economic outcomes over most of the 20th century, with substantial resource extraction having occurred throughout. The other endowment studies take a similar empirical approach, implicitly or explicitly interacting endowments with incentives for their development.

Empirical approaches based on endowments interacted with prices is similar in spirit to the previously mentioned approach for studying the local or regional effects of expansions or contractions of broad sectors within a local economy (Autor et al., 2013, 2016). Here, the initial characteristics interact, either implicitly or explicitly, with changing macroeconomic conditions, such as prices or international competition. Resource endowments, however, are arguably more likely to be unrelated to local economic conditions or trends than certain characteristics, such as the share of the local economy accounted for by a particular sector or industry (Acemoglu et al., 2016). As mentioned before, dependence measures can increase or decrease with shocks that affect sectors outside of the sector or industry being studied.

Endowment-based approaches also have a connection with the literature studying the influence permanent surface characteristics like climate or geography (Easterly and Levine, 2003; Rodrik et al., 2004). Credibly estimating the causal effect of resource endowments that lie below the surface, however, is more straightforward than estimating the effect of surface attributes that have shaped an economy since its inception.

An attractive quality of endowment-based approaches is that the source of variation in endowments from place to place is generally easy to understand. If purely geological characteristics (e.g. shale depth) or pre-extraction endowments (e.g. the locations of major oil fields) are used, then the spatial variation comes entirely from natural factors dating back to prehistoric times. If current reserves are used and some extraction has already occurred, the variation comes from a mix of initial resource endowments, which are determined by natural factors, as well as the previous extent of extraction, which reflects economic factors. For example, Cascio and Narayan (2015) use oil and gas reserves as of 2013, while Allcott and Keniston (2015) combine past production with measures of proven and undiscovered reserves, in order to construct a measure of reserves as of 1960.

2.3 Extraction

Extraction-based measures are also commonly employed in many studies, such as the presence of coal or the number of oil wells drilled, as shown in the third column of Table 1. The literature now includes a wide range of these examples, such as the labor or local inputs used by a mine (Aragon and Rud, 2013), the presence of a producing mine (Loayza et al., 2013), the presence of coal production (Douglas and Walker, 2016), the quantity or value of oil and gas production (Buccellato and Mickiewicz, 2009; Caselli and Michaels, 2013), a certain level of drilling activity (Fleming and Measham, 2014a,b, 2015; Munasib and Rickman, 2015; Parades et al., 2015; Wrenn et al., 2015; Jacobsen and Parker, 2016; Komarek, 2016; Rickman et al., 2016), or the number of active oil and gas drilling rigs (Agerton et al., 2015; Brown, 2015).

Empirical approaches using extraction-based measures have few counterparts in the broader economics literature, where the intensity of industry activity is usually measured by industry establishments or employment, as opposed to activities linked to production, such as wells drilled. The closest link is perhaps with studies measuring the effects of sports stadiums (Coates and Humphreys, 1999, 2003; Siegfried and Zimbalist, 2000) and the hosting of large events (Rose and Spiegel, 2011; Billings and Holladay, 2012; Baade and Matheson, 2016). Here, researchers are most interested in the economic effects where the stadium is built or the event occurs, not necessarily where firms in the sports industry are located. In the same way, researchers are often interested in the economic effects where extraction occurs, not necessarily where extraction-related firms are located. Extraction can bring local social and environmental costs that researchers often want to compare with economic benefits in the same area, thereby motivating a focus on the effects where extraction occurs.

An emerging trend in the literature is to combine endowment and extraction measures to better estimate the causal effect of extraction on economic outcomes. Extraction decisions, such as where and how much to drill, may depend on important and hard-to-observe characteristics of the local economy that are in turn correlated with economic outcomes. For example, either higher prices or better technology can cause firms to pursue extraction in high-endowment areas. Some high-endowment areas, however, may be home to high-income residents who refuse to lease their land for extraction or, alternatively, act to prohibit local extraction. Estimation of the extraction effects can be confounded if the characteristics and actions of local residents are correlated with where extraction occurs or with economic trends.

To avoid confounding estimates with such correlations, researchers can employ a statistical technique known as instrumental variable estimation, in order to study the effect of endowment-driven variation in extraction. In the example given, high income areas may also be experiencing above-average income growth because of the increasing returns to skill in the labor market. Although there are good reasons to expect geological endowments to be uncorrelated with local economic conditions outside of their relationship with extraction, it is not a foregone conclusion that endowments are always exogenous to the outcomes under study. It is possible that economic trends are correlated with geological endowments in certain regions and time periods. Because endowments are spatially correlated, any economic shock that is geographically focused could introduce a correlation between geological endowments and particular economic trends.

Studies combining the endowment and extraction measurement are listed in the fourth column of Table 1. Examples of this approach include the percent of a county covering an unconventional natural gas formation to explain the growth in natural gas production (Weber, 2012, 2014; Brown, 2014), the growth in drilling (Lee, 2015), or the growth in oil and gas employment (Weinstein, 2014; Tsvetkova and Partridge, 2016). Similarly, Fetzer (2014) uses the presence of an unconventional formation in a county to explain increases in the mining share of employment, while Feyrer et al. (2015) use distinct shale formation binaries to explain the growth in the value of oil and gas production. Maniloff and Mastromonaco (2015) use shale formation and oil and gas reserve data to explain the presence of unconventional development, as well as the change in the number of wells drilled. Lastly, Weber et al. (2016)

use shale characteristics (the ratio of shale thickness to depth) interacted with natural gas prices to predict changes in the oil and gas property tax base, which largely depends on the number of producing wells in the locality and their productivity.

3 Aggregate Labor Market Outcomes

A labor market is typically characterized within a neo-classical framework, where the primary labor outcomes are represented in two dimensions, with the level of employment on the x-axis and the wage rate on the y-axis. The demand for labor by firms is represented by a downward sloping curve, and the supply of labor by workers is represented by an upward sloping curve, with their intersection determining the equilibrium wage rate and employment level for a particular labor market. When the effects of natural resources are considered, this labor market would represent all firms and workers involved in the extraction of resources. Local labor markets could then be introduced as an additional source of variation (Topel, 1986; Bartik, 1991, 1996), further differentiating labor markets by geography within a framework recently generalized by Moretti (2011).

Because labor demand is defined as the marginal product of labor within an industry multiplied by the output price of the good being produced, a boom in resource prices, as well as improvements in extraction technology, would cause the labor demand curve to shift outward. Put differently, higher prices or better technology can create the incentive to exploit resource stocks that were previously uneconomical to extract, and the drilling of new oil and gas wells or the mining of more coal will invariably require more labor. Just as high resource prices can cause an extraction boom, a return to low prices can characterize a bust. And although the bust may have qualitatively similar effects to the boom, just of the opposite sign, the magnitude of its labor demand shift need not match.

The labor market outcomes of employment and earnings, both inside and outside of the extraction industry, are likely to increase during a boom, with earnings defined as the hourly wage rate multiplied by the hours of work. The changes in these labor market outcomes relate to further changes in the more general outcomes of population, which add individuals outside of the labor market to employment, and income, which adds non-labor flows to earnings. Total employment and population will grow in a boom, as long as more local residents are willing to work, or people immigrate from elsewhere, or both. If this were not the case, workers would simply shift from other industries to the extraction sector, and the net change in employment would be zero. In the aggregate, a boom should also lead to greater earnings and income, from higher wages, more total hours worked, or both. Non-labor sources of income may also increase, as rental rates rise and payments are made to local resource owners, and the spending of this non-labor income can have additional labor market effects (Brown et al., 2016a,b).

The growth in earnings and income may, however, overstate the local welfare gains of greater resource extraction. Even if wage effects are equally distributed across the local population, higher wages may in part reflect a premium to compensate for worsening local amenities (e.g. poorer air quality, greater traffic congestion) or a higher cost of living (e.g. higher housing prices). Bartik et al. (2016), for example, use estimated changes in income, population, and housing values to infer changes in amenities from hydraulic fracturing, where lower-than-expected immigration, given a particular rise in wages, indicates a decline in amenities following the Roback (1982) framework. It is also possible that higher wages are needed to attract workers to the booming area if the boom is expected to be short-lived (Topel, 1986). With a temporary boom, higher earnings during the boom are needed to compensate workers for lower post-boom earnings (or post-boom moving costs).

3.1 Employment and Population

The estimated effects for employment are difficult to compare across studies due to differences in resource measures and the empirical approaches previously discussed, as well as differences in regions and the type of natural resources under consideration. These estimates can also range from being an average effect of a boom to the effect of additional production. They could also be reported annually or over a longer period of time, like five or ten years. That said, all studies are tied to a similar narrative of either increased or decreased extraction in some way. While some studies use dependence as a measure of exposure to extractive booms and busts, others directly estimate the effect of greater extraction, as measured by indicators such as wells, production, or oil and gas employment, and still others instead use endowments to instrument for extraction.

The variety of these estimated employment effects are managed by grouping similar local labor market studies in Table 2. Studies that examine the aggregate outcomes of either employment, population, or both, are labeled with a "Yes" in the Employment and Population column. An additional "Yes" in the Earnings and Income column then specifies whether those aggregate outcomes are also analyzed, while the Resource Measure column indicates which of the previous discussed resource measures is primarily used. Despite the variation in measures and methods, these studies overwhelmingly find that the growth in natural resource extraction increases total employment.

Studies reporting the average employment effects from a binary resource measure are first considered. An early resource-related paper, Carrington (1996), differs from the work that followed in that it examines the temporary labor demand shock created by the construction of the Trans-Alaska Pipeline System. Given the small Alaskan labor market, a huge influx of workers was needed to build the project. Employment in the state grew by 57 percent during the project's duration from 1974 to 1977, but it returned to its initial equilibrium employment trend by 1981.

Switching to mining, Black et al. (2005a) studied U.S. counties within the coal-producing states of Kentucky, Ohio, Pennsylvania, and West Virginia. Looking at annual total employment growth, coal counties grew by 2 percent more than non-coal counties during the boom and 2.7 percent less during the bust. When only the mining sector was examined, the employment effect was roughly three times larger than for all industries. Looking over two energy booms in Western Canada since the 1970s, Marchand (2012) found a generalized 33 percent decadal employment increase in the non-energy sector. Similarly, Jacobsen and Parker (2016) estimated a 24 percent increase in total employment over roughly a decade, covering the 1970s oil boom in the Western United States.

Looking at the recent U.S. shale boom, Weber (2012) showed that a boom in natural gas drilling increased total employment in boom counties by 12 percent over an eight-year period. More recently, Maniloff and Mastromonaco (2015) find that the boom caused a 24 percent increase in employment in boom counties across the U.S. over the 2000-2010 period. Over a similar period, Munasib and Rickman (2015) estimate a 32 percent increase in employment in the shale counties of North Dakota, but find smaller or statistically insignificant effects for shale counties in other key formations of the U.S. Looking at annual changes in employment, Weinstein (2014) estimates that the shale boom increased employment growth in U.S. boom counties by 1 percent, while Fetzer (2014) finds that a shale-driven ten percentage point increase in the mining share of employment increased county-level employment by 2 percent.

Focusing on Pennsylvania's Marcellus Shale, Wrenn et al. (2015) find a 3 to 4 percent increase for boom counties, while Komarek (2016) finds a larger effect of 7 percent. Similarly, Allcott and Keniston (2015) show how a national shock to oil and gas employment affects U.S. county-level employment, based on the county's oil and gas endowment. Their estimates indicate that a more than doubling of national oil and gas employment (by 100 log points) increases annual county-level employment by 2.8 percent for each standard deviation in additional endowment. Most recently, Bartik et al. (2016) find that the introduction of hydraulic fracturing led to a 3 to 5 percent increase in employment for counties in the top quartile of shale prospectivity relative to counties in lower quartiles.

Instead of estimating the average effects of extraction, several studies estimate how marginal changes of extraction affect total employment, with a marginal change measured by an industry's output (natural gas) or intermediate inputs (wells or drilling rigs). Although not directly estimating a marginal effect, Weber (2012) translated his average employment effect into jobs created due to additional natural gas production, finding that one million dollars in production growth created 2.35 total jobs in the county where production occurred. Looking across the U.S., Feyrer et al. (2015) estimates the effect of an increasing value of production and finds that the same value of oil and gas production generated 0.78 jobs in the county of production and 2.49 jobs within 100 miles from where production occurred. For the quantity of production, Brown (2014) studies nine centrally-located states and shows that an additional billion cubic feet of natural gas production created 7.3 jobs. For the four-state region of Arkansas, Louisiana, Oklahoma, and Texas, Weber (2014) finds that the same quantity of production created 18.5 total jobs, more than double Brown's estimate.

Other studies provide rig-based and well-based estimates. According to Agerton et al. (2015), an additional rig creates 37 immediate jobs and 224 long-run jobs across U.S. states in the 2000s. Similarly, Brown (2015) looks at twelve states and estimates that removing one rig leads to an immediate loss of 28 jobs and the eventual loss of 171 jobs. In per well terms, Parades et al. (2015) estimate that each active well in Pennsylvania's Marcellus Shale generates 6 to 16 jobs in the county. Lee (2015) finds that each gas well in Texas during the 2010s created around 6 jobs in the county, and each oil well created a little more than 2 jobs.

If the local labor market is very large relative to the natural resource sector, much of the greater demand for labor might be met by local residents. If not, the increased labor demand will encourage people from elsewhere to move to the areas experiencing greater resource extraction, due to the higher wages being offered by the resource sector, underemployment elsewhere, or both. Immigration, in turn, will increase the local population. Many of the studies that examine employment also examine changes to the population, and they generally find evidence that population growth accompanies gains in employment. This is shown even over the long term, as oil and gas abundance in the south-central U.S. led to greater growth in population density during the mid-20th century, with this higher density persisting at least until 1990 (Michaels, 2010).

Two exceptions to these positive population effects are Marchand (2012) and Caselli and Michaels (2013). Caselli and Michaels (2013) study the effect of oil revenues on Brazilian municipalities and find no population effects. Their study is the exception that proves the rule. These particular oil revenues are from offshore production, and the offshore industry has almost no link with onshore communities to which the revenues accrue. As a result, one would not expect revenues to affect local labor demand or the population. The population effects from Marchand (2012), for Western Canada, are more nuanced. For various age cohorts, no statistically significant changes to the population are found across two energy booms. The 1981 to 1991 bust period, however, was associated with greater declines of the population in resource areas relative to non-resource areas, especially for older cohorts.

3.2 Earnings and Income

As with the studies of employment and population, the local labor market studies of earnings and income also vary in their resource measures and empirical approaches, as shown by the studies labeled with a "Yes" in the Earnings and Income column of Table 2. Similarly, the evidence overwhelmingly shows that extraction increases earnings and income. This finding is observed for particular regions of the U.S. (Black et al., 2005a; Weber, 2012; Lee, 2015; Munasib and Rickman, 2015; Parades et al., 2015; Jacobsen and Parker, 2016; Komarek, 2016), for a typical U.S. county (Weinstein, 2014; Feyrer et al., 2015; Maniloff and Mastromonaco, 2015; Bartik et al., 2016), and for localities within other countries, including Canada (Marchand, 2012) and Peru (Aragon and Rud, 2013). As with the population effects, Caselli and Michaels (2013) is once again the rule-proving exception. They find no effect of oil production or its revenues on average household income among Brazilian municipalities, which is as expected, given that few local residents work in the offshore oil industry.

A subset of studies looks specifically at measures of wages, such as earnings per worker, and find evidence that extraction increases the wage rate. Black et al. (2005a) showed that the 1970s coal boom caused a 5.5 percent annual increase in earnings per worker. For the same period, Jacobsen and Parker (2016) show an 11 percent increase in wages per capita from the oil boom in western U.S. states. Similarly, the 1970s oil boom in Western Canada caused an almost 20 percent decadal increase in earnings per worker, according to Marchand (2012).

For the 1970 to 2012 period, Allcott and Keniston (2015) find that a one percent increase in national oil and gas employment increases earnings per worker by one to three percent for each additional standard deviation in oil and gas endowment. Looking at the recent shale boom, Fetzer (2014) estimates that a percentage point increase in the mining share, which is used as a proxy for exposure to the shale boom, is associated with higher wages across different sectors. Similarly, Brown (2014) estimates that each billion cubic feet in natural gas production growth causes a $43 increase in the average annual earnings per job in the county, while Weber (2014) finds a slightly smaller effect of $30. For the Pennsylvanian Marcellus Shale, Komarek (2016) estimates that the drilling boom increased earnings per worker by 11 percent.

While the discussion thus far has focused on local labor market effects during booms, several studies also cover a time frame wide enough to include the bust that followed. One question of interest is whether the economic gains of a boom are partially, fully, or more than fully offset by declines during a bust. On this question, the literature offers mixed findings. For the construction of the Trans-Alaska Pipeline, Carrington (1996) found that, while state-level earnings grew by 56 percent during the 1974-1977 construction period, they returned to their initial equilibrium earnings trend by 1979, only two years later.

Looking at the coal boom and bust in the Appalachian U.S., Black et al. (2005a) found that the bust was as bad, if not slightly worse, than the boom was good, with earnings growing by 5 percent more on an annual basis in the coal counties during the boom and dropping by 5.5 percent during the bust. Earnings per worker had similar movements of a 3 percent gain followed by a 2.8 percent drop. Douglas and Walker (2016) find that the presence of coal production was associated with less income growth among Appalachian counties over the 1970-2010 period on average, but that the opposite occurred in times of higher oil prices. For the oil and gas boom of the 1970s in the American West, Jacobsen and Parker (2016) find that, following the boom, per capita incomes fell below their pre-boom levels. Similarly, according to Komarek (2016), the positive income effects from the recent wave of natural gas drilling in Pennsylvania disappeared four years after peak drilling.

Two studies that find more positive long-term effects are Michaels (2010) for the U.S. and Marchand (2012) for Western Canada. Looking at oil abundant counties over most of the 20th century, Michaels (2010) found that oil counties retained higher per capita incomes in the decades after the peak in drilling. For the 1970-1990 period, Marchand (2012) showed that few, if any, of the earnings gains from the 1970s boom were lost during the 1980s bust.

All of the studies of earnings and income, as well as of employment and population, have thus far considered resource endowments or their extraction, or have used resource dependence interacted with time indicator variables, in order to capture the effects of extraction booms or busts. Several studies instead look at the relationship between the initial resource dependence and income growth over the subsequent years, regardless of whether the natural resource sector was expanding or not. Papyrakis and Gerlagh (2007) found that U.S. states with a larger natural resource share of their economy in 1986 had slower per capita income growth over the 1986-2000 period. James and Aadland (2011) perform a similar analysis for U.S. counties during the 1980-1995 period and found a similar result. However, James and James (2011) found that resource dependence is associated with higher income growth among U.S. states, once the growth of the mining sector is taken into account. Looking at parts of the Western U.S., Haggerty et al. (2014) estimates how initial dependence on the oil and gas sector affected per capita income growth from 1980 to 2011, with differing effects based on the number of years in which a county had above average earnings from oil and gas. They find some evidence of lower income growth among counties with a higher initial dependence on this resource sector.

Lastly, for U.S. counties within and neighboring the Appalachian region, Betz et al.

(2015) looks at how the initial share of coal mining, other mining, and oil and gas employment affected income growth over the 1990-2000 and 2000-2010 periods. The positive and negative effects they find depend on the sample and study period used, which is a mixed but understandable result. Whether initial resource dependence is associated with subsequent economic growth or decline (relative to less resource-dependent areas) depends on whether the resource sector grows by more or less than the non-resource sector, a point made by James and James (2011). This will be true in some periods and regions, but not true in others.

4 Related Labor Market Outcomes

4.1 Spillovers and Multipliers

The increase in employment documented by many of the aggregate labor market studies of extractive booms may reflect job creation both inside and outside of the resource sector. The drilling of an oil well, for example, not only requires drilling rigs, but also large amounts of cement, leading to increased sales for local cement companies and a greater need for salespeople. Moreover, the additional income earned by oil workers, as well as cement workers, can have a further ripple effect, as this money is spent on restaurant meals, home improvements, or other locally provided goods and services, leading to more jobs in those industries as well.

One industry's effect on another industry, or on the rest of the economy, is often referred to as a spillover effect. Corden and Neary (1982) first introduced a theoretical model of how impacts in a booming sector affect the non-booming, tradable-good sector. In practice, some industries may receive larger spillovers than others. For example, Carrington (1996) found that the directly-impacted construction industry produced earnings spillovers into service, trade, transport, utilities, finance, and mining due to the building of the Trans-Alaska Pipeline System during the 1970s, but not into manufacturing or government services.

Spillover effects can be measured using a common empirical approach that estimates what is known as a job multiplier. Job multipliers have historically been constructed from simulations based on input-output tables. Simulating the effect of an expansion of one industry resulted in a matrix of effects, where each industry's effect on itself was on the diagonal, meaning that the total sum of any row or column included the initial expansion of the industry under study (see Schaffer, 1999). Under this approach, simulating the effect of adding one job in the oil and gas industry, for example, might produce a multiplier of two, reflecting the initial oil and gas industry job and one additional job created in another industry. Within a regression framework, this approach can be misleading if the null hypothesis on which statistical significance is based assumes that the multiplier is zero. In this scenario, the null hypothesis is likely rejected even in absence of a spillover effect.

More recently, Moretti (2010) described the local multiplier estimation approach within the context of manufacturing jobs to non-manufacturing jobs. In this approach, the directly created jobs are only within the independent variable, whereas the indirectly created jobs are only within the dependent variable. The resulting coefficient therefore reflects the number of jobs created (or destroyed) in an indirectly-impacted industry stemming from the creation (or destruction) of one job in the directly-impacted industry. A multiplier of two using this approach means that one new job in the directly-impacted industry creates two additional jobs in other industries. For the spillovers that follow, the latter convention for discussing multipliers is used, as it is common in empirical studies (as opposed to input-output studies).

The first column of Table 3 lists the local labor market studies of spillovers using these types of multipliers. Black et al. (2005a) was the first to apply this local multiplier approach to natural resources in examining a U.S. coal mining boom and bust in Appalachia over the 1970s and 1980s. For each coal mining job created during the boom, 0.174 jobs were created across the local sectors of construction, retail, and services, but the multiplier was even larger during the bust, as 0.349 local sector jobs were lost for every lost coal sector job. Nearly a decade later, Fetzer (2014) found a larger multiplier for oil and gas sector jobs associated with the 2000s shale boom across the U.S., with each oil and gas sector job creating 2.17 other jobs.

Focusing on natural gas production in multi-state U.S. regions, Brown (2014) estimated that one natural gas mining job created 0.7 non-mining jobs over a multi-year period, while Weber (2014) found a larger estimate of 1.4 jobs in other sectors. Weinstein (2014) finds a much lower oil and gas multiplier across the lower 48 states, at just 0.3 jobs over a shorter period. Lee (2015) focuses on oil extraction in Texas and estimates a long-run multiplier of 1.65 jobs. Munasib and Rickman (2015) estimate within-state multipliers for three key shale states and find a multiplier for shale oil and gas production of 1.77 in Arkansas and 3.37 for North Dakota, but a statistically insignificant multiplier for Pennsylvania. Most recently, Tsvetkova and Partridge (2016) estimate multipliers associated with oil and gas employment over the 1993 to 2013 period for the U.S. and find a range of multipliers depending on the specification and time period (e.g. annual growth or growth over multi-year periods). For non-metropolitan counties, for which their estimates are most precise, the estimates range from each oil and gas job creating no jobs elsewhere to an additional 1.8 jobs.

There are several studies that provide multiplier estimates for outside of the United States as well. Within the four western provinces of Canada and generalized over two energy booms (of the 1970s and 2000s), Marchand (2012) found that 10 new energy extraction jobs created an additional 3 construction jobs, 2 retail trade jobs, and 4.5 services jobs. Put differently, each energy extraction job created at least one other local job during the boom, although not all local industries were estimated. For the local government areas of Australia during the mining boom of the 2000s, Fleming and Measham (2014a) find that each new mining job was associated with 1.4 more non-mining jobs in areas with operating mines. Limited to only the coal seam gas industry of southern Queensland in Australia over the same period, Fleming and Measham (2014b) estimate a slightly larger multiplier of 1.8 non-mining jobs, which primarily reflects jobs created in construction and professional services.

4.2 Inequality and Poverty

Given the ubiquitous evidence of income and earnings growth attributable to natural resources, several studies further explore their effects on the distribution of income and the poverty rate. If the income gains or losses from labor demand shocks are equally distributed across the population, inequality would remain unchanged, while poverty would decline in a boom and rise in a bust. If these gains or losses are unequally distributed, however, then the impacts on inequality and poverty would depend on where those gains or losses accrued across the distribution. For example, if only individuals at the top of the distribution were affected by natural resources, inequality would rise in a boom and decline in a bust, with poverty unchanged.

The local labor market evidence linking natural resources to inequality, with studies listed in the second column of Table 3, is decidedly mixed: some studies document decreases, some document increases, and some find no impact at all. This mixed evidence is found among the developed nations of the U.S., Canada, and Australia, as well as among several developing countries within Latin America and Asia. In the lone U.S. study, Michaels (2010) showed that oil development in southern states did not affect local income inequality over a fifty year period, despite having increased per capita income. For Canada, Fortin and Lemieux (2015) use provincial differences to show that much of the decrease in inequality in the lower half of the distribution since the late 1990s is partially attributable to a booming extraction sector. Within local areas of Western Canada, Marchand (2015) shows that U-shaped growth across the earnings and income distributions due to the recent energy boom generally increased local inequality, with inequality decreases only observed towards the bottom of the distribution and for the service industry.

Outside of the U.S. and Canada, Bhattacharyya and Williamson (2013) found that, over most of the previous century in Australia, sustained price increases in renewables (wool) led to a reduction in inequality, while it increased inequality for non-renewables (minerals, petroleum), with agricultural price increases having no effect. Also looking at Australia, Fleming and Measham (2015) examine the mining boom in the 2000s and find that income inequality rose by twice as much in non-mining areas compared to mining areas, attributing an inequality decrease to mining. In Latin America, López-Feldman et al. (2007) documented that, despite forest-based income being unequally distributed in Mexico, inequality was somewhat lowered by these gains, and Loayza et al. (2013) showed that a mining boom increased consumption inequality across districts in Peru. On the Asian continent, Buccellato and Mickiewicz (2009) showed that oil and gas abundance contributed to inequality in Russia, while Howie and Atakhanova (2014) find that an oil and gas boom lowered inequality in Kazakhstan.

Regarding the local labor market effects of natural resources on poverty, roughly half of the studies listed in the third column of Table 3 cover the U.S., with findings that favor a reduction of poverty from resource extraction, at least in the short-run. Within three shale states, Weber (2012) found that the recent gas boom had a negative, but statistically insignificant, effect on poverty. Using three different shale states, Munasib and Rickman (2015) find poverty reductions due to the boom to be consistent across states. Regarding coal mining in the Appalachian region: Black et al. (2005a) found that the 1970s boom greatly decreased poverty, but the 1980s bust undid most of that reduction; Deaton and Niman (2012) showed that the mining share of employment is contemporaneously associated with less poverty, but its lagged value is associated with an even larger increase in poverty; and Partridge et al. (2013) found that the historically positive relationship between mining and poverty has more recently changed to a negative one, resulting in less poverty overall.

Evidence from outside the U.S. clearly shows a poverty reduction due to natural resources. For Western Canada, Marchand (2015) shows that an energy boom lifted close to half of individuals out of absolute poverty, but it also slightly increases relative poverty. The rest of the non-U.S. studies focus on Latin America. For Mexico, López-Feldman et al. (2007) found that poverty was somewhat lowered by increases in forest-based income. Looking at Brazilian municipalities, Caselli and Michaels (2013) found weak evidence that oil revenues reduced poverty. And in Peru, both Aragon and Rud (2013) and Loayza et al. (2013) showed that mining booms decreased poverty across localities.

4.3 Education and Schools

The presence of natural resources in a local labor market may also provide incentive for individuals to accumulate less human capital than they would otherwise. This is due to the availability of relatively high-paying, low-skill jobs, which increases the opportunity cost of education and lowers its return. Less human capital could, in turn, depress the growth of resource-dependent areas over the longer term. From the perspective of a school, a boom in natural resources may increase wages by enough to encourage both students and teachers to leave the classroom for lucrative job opportunities, with the effect determined by which types of students (i.e. vocational or college bound) and teachers (i.e. inexperienced or experienced) remain. At the same time, the growth in resource extraction may provide greater revenue to schools, either directly through local taxes (e.g. property taxes) or indirectly through educational spending from state or provincial taxes, with its effect determined by how the additional money was spent.

The fourth column of Table 3 lists the local labor market studies of resources on education. Focusing solely on the labor market effects, Black et al. (2005b) were the first to find that the increased returns to low-skilled labor from the 1970s boom in coal mining led to more high school dropouts across U.S. Appalachian counties, with a 10 percent increase in their earnings resulting in a 5 to 7 percent drop in high school enrollment. For the Canadian province of Alberta, Emery et al. (2012) use school-age birth cohorts from before, during, and after the 1970's oil boom to find that males delayed their timing of education, but did not decrease their eventual educational attainment. While the former study suggests that the human capital effects of natural resources may be long-term, the latter study argues that the boom effects are temporary and suggests that a greater concern is a decline in school spending during a bust.

Several other more recent studies provide evidence of the effects on human capital. In the U.S., Kumar (2014) shows that the 1970s oil boom raised the opportunity cost of attending college and lowered the returns to a college degree, causing those of high school age during the boom to be less likely to have a college degree by their mid-30s. Douglas and Walker (2016) find that coal dependence in Appalachian counties from 1970 to 2010 was associated with an increased share of high school dropouts and decreased share of college graduates, which contributed to roughly a quarter of the decline in local per capita income over the study period. With regards to the recent U.S. shale boom, Cascio and Narayan (2015) find that it increased the dropout rates among teenage men by increasing their wages relative to more educated men and female dropouts. Similarly, Rickman et al. (2016) show that the shale boom significantly reduced high school and college attainment among initial local residents of Montana, North Dakota, and West Virginia.

Some studies also address how natural resources affect school revenue and local spending. For Brazilian municipalities, Caselli and Michaels (2013) provide suggestive evidence that oil revenue increased education spending, thereby increasing the number of teachers and classrooms per capita. For eight U.S. states, Raimi and Newell (2014) document cases where shale development expanded the local tax base and directly generated revenue for schools, or alternatively, it increased revenue to the state government, which subsequently redistributed it to schools. James (2015) finds that public spending on education is much higher in resource-rich U.S. states, imperfectly crowding out private educational services. Bartik et al. (2016) find that U.S. counties with high prospectivity did not experience consistent increases in primary and secondary education spending per student relative to counties with lower prospectivity on average. And, Weber et al. (2016) find that the development of the Barnett Shale in Texas caused a large property tax base increase, which then increased per student school revenue. This increase, however, was modest in part because of tax rates being lowered as the tax base expanded.

Only two recent papers directly link resource-based spending to student outcomes. Using the location of waterfalls in Norway, Haegeland et al. (2012) showed that the increased local tax revenue from hydroelectric power plants caused greater school spending, which then improved student performance. Using shale depth variation across school districts, Marchand and Weber (2017) explore both the labor market and school finance effects on a variety of educational outcomes during the shale boom in Texas over the 2000-2013 period. They show that the shale boom greatly increased school spending, but mostly for capital projects and not at all for teacher salaries. Rising private sector wages attracted vocational and economically disadvantaged students into the labor market, while increasing teacher turnover and the number of inexperienced teachers in the classroom. On net, student performance did not improve in shale districts relative to non-shale districts. Thus, merely having more resources does not mean that schools will spend them in productive ways or that the additional spending will be sufficient enough to offset the countervailing labor market effects.

5 Conclusion

This synthesis of the literature on the local labor market effects of natural resources follows in the wake of a handful of seminal cross-national papers and the recent burst of sub-national studies concurrent with the development of unconventional oil and gas resources. The contributions of this synthesis are two-fold. First, it creates a typology of ways that researchers have measured natural resources (by dependence, endowment, and extraction). Second, it delineates the results from recent studies, by grouping conceptually-linked outcomes and summarizing the findings for each group (employment and population; earnings and income; spillovers and multipliers; inequality and poverty; and education and schools).

The typology of resource measurement highlights the need for caution when comparing studies and their findings. Two studies using the same resource, such as oil or natural gas, within the same region, such as the mid-western United States, may find very different economic effects, because each study examines something different. One study might measure a locality's resources through its economic dependence on the resource sector, while another study measures its resources through the scale of extraction within a locality. Acknowledging these differences may help researchers think more carefully about which resource measure best fits their purpose. As a result, future studies may offer clearer explanations for why they used one measure over another.

This synthesis of the evidence reveals that the growth in resource extraction clearly increases employment, attracts more people to the area, and raises aggregate earnings and income, although the magnitudes of these effects vary. These findings are established by many studies, which as a whole, cover diverse outcomes, periods, places, and resources. In addition, a booming resource sector can create jobs in other sectors, indicating that there is not a one-to-one crowding out of other industries. To the contrary, several studies document that each resource sector job creates around one to two jobs in other sectors of the local economy. Less well established in the literature are the effects of resource extraction on inequality, although most studies in developed and developing countries show a decline in the poverty rate. As for education, the evidence indicates that resource booms result in more dropouts from high school, but the magnitude and timing of future human capital attainment remains uncertain, due to the potential spending effects at play and the lack of many long-term panel studies.

One value of a synthesis is to expose gaps in the literature, thereby making it easier to identify research questions with the most promising payoffs. Along these lines, several related literature gaps were identified. First, few studies consider whether busts are generally worse for the local economy than booms are good. That might soon change. The dramatic decline and stagnation in the prices of oil and natural gas, beginning in late 2014, may provide an opportunity for convincing research in this area, especially given that so many studies have documented the economic gains brought about by the expansion in drilling. Second, the literature on natural resources and educational attainment is just beginning to grow as researchers grasp the diverse ways that resources can affect schools, students, and teachers.

For example, while a consensus is emerging regarding increased high school dropout rates, almost no work explores the effects on students who remain in the classroom.

The exposure of these gaps relates to the uncertainty surrounding two broader questions: what are the long-term effects of extraction, and what happens when economically attractive resources have largely been exhausted? An initial step towards answering these questions lies in the further examination of resource busts, and how they might put a locality on a particular growth trajectory. The well-established link between education and long-term growth also suggests that the long-term effects may depend on the links between natural resources and schools. The lack of studies in all of the above areas could serve as targets for future research for those interested in producing relevant theoretical models and empirical estimates.

In addition to highlighting promising avenues for future research, this synthesis hopes to encourage and lay the foundation for future meta-analyses on the effects of natural resources on local labor markets. If the literature continues to progress at close to or faster than its current pace, a sufficient number of studies should eventually permit this type of analysis in at least one of the studied areas. At the moment, the greatest number of studies focuses on the aggregate outcomes of employment and income. However, any such meta-analysis will be constrained not only by the availability, but also the compatibility, of the estimates. In this regard, the resource-measure typology could aid such an effort by providing a foundation for identifying comparable studies. But, differences in the way the employment and income estimates are constructed make a meta-analysis problematic. Similarly, the education estimates are fewer in number, more inconclusive, and more difficult to compare.

The most promising area for a meta-analysis is likely the spillover effects, because these estimates are reported with a common metric: the number of non-resource jobs created for each resource job using a multiplier. This commonality ensures greater comparability across estimates relative to the many available estimates of the aggregate outcomes, which are reported in diverse ways. While most job-for-job multipliers are quite comparable, they are not nearly as numerous as the employment or income estimates. Therefore, more estimation in this particular area could permit an illuminating meta-analysis. One way this might be accomplished is through the incorporation of the many multipliers that exist within previous input-output studies. This would require the additional documentation of any systematic differences between the observation-based and simulation-based estimates.

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Table 1: Studies Organized by Resource Measure

Dependence	Endowment	Extraction	Endowment and Extraction
Black, McKinnish, and Sanders (2005a)	Black, McKinnish, and Sanders (2005b)	Buccellato and Mickiewicz (2009)	Weber (2012)
Papyrakis and Gerlagh (2007)	Michaels (2010)	Aragon and Rud (2013)	Brown (2014)
James and Aadland (2011)	Emery, Ferrer, and Green (2012)	Caselli and Michaels (2013)	Fetzer (2014)
James and James (2011)	Allcott and Keniston (2015)	Loayza, Teran, and Rigolini (2013)	Weber (2014)
Deaton and Niman (2012)	Cascio and Narayan (2015)	Fleming and Measham (2014a)	Weinstein (2014)
Marchand (2012)	Bartik, Currie, Greenstone, and Knittle (2016)	Fleming and Measham (2014b)	Feyrer, Mansur, and Sacerdote (2015)
Partridge, Betz, and Lobao (2013)	Marchand and Weber (2017)	Agerton, Hartley, Medlock, and Temzelides (2015)	Lee (2015)
Haggerty, Gude, Delorey, and Rasker (2014)		Brown (2015)	Maniloff and Mastromonaco (2015)
Betz, Partridge, Farren, and Lobao (2015)		Fleming and Measham (2015)	Tsvetkova and Partridge (2016)
		James (2015)	Weber, Burnett, and Xiarchos (2016)
		Munasib and Rickman (2015)	
		Parades, Komarek, and Loveridge (2015)	
		Wren, Kelsey, and Jaenicke (2015)	
		Douglas and Walker (2016)	
		Komarek (2016)	
		Jacobsen and Parker (2016)	
		Rickman, Wang, and Winters (2016)	

Notes: Studies are listed in ascending chronological order and then ascending alphabetical order of last name of first author. No paper appears in more than one column by design.

Table 2: Studies Organized by Aggregate Labor Market Outcome

	Employment and Population	**Earnings and Income**	**Resource Measure**
Black, McKinnish, and Sanders (2005a)	Yes	Yes	Dependence
Papyrakis and Gerlagh (2007)	.	Yes	Dependence
Michaels (2010)	Yes	Yes	Endowment
James and Aadland (2011)	.	Yes	Dependence
James and James (2011)	.	Yes	Dependence
Marchand (2012)	Yes	Yes	Dependence
Weber (2012)	Yes	Yes	Endowment and Extraction
Aragon and Rud (2013)	.	Yes	Extraction
Caselli and Michaels (2013)	Yes	Yes	Extraction
Brown (2014)	Yes	Yes	Endowment and Extraction
Fetzer (2014)	Yes	Yes	Endowment and Extraction
Haggerty, Gude, Delorey, and Rasker (2014)	.	Yes	Dependence
Weber (2014)	Yes	Yes	Endowment and Extraction
Weinstein (2014)	Yes	Yes	Endowment and Extraction
Agerton, Hartley, Medlock, and Temzelides (2015)	Yes	.	Extraction
Allcott and Keniston (2015)	Yes	Yes	Endowment
Betz, Partridge, Farren, and Lobao (2015)	.	Yes	Dependence
Brown (2015)	Yes	.	Extraction
Feyrer, Mansur, and Sacerdote (2015)	Yes	Yes	Endowment and Extraction
James (2015)	.	Yes	Extraction
Lee (2015)	Yes	Yes	Endowment and Extraction
Maniloff and Mastromonaco (2015)	Yes	Yes	Endowment and Extraction
Munasib and Rickman (2015)	Yes	Yes	Extraction
Parades, Komarek, and Loveridge (2015)	Yes	Yes	Extraction
Wren, Kelsey, and Jaenicke (2015)	Yes	.	Extraction
Bartik, Currie, Greenstone, and Knittle (2016)	Yes	Yes	Endowment
Douglas and Walker (2016)	.	Yes	Extraction
Komarek (2016)	Yes	Yes	Extraction
Jacobsen and Parker (2016)	Yes	Yes	Extraction

Notes: Studies are listed in ascending chronological order and then ascending alphabetical order of last name of first author. Each row represents one study.

Table 3: Studies Organized by Related Labor Market Outcome

Spillovers and Multipliers	**Inequality**	**Poverty**	**Education and Schools**
Black, McKinnish, and Sanders (2005a)	*López-Feldman, Mora, and Taylor (2007)*	*Black, McKinnish, and Sanders (2005a)*	Black, McKinnish, and Sanders (2005b)
Marchand (2012)	Buccellato and Mickiewicz (2009)	*López-Feldman, Mora, and Taylor (2007)*	Emery, Ferrer, and Green (2012)
Brown (2014)	Michaels (2010)	Deaton and Niman (2012)	Haegeland, Raaum, and Salvanes (2012)
Fetzer (2014)	Bhattacharyya and Williamson (2013)	Partridge, Betz, and Lobao (2012)	*Caselli and Michaels (2013)*
Fleming and Measham (2014a)	*Loayza, Teran, and Rigolini (2013)*	Weber (2012)	Kumar (2014)
Fleming and Measham (2014b)	Howie and Atakhanova (2014)	Aragon and Rud (2013)	Raimi and Newell (2014)
Weber (2014)	Fleming and Measham (2015)	*Caselli and Michaels (2013)*	Cascio and Narayan (2015)
Weinstein (2014)	Fortin and Lemieux (2015)	*Loayza, Teran, and Rigolini (2013)*	James (2015)
Lee (2015)	*Marchand (2015)*	*Marchand (2015)*	Bartik, Currie, Greenstone, and Knittle (2016)
Munasib and Rickman (2015)		*Munasib and Rickman (2015)*	Douglas and Walker (2016)
Tsvetkova and Partridge (2016)			Rickman, Wang, and Winters (2016)
			Weber, Burnett, and Xiarchos (2016)
			Marchand and Weber (2017)

Notes: Studies are listed in ascending chronological order and then ascending alphabetical order of last name of first author. Italics denote papers appearing in more than one column.

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