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The Distributional Impacts of an Energy Boom in Western Canada

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Abstract

In the energy-rich provinces of Western Canada, inequality rose over the past two decades while poverty declined, begging the question of whether the recent energy boom was a contributing factor. This study uses local labor market variation in energy extraction intensity to identify these distributional impacts. The growth in local outcomes attributable to the boom is found to be U-shaped and significant across all distributional segments, leading to somewhat increased local inequality aggregates and reduced local poverty. This pattern is preserved but varies across sectors, driving a large local inequality increase in energy extraction, with smaller rises and reductions in other industries.

JEL Codes: J31, Q33, R23.

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1 Introduction

Within a local labor market, the gains generated from the positive labor demand shock induced by an energy boom may be distributed either uniformly or unevenly across the earnings distribution. In the case where all individuals proportionately benefit from the gains of an energy boom, overall inequality is expected to remain unchanged while poverty is expected to decline. If, however, these benefits only accrue to certain individuals at either the top or the bottom of the distribution, overall inequality would either rise or fall respectively, with poverty only being reduced if the bottom benefits. While there is a general consensus in the literature that energy-driven labor demand shocks do have significant effects on wages and employment, the distributional impacts remain unclear due to differences in data sets and identification approaches.

In the earlier literature, several cross-national studies concluded that income inequality was positively correlated with a country's natural resource dependence (Bourguignon and Morrison, 1990; Leamer et al., 1999; Gylfason and Zoega, 2003; Breisinger and Thurlow, 2008; Buccellato and Alessandrini, 2009). However, in a more recent cross-national study, Goderis and Malone (2011) offer a theoretical framework where a resource boom immediately reduces inequality in the short-run, but returns it to its original steady state over time. According to their evidence across developing countries, only a third of the initial inequality reduction remained after five years. Rather than continuing the cross-national approach, much of the present literature instead utilizes the geographic variation within countries. These studies can be divided into those involving developed or developing countries.

Papers studying the changes within developing countries provide mixed evidence regarding the impact of an energy boom on inequality, but agree that poverty tends to be reduced. Using a general equilibrium model on Bolivia, Lay et al. (2006) found offsetting effects of an energy boom that left inequality unaltered but reduced poverty. For Mexico, López-Feldman et al. (2007) documented increased resource income somewhat lowering inequality and poverty, but resource income was itself unequally distributed. For Russia, Buccellato and Mickiewicz (2009) showed that oil and gas abundance led to local level inequality. Caselli and Michaels (2009) found that oil may have reduced poverty in Brazil, but the results were not robust. In Peru, Loayza et al. (2013) showed that consumption inequality increased and poverty decreased across districts of a mining province during a boom, while Aragon and Rud (2013) found a significant poverty reduction due to gold mining. Most recently, Howie and Atakhanova (2014) showed that a resource boom in Kazakhstan lowered inequality.

The studies using changes within developed countries mostly focus on the United States, with general agreement that an energy boom reduces poverty, but there is not much evidence regarding its impact on inequality. Black et al. (2005) used local labor markets within four mid-western coal states to find that the boom in the 1970s was associated with a decrease in poverty, but the subsequent bust undid much of that reduction. On the other hand, Weber (2012) examined the recent shale gas boom in three western states and found no statistically significant effect in the poverty rate, although the coefficients were negative. In Deaton and Niman (2012), a relative increase in the mining sector in Appalachia had an immediate effect of poverty reduction, while a lag effect then increased it. Partridge et al. (2012) also examined Appalachia to show that the historic positive relationship between coal mining and poverty has recently changed to a negative effect, resulting in less poverty. Michaels (2010) found that oil development was not significantly associated with increased local income inequality in the southern states during a fifty year period. And, Bhattacharyya and Williamson (2013) showed that the impact of a resource price shock in Australia increased inequality over the long run.

The current paper investigates the relationship between inequality, poverty, and energy booms in the developed country of Canada, specifically focusing on the region of Western Canada containing the majority of its energy resources. In recent decades coinciding with an energy boom, inequality trended upward while poverty trended downward, with the magnitude of the trends seemingly corresponding to the relative amounts of their available resources. Using a local labor market approach that exploits variation in energy extraction intensity, this study asks and answers several questions regarding the distributional impacts of an energy boom: Where are the gains from an energy boom concentrated across the distribution? Do those gains result in more or less inequality? Does an energy boom help to alleviate poverty? Where are the gains from an energy boom concentrated across the distributions of different sectors? How do those gains impact within sector inequality?

The evidence shows that all individuals benefited from the gains of the recent energy boom in Western Canada, albeit unevenly across the distribution, with significant growth across all segments but relative magnitudes that are decidedly U-shaped. Due to this growth pattern, the boom somewhat increased local inequality and significantly reduced low income poverty when using the aggregate measures, although relative poverty slightly increased. When further disaggregated by sector, the U-shape pattern of growth across the distribution was preserved, but the shape and magnitudes of this growth differed. These pattern differences led to an increase in local inequality that was large in the directly-impacted energy extraction industry and smaller in the indirectly-impacted industries of construction and retail trade. At the same time, local inequality was slightly reduced by the boom in the industry of all services.

2 Latest Boom and Recent Trends in Western Canada

Energy prices increased rapidly in Canada over the 1990s and 2000s, highlighting its latest energy boom. The annual real price trends of the two most important energy resources produced in Western Canada, crude oil and natural gas, are displayed from 1990 to 2010 in Figure 1. Over the early to mid-1990s, the price movements of these products were relatively flat, with repeated but relatively small fluctuations in natural gas and a small increase followed by a moderate decrease in crude oil. From the mid-1990s to early 2000s, both products experienced steep price increases in tandem, until the relatively small declines for oil in 2001 and for natural gas in 2002. Over the 2000s, the price for crude oil continued along its upward path until 2008, while the natural gas price had small but repeated fluctuations. Both real energy prices experienced declines from 2008 to 2009, attributable to the recession.

Over these same two decades that energy prices were rising, inequality in Canada also steadily rose (Fortin et al., 2012; Osberg, 2008), while poverty rates initially rose and then repeatedly fell (Murphy et al., 2012; Osberg, 2000), begging the question of whether the energy boom was at least partly responsible. Western Canada offers an interesting economic environment to examine the distributional issues induced by this energy boom, as it is the region most associated with the extraction of energy resources and the exposure to these cyclical price shocks. The trends in the annual provincial aggregates of inequality and poverty are respectively displayed in Figures 2 and 3 for the four Western provinces of Alberta, British Columbia, Manitoba, and Saskatchewan, as well as for the rest of Canada as a comparison. These provincial trends seem to mimic the greater trends in inequality and poverty happening across Canada, but with important inter-provincial differences.

Inequality across the Western provinces, as measured by the Gini coefficient, has exhibited an overall increasing trend over the 1990s and 2000s. While provincial inequality rose and then fell in tandem around 1992, the early 1990s was a time of relatively little dispersion both within and between the four Western provinces. During the late 1990s, however, inequality began to repeatedly rise within these provinces, with larger increases for Alberta and British Columbia than for Manitoba and Saskatchewan. In the early 2000s, Saskatchewan also experienced a rapid increase in inequality. What is most notable about these trends is that Alberta contains the greatest amount of energy resources, with British Columbia and Saskatchewan containing moderate amounts, and with no significant energy resources appearing in Manitoba. The mid-2000s once again led to tandem increases in inequality for all provinces except British Columbia, while the years following the 2008 recession saw much more dispersion between the provinces, with inequality falling in Manitoba, both Alberta and Saskatchewan leveling off, and British Columbia once again rising.

When energy prices and provincial inequality were increasing in Western Canada, provincial poverty rates based on the low-income cut off were on the decline. In the early 1990s, poverty climbed in all four Western provinces, before stabilizing and remaining very similar, both within and between the provinces, over the mid-1990s. During the late 1990s, dispersion in these poverty rates began to appear, with rapid declines in Alberta and Saskatchewan, a slight decline in Manitoba somewhat later, and poverty in British Columbia remaining constant. During the early 2000s, the poverty rate in Alberta continued its rapid decline, joined by British Columbia a few years later, while Manitoba followed a steady descent, and Saskatchewan stabilized. By the late 2000s, Alberta's poverty rate was markedly lower than the other provinces, which then equated with Saskatchewan's rate towards the end of the period. The highest poverty rates during this time were found in British Columbia and Manitoba. Again, given the relative concentration of energy resources in Alberta, and then in British Columbia and Saskatchewan, and not in Manitoba, the implication is that these trends in energy prices and poverty rates may be correlated.

3 Identification through Local Labor Markets

The provinces of Canada have previously been used to identify particular changes in poverty and inequality, which are potentially driven by the differences in their traits. For example, Osberg and Xu (1999) compared the poverty intensity across Canadian provinces to highlight the impact of their differential social assistance, which then relates to changes in poverty over time, with a general reduction in intensity over the 1980s that was partially undone in the 1990s. In a very recent study, Fortin and Lemieux (2014) use provincial variation within Canada to better understand wage movements and how differing minimum wage policies and the energy boom might play a role. For the potential boom effects, they compare the wage movements of the resource-based provinces of Alberta, Newfoundland, and Saskatchewan to the benchmark province of Ontario. Using this strategy, they conclude that, while the overall wage growth and the growth in energy extraction employment were much greater in the resource provinces, this resulted in an overall decrease in inequality attributable to the boom.[1]

The current study uses identification through local labor markets to investigate the mechanisms of the distributional effects of an energy boom in the region of Western Canada, where the majority of the country's energy resources are located. Rather than focusing on the potential correlation of the provincial trends in energy prices, inequality, and poverty that were presented in the previous section, these trends are instead used as motivation for a more local identification strategy. This approach is very much in the spirit of Bartik (1996), who examined similar questions regarding the distributional effects stemming from overall changes in local labor demand for the United States. Across Western Canada, some local areas contain little to no resources of crude oil, natural gas, or coal reserves, while other areas have large amounts of these energy resources. The local differences in energy

[1] Fortin and Lemieux (2014) use data from the 1997 to 2012 Canadian Labour Force Survey.

extraction intensity due to the location of these resources allow for the identification of the energy boom effect, with energy areas serving as the treatment set receiving the energy price shock and non-energy areas serving as the comparison set and counter-factual for what would have happened to the energy areas had the boom not occurred.

In order to construct the average local measures of inequality and poverty and have proper representation for each of these independent observations, a sufficient number of individuals is required within each local labor market. The current paper relies on data from the Canadian Census of Population, as it contains the most individual variation available among the nationally-representative surveys. In particular, the Research Data Centre (RDC) version of the Census data is used for its detailed variables of geography and industry. The 1996 and 2006 Census waves are closest to capturing most of the upward trend during the recent energy boom from the mid-1990s to the mid-2000s, as shown in Figure 1, with each Census wave reflecting the labor market responses for the previous year. The local labor markets for this study are defined at the Census division level, based upon the location of an individual's current residence, with a total of eighty-eight Census divisions across the four western provinces.

The labor market outcomes of total income, total earnings, and wages & salaries generate the distributions that are used to construct the inequality and poverty measures across Census divisions. Total income includes all money income received during the year, including total wages and salaries, net self-employment income, total money transfers from the government, total investment income, and all other money income. Because this outcome includes transfers from the government, it is expected to reflect a lower level of inequality than if it contained only income from market sources (i.e. work or investment). Total earnings includes total wages and salaries and net self-employment income, with the latter component originating from farms, unincorporated non-farm businesses, and professional practices. Wages & salaries represents total wages and salaries, which excludes deductions for income tax, pensions, and employment insurance.[2] Both of the earnings outcomes are expected to reflect higher levels of inequality and greater impacts from an energy boom, as

[2] With the exception of the net self-employment income component, all other values are provided before taxes, due to the availability of information in both the 1996 and 2006 Census waves. The after-tax values are additionally available in only the 2006 Census wave.

they are more narrowly focused on the returns from labor. All outcomes are restricted to real, positive values.[3]

The treatment and comparison sets of local labor markets used for this study expand upon the work of Marchand (2012), as they are similarly based on the intensity of energy extraction through the percentage that industry generates in total wages & salaries within a Census division.[4] The energy extraction sector is defined as oil and gas extraction, coal mining, and support to oil, gas, and mining, based on the three-digit Standard Industry Classification equivalent of the detailed RDC industry code.[5] The full treatment set is formed of seventeen Census divisions which derive ten percent or more of their total wages & salaries from this energy extraction sector. A top treatment set of seven Census divisions is also formed as a subset of the full treatment, with the prediction that the more intense the energy extraction activity, the larger effect of the boom.[6] The comparison set is constructed of fifty-seven Census divisions that do not exceed five percent of their total wages & salaries from the energy extraction sector in the pre-boom period of 1995, nor exceed ten percent of their total wages & salaries from this sector in the post-boom period of 2005. Fourteen Census divisions are also dropped from the analysis altogether, for either falling between the definitions of the treatment and comparison sets or for being a large city exceeding 500,000 inhabitants.[7] These treatment areas are spread out across the northern half and eastern border of Alberta, the northeast and southeast corners of British Columbia, and the mid-western portion and southeast corner of Saskatchewan, with no significant energy resource deposits found in Manitoba, as seen in Figure 4.

The differential changes in the measures of inequality and poverty, before and after the boom and between treatment and comparison areas, are used to identify the distributional impacts of the recent energy boom through the local labor market variation in the equation:

[3] While only the positive values are used to construct the inequality measures and poverty cutoffs, all of the values are included in the poverty headcounts.

[4] Marchand (2012) provides a detailed discussion of the local employment and earnings effects that happened over the entire boom-bust-boom cycle of the last four decades in Western Canada.

[5] The other local industries used in the paper are based on the two-digit SIC equivalent of this RDC industry code.

[6] All of the treatment Census divisions are listed in descending order of energy extraction intensity in Appendix Table A1.

[7] These large cities are Calgary, AB, Edmonton, AB, Vancouver, BC, and Winnipeg, MN. No Census division grows into this definition of a large city from the pre-boom to the post-boom period.

$$\Delta ln(Outcome_c) = \beta \cdot Treatment_c + \varepsilon_c \tag{1}$$

where $ln(Outcome_{ct}) - ln(Outcome_{ct-1})$ is the change in the natural log of the labor market outcome over time and $Treatment_c$ is a binary indicator for whether the Census division, *c,* is in either the treatment or comparison group. Huber-White standard errors are used for these estimates. Unless otherwise stated, these differential regressions are the assumed specification. Where specified, however, direct change regressions are also run for the sector-specific analysis of the energy extraction industry, which is done for the full treatment areas only, with two annual observations per Census division following the equation:

$$ln(Outcome_{ct}) = \alpha + \delta \cdot After_{ct} + \eta_{ct} \tag{2}$$

where $ln(Outcome_{ct})$ is simply the natural log of the labor market outcome and $After_{ct}$ is a binary indicator for whether the area-year, *ct*, observation is in the post-boom year of 2005 or the pre-boom year of 1995. Clustered standard errors by Census division are used for this specification.

The large number of individuals within each locality allows for the precise estimation of the local distributional impacts of the energy boom in this study. These local outcomes overcome the criticism of Tarozzi and Deaton (2009) regarding the small local sample sizes that tend to plague the studies on developing countries. However, given that the identification of this paper is based upon cross-sectional data to construct the local labor market averages, migration into or out of these labor markets over time remains an issue that affects the estimation. As a partial defense to this criticism, Marchand (2012) shows that, while local populations were growing within Census divisions during this time period, they did not grow differentially between the treatment and comparison areas. But this issue can only be completely overcome by using longitudinal data, which follows the same individuals over time, and there does not currently exist a longitudinal data set rich enough in its number of individuals to represent the local level used in this study. As discussed by Bartik (1991, 1996), migration will reduce the wage and employment effects of a local labor demand shock through potential adjustments in local labor supply. Therefore, any estimates based on cross-sectional data can be considered as the lower bound of the true impacts of an energy boom, as the possibility of migration is expected to lead to an underestimation of the coefficients.

4 Distributional Evidence of an Energy Boom

4.1 Local Sums within Deciles of the Distribution

Where are the gains from an energy boom concentrated across the distribution? In order to answer this question, a sufficient number of distributional segments must be used for the analysis while maintaining the representativeness of individuals within each segment. Deciles were chosen as the best solution to balance this tradeoff.[8] Rather than examine the changes in the cutoffs between these segments using techniques such as quantile regression, the local summation of the outcome within each decile is used to measure the changes across the distribution. The differential changes in these local sums between the treatment and comparison areas are estimated for each decile using equation (1).

The columns of Table 1 contain the log change estimates from the bottom to the top decile of the outcome distribution, with the rows representing each of the labor market outcomes of total income, total earnings, and wages & salaries using the full and top treatments. All deciles of the distribution experience significant differential growth due to the boom, with all of the estimates being statistically significant at the one percent level, regardless of the outcome definition or treatment set. This implies that all individuals gain from the local labor demand shock of the energy boom. The relative magnitudes of these within decile estimates provide even more insight when compared across deciles and between treatment sets and outcome definitions.

The relative magnitudes of the estimates across deciles exhibit a distinct U-shaped pattern, with a high differential change toward the bottom of the distribution, a low differential around the middle of the distribution, and a return to a high differential at the top. This

[8]The numeric boundaries of these deciles were determined separately for each outcome distribution by local labor market and year. If these deciles boundaries were instead held constant across geography or time, this would introduce asymmetries to the distributions, hindering the accuracy of their results and making them incomparable to one another over time.

differential growth pattern implies that individuals at the lower end of the distribution are catching up with individuals in the middle, while at the same time, individuals towards the top of the distribution are pulling away from those in the middle. Using the full treatment for total income, the 0.616 coefficient for the first decile is equivalent to a 61.6 differential percentage change between treatment and comparison areas, which declines to a 29.6 percent difference at the seventh decile and rises back up to a 43.2 percent difference by the tenth decile. This U-shape pattern is consistent across outcomes definitions and treatment sets, but the top treatment unambiguously produces larger differential growth than the full treatment across all deciles and outcomes, with few exceptions. Therefore, the intensity of the treatment does lead to a greater impact of the shock.

While the U-shape originates at the first decile for total income, it only begins at the second to the fourth deciles for total earnings and wages & salaries, implying increasing differential growth prior to a narrower U-shaped pattern for those outcomes. The largest differential growth across all outcomes is found for total income in the lower half of the distribution, with a 63.8 differential percentage change using the top treatment. The smallest differential change of 28.5 percent is found at the seventh decile for total earnings, which is similar to the other outcomes using the full treatment, but it is in the ninth decile for the top treatment, implying that the two sides of the U-shaped differential growth are not symmetric. There is also a sharp rise in the magnitude of the differential change between the ninth and tenth deciles regardless of outcome definition or treatment, with the largest change being 60.5 percent for wages & salaries using the top treatment at the tenth decile.

4.2 Local Inequality Aggregates

Does an energy boom result in more or less inequality? To investigate this question, inequality is summarized locally using three different aggregate measures, each with its own sensitivity to changes in a particular segment of the distribution. The Atkinson index is more sensitive to changes in the lower end of the distribution, especially as the value of its aversion parameter grows.[9] The Gini coefficient is more sensitive to changes in the middle

[9]This aversion parameter is set to a value of two in this study, which has been previously used to imply a lot of weight on the lower tail of the distribution. The results for the Atkinson index with an aversion parameter set to one are available upon request for the author, and in almost all cases, were of smaller

of the distribution than either of its tails, as compared with other measures of inequality. Lastly, the Theil entropy index is more sensitive to changes in the upper portion of the distribution.[10] Using equation (1), the differential changes are estimated for each of these local inequality aggregates between the treatment and comparison areas.

Table 2 presents the results in terms of the numeric and logarithmic changes for each inequality measure, where the sensitivity from the bottom to the top of the distribution matches the movement from the leftmost to the rightmost column. The rows represent the outcome definitions of total income, total earnings, and wages & salaries, using both the full and top treatments. The differential changes of the local inequality aggregates range from statistically insignificant to significant at the ten, five, and one percent levels. This varying significance may reflect the ambiguity of how the U-shaped differential growth found across the distribution translates into differential changes in the local inequality aggregates.

Due to the boom, local inequality slightly decreased or remained unchanged for the bottom-sensitive measure, slightly increased for the middle-sensitive measure, and moderately increased for the top-sensitive measure. The changes to the Atkinson index were only statistically significant for the outcome of total income at the five percent level, attributing a slightly equalizing effect to the recent energy boom, with a differential reduction in local inequality of 1.8 to 3.5 percent across treatments. The changes in the Gini coefficient show that the energy boom led to a 1.7 to 3.1 differential percentage rise in local inequality across total income, total earnings, and wages & salaries using the full treatment. Using the top treatment, however, this result is only statistically significant for total income. A larger increase in inequality is shown using the Theil entropy index, with a 12.8 to 19.8 differential percentage increase attributable to the boom, from the full to the top treatment. The top treatment effects are all significant and larger in magnitude than the full treatment effects, implying that those areas with more exposure to an energy boom experience larger increases in inequality. But, the boom effect remained relatively constant in magnitude across labor market outcomes using the top treatment.

magnitude than those presented.

[10] The half of the square of the coefficient of variation was also used as a measure even more sensitive to changes at the top of the distribution as compared to the Theil index. In almost all cases, the results were of greater magnitude in both numeric and logarithmic changes than those of the Theil index. These results are available upon request from the author.

The local aggregate findings are consistent with the U-shape pattern in the growth of the local sums within deciles. The bottom-sensitive measure, placing more weight on the differential increase in growth at the bottom of the distribution, predicts a differential reduction in inequality due to energy boom, while the top-sensitive measure, placing more weight on the differential increase towards the top of the distribution, predicts a differential increase in inequality. This highlights the importance of understanding the impacts across the distribution rather than relying on a single inequality aggregate, and it potentially explains some of the conflicting findings in the literature. Overall inequality is also greater when using total earnings and wages & salaries than when using total income, in accordance with the previous inequality results for the entire nation of Canada (Fortin et al., 2012).

4.3 Local Poverty Aggregates

Does an energy boom help to alleviate poverty? The answer begins with the local aggregation of poverty based on the headcount of individuals living below two different thresholds, which are divided by the local population size to form poverty rates.[11] The low income cut-off (LICO) has been continually produced by Statistics Canada since 1968, as an unofficial but widely-used quantification of poverty. It is a partly-absolute, partly-relative threshold that is based on the percentage of income an average family spends on the necessities of food, clothing, and shelter, plus an additional twenty percentage points.[12] This cut-off in total income is also differentiated by family size and urbanization, as well as adjusted over time by a consumer price index.[13] The half of the median value is a purely relative threshold, which is calculated for all of the respective outcomes of total income, total earnings, and wages & salaries. This relative measure may better account for more local price differences and reflects changes in inequality as well as poverty. Table 3 displays the effects from the energy boom across the various poverty measures, which are estimated through the

[11] The raw headcounts of the number of individuals living in poverty were also used as measures, with similar results, albeit at smaller magnitudes in their percentage changes. These results are available upon request from the author.

[12] The market basket measure of poverty, recently developed by Human Resources and Skills Development Canada, is the closest to an absolute poverty measure for the nation. Murphy et al. (2012) compare the levels and trends of these different poverty measures over time.

[13] The before-tax version of the LICO measure comes pre-defined within the Canadian Census dating back to the 1991 wave, while the after-tax version is additionally available in the 2006 wave.

differential change specification in equation (1). Each effect is calculated as a percentage point and percentage change. All of the poverty estimates are statistically significant at the one percent level.

Altogether, the hybrid measure of absolute and relative poverty decreases substantially, while the purely relative measure slightly increases. The most recent energy boom is associated with a 4.8 to 4.9 differential percentage point decline in individuals living below the low income cut off. This drastic differential reduction of 45.2 to 47.6 percent, an almost halving of the initial poverty rate, is even more notable considering that both energy and non-energy areas were experiencing overall poverty reductions, as partly shown by the provincial aggregates in Figure 3. This differential change was similar in magnitude using either the full or the top treatment set. The results for the purely relative measure show that individuals living below half of the median differentially increased due to the boom, albeit at small magnitudes, ranging from a 0.7 to 1.5 differential percentage point increase and a 4.5 to 7.5 differential percentage increase across all outcomes and treatments. Surprisingly, the top treatment estimates are lower in magnitude for the two earnings outcomes than for total income.

According to the weakly relative poverty arguments of Ravallion and Chen (2011), a proportional increase across the income or earnings distribution will automatically lower absolute poverty, while leaving relative poverty unchanged. In the current study, individuals are being lifted out of poverty according to the low income cut-off, but they are not necessarily catching up with the individuals further up the distribution in a relative sense. If all individuals across the distribution share in the gains from the energy boom, then this helps explain why it also led to a substantial decrease in the absolute-relative poverty hybrid. On the other hand, the slight increase in the purely relative poverty measure is still in line with the U-shape behavior across most segments of the distribution. Although this growth pattern implies that the bottom of the distribution is growing by more than the middle, it must not be growing by enough for individuals at the bottom to pass the relative threshold of one half of the median outcome.

4.4 Local Sums within Deciles by Sector

Where are the gains from an energy boom concentrated across the distributions of different sectors? The energy boom is expected to directly impact the energy extraction industry, as it is the sector where the initial local labor demand shock is concentrated. Therefore, any distributional boom effects should be greatest in this sector. In the presence of industry spillovers, however, other local industries might also indirectly experience a labor demand shock. Given that local goods cannot be traded, industries such as construction, retail trade, and all services can be used to provide a representation of the other localized impacts taking place outside of energy extraction due to the boom.[14] Therefore, the indirect distributional effects are likely to be experienced in these particular industries.

The local summations within distributional segments are calculated separately for the energy extraction industry and each of the other local sectors. The direct changes within deciles of the energy extraction sector are estimated using equation (2), before and after the latest boom, but only within the full treatment areas, as the energy extraction industry is not well represented in the comparison areas by definition. The indirect differential changes within deciles of the local goods industries of construction, retail trade, and all services are each estimated between the treatment and comparison areas, before and after the latest boom, using the specification from equation (1). The outcome variable is now limited to wages & salaries, as it best reflects the local labor market impacts of an energy boom, and only the full treatment set is used. This allows the rows of Table 4 to represent the different local sectors, with energy extraction followed by each of the other local industries. All deciles of the distribution experience significant direct or indirect growth due to the boom, with statistical significance at the one percent level across all of the estimates.

The distinct U-shaped pattern in the magnitudes of the differential growth is preserved across all sectors, and the magnitudes of these within decile changes are much higher for the energy extraction and construction sectors than for the general findings. The 55.7

[14] There are likely other local industries that could additionally experience spillovers, but the use of these particular local sectors follows the work of Black et al. (2005) and Marchand (2012), which both identified significant employment and earnings spillovers from the energy extraction sector into these industries. The theoretical work of Cordon and Neary (1982) also defines its non-traded goods sector as “services” in its model of the labor market effects of an energy boom.

percentage increase in the first decile of the energy extraction distribution declines to a 45.9 percentage increase in the fourth decile and then goes up to a 95.4 percent increase in the tenth decile. The differential growth in the construction industry exhibits almost the same pattern, as well as similar magnitudes in its upper deciles, as the direct changes in energy extraction, but with much larger growth taking place its lower and middle deciles. Although the U-shape originates at the first and second deciles across all sectors, implying a wide U-shaped pattern, its inflection point lies at the fourth and fifth deciles for the construction and energy extraction industries, while it is further up the distribution for retail trade and all services.

For the retail trade industry, the pattern of growth across deciles was similar to that of construction and energy extraction, but at much smaller magnitudes, ranging from a 39.5 differential percentage increase in the first decile to a similar 40.9 percent differential change in the tenth decile. The smallest differential growth of 18.6 percent is found at the eighth decile for the retail trade industry, an inflection point that is shared for all services. However, the most notable deviation for all services is that its differential decile growth is decreasing when moving from the bottom to the top of the distribution, with the exception of a small increasing trend at the very top. The largest differential for all services is found at the bottom decile with a 69.4 percent increase, which is at the opposite end of the distribution of the largest differential for all of the other sectors.

4.5 Local Inequality Aggregates by Sector

How does an energy boom impact inequality within different sectors? The aggregate measures of the Atkinson index, Gini coefficient, and Theil entropy index are now used to quantify inequality within each of the local sectors. Table 5 presents the estimates of the boom effect on the inequality measures by sector as both numeric and logarithmic changes, using equation (2) for the direct estimation in energy extraction in the local treatment areas only, and using equation (1) for the indirect differential estimation in all of the other local industries between the treatment and comparison areas. The outcome is again limited to wages & salaries and only the full treatment set is used. The statistical significance of these estimates varies across measures and sectors, from the bottom-sensitive measure only being significant for services, to the middle-sensitive measure being significant for all sectors, to the top-sensitive measure being significant for all sectors but services.

The aggregates for energy extraction display large and significant increases in local inequality due to the boom, with a direct increase of 18.8 percent in the Gini coefficient and a larger direct increase of 43.3 percent in the Theil index. The changes were not significant, however, for the bottom-sensitive measure of the Atkinson index.[15] These results are consistent with the increasing magnitude of growth across the middle and top segments of the distribution in this sector, while the decreasing magnitudes in the lower end of the distribution were not substantial enough to generate changes in the aggregate. These inequality increases for energy extraction are much greater than that of the general differential increases, supporting the view that an energy boom is associated with more inequality in the directly impacted sector than in the overall locality.

The same pattern of the boom increasing inequality was also found for the indirect differential changes in the aggregates for the construction and retail trade industries, albeit at much lesser magnitudes. For the construction industry, there was a 6.2 differential percentage increase in the Gini coefficient and a 24.8 differential percentage increase in the Theil index. For the retail trade industry, the recent boom lead to a smaller increase in inequality, with differential growth of 4.3 percent in the Gini coefficient and of 16.7 percent in the Theil index. Neither of these local industries displayed significant changes in their Atkinson indices, similar to the energy extraction industry, which also match their patterns of within segment growth across their distributions.

Most interestingly, whereas the boom led to a differential increase in inequality for the local industries of construction and retail trade, it appears to have reduced inequality in all services, with a 2.7 percent differential decrease in the Gini coefficient and a 4.4 percent differential decrease in the Atkinson index. Inequality changes with respect to the top-sensitive Theil index were also negative but insignificant. Because Marchand (2012) documented that the largest employment spillovers of the recent boom in Western Canada were found from the energy extraction sector to all services, this may explain why inequality

[15] There is a statistically significant differential increase in the Atkinson index for energy extraction when the aversion parameter is set to a lower value of one, but with a similar change in magnitude as the Gini.

in this particular sector is lowered in this study. This equalizing effect of the energy boom in this sector is also interesting given that overall employment in Canada, as well as for most developed countries, is heavily concentrated in services. This implies that, if the spillovers from energy extraction to services are sufficiently large, they might offset some of the inequality increases attributable to the energy boom in the other local industries

5 Conclusion

In Western Canada, a region known for its energy resources, much of the recent rise in inequality and decline in poverty took place during the energy boom from the mid-1990s to the mid-2000s. These trends are ostensibly more pronounced in the provinces containing greater energy resources than in those with lesser amounts of these resources. This study attempts to answer several questions regarding the extent to which the recent energy boom affected the distribution, through its positive shock to labor demand, using an empirical approach based on local labor markets. Various measures of inequality and poverty are aggregated at the local level to identify these impacts, utilizing local variation in energy extraction intensity. This research is a unique contribution to the literature in its offering of a complete investigation of the local distributional effects of an energy boom within a developed country.

The gains from an energy boom are shown to be widely distributed across all segments of the distribution, forming a significant U-shaped pattern in the relative magnitudes of its growth in earnings and income. The decreasing relative magnitudes from the bottom to the middle of the distribution led to a slight equalizing effect of the boom in one local inequality aggregate, while the increasing relative growth from the middle to top tended to modestly increase inequality in the other local aggregates. The boom effects were larger for total earnings and wages & salaries than for total income, as well as larger for localities with a greater dependence on energy extraction earnings. Low income poverty drastically decreased due to the boom-induced gains in the bottom of distribution, while relative poverty slightly increased, as the bottom of the distribution did not grow fast enough to catch up with those further up the distribution.

When the results were further disaggregated by sector, the U-shaped pattern and its significance across all segments of the distribution were preserved. The energy boom is attributed to a large local inequality increase in the directly-impacted energy extraction industry, driven by its significant increases in the relative magnitude of growth while moving up the distribution, and moderate indirect local inequality increases in the industries of construction and retail trade. There was also a slight reduction in inequality for the services sector, due to the decreasing relative magnitudes of growth across its distribution. Altogether, this evidence suggests that a rising tide may have the ability to lift all boats, although not proportionately.

Despite the differences in data sets and identification approaches, the results of this local labor market study are in agreement with the provincial-level work of Fortin and Lemieux (2014), with regards to the impacts of an energy boom in Canada being found across the entire distribution and its contribution to a small reduction in inequality in the lower half of the distribution. However, there is disagreement as to whether the boom also led to a modest increase in inequality overall, as shown in this study as being caused by the increasing relative magnitude growth from the middle to the top of the distribution and the large inequality increases in the energy extraction sector. That said, the level of employment in the energy extraction industry is quite small and there was further evidence in the current study regarding a reduction in local inequality for the services sector, which employs the majority of the work force. This might then translate into less provincial inequality when taken together. Given the data and identification differences, more work would need to be done in order to link the local results of the boom to the provincial and national aggregates.

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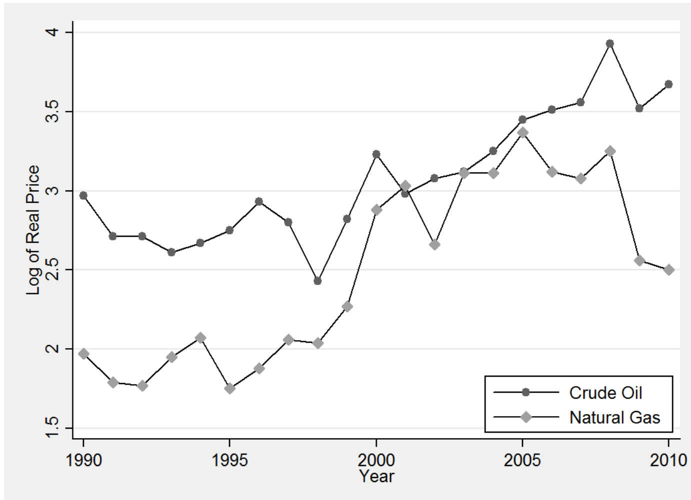
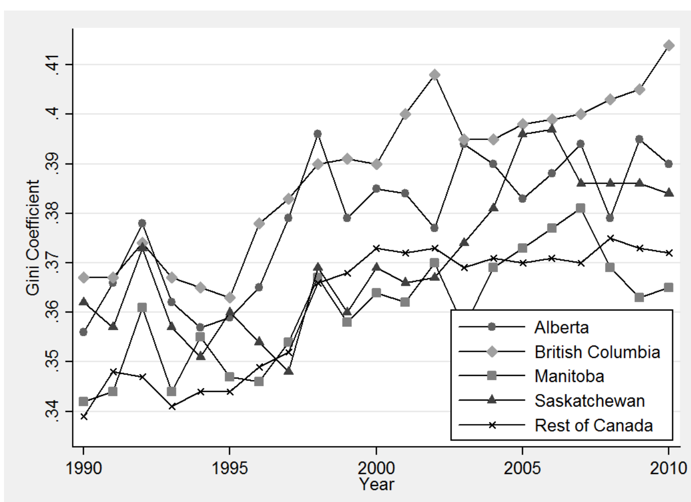
Figure 1: Real Price Trends of Crude Oil and Natural Gas



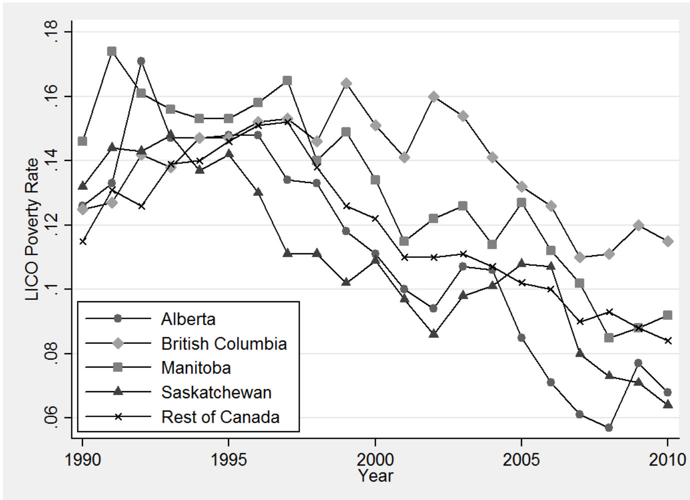
Notes: Author's calculations based on 1990 to 2010 public-use data from the Canadian Association of Petroleum Producers. The log real prices of crude oil and natural gas are based on the average wellhead/plant gate prices in dollars per cubic meter and per thousand cubic meters, respectively.

Figure 2: Provincial Inequality Trends for Western Canada



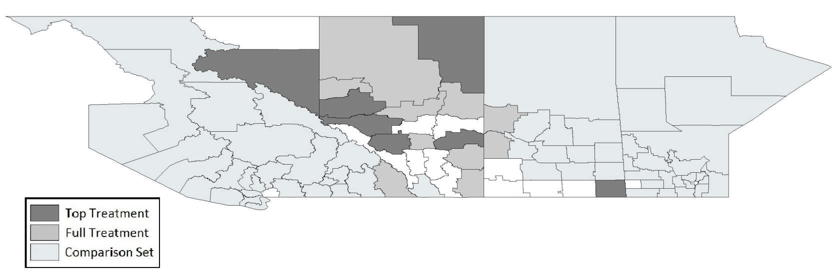
Notes: Author's calculations based on CANSIM Table 202-0705 of Statistics Canada, representing the 1990 to 2010 public-use data of the Survey of Consumer Finances and Survey of Labour and Income Dynamics. The inequality measure is the Gini coefficient using the after-tax total income of all family units. The rest of Canada is the average of Ontario, Quebec, and the Atlantic provinces.

Figure 3: Provincial Poverty Trends for Western Canada



Notes: Author's calculations based on CANSIM Table 202-0802 of Statistics Canada, representing the 1990 to 2010 public-use data of the Survey of Consumer Finances and Survey of Labour and Income Dynamics. The poverty rate is defined using the after-tax low income cut-off of all persons. The rest of Canada is the average of Ontario, Quebec, and the Atlantic provinces.

Figure 4: Local Treatment and Comparison Areas in Western Canada



Notes: Author's calculations based on wages & salaries in the 1996 Census data using the 2006 Census division boundaries. The Census divisions within the full and top treatment sets are listed in descending order of energy extraction intensity in Appendix Table A1.

Table 1: Differential Changes in Local Sums within Deciles over the Boom

	Δ in Logs of Local Sums within Deciles									
Total Income	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Full Treatment	0.616***	0.474***	0.379***	0.343***	0.341***	0.329***	0.296***	0.298***	0.298***	0.432***
	(0.058)	(0.052)	(0.049)	(0.051)	(0.049)	(0.049)	(0.049)	(0.050)	(0.048)	(0.058)
Top Treatment	0.638***	0.493***	0.417***	0.381***	0.365***	0.346***	0.307***	0.316***	0.302***	0.494***
	(0.080)	(0.097)	(0.094)	(0.100)	(0.092)	(0.095)	(0.091)	(0.088)	(0.078)	(0.095)
Total Earnings										
Full Treatment	0.368***	0.396***	0.403***	0.370***	0.334***	0.341***	0.285***	0.343***	0.324***	0.483***
	(0.084)	(0.067)	(0.065)	(0.065)	(0.056)	(0.059)	(0.050)	(0.057)	(0.051)	(0.059)
Top Treatment	0.446***	0.474***	0.466***	0.402***	0.386***	0.328***	0.336***	0.328***	0.312***	0.541***
	(0.143)	(0.102)	(0.119)	(0.106)	(0.103)	(0.106)	(0.088)	(0.090)	(0.080)	(0.104)
Wages & Salary										
Full Treatment	0.298***	0.464***	0.463***	0.471***	0.371***	0.379***	0.371***	0.380***	0.371***	0.562***
	(0.098)	(0.062)	(0.061)	(0.055)	(0.055)	(0.056)	(0.047)	(0.053)	(0.050)	(0.053)
Top Treatment	0.361**	0.525***	0.498***	0.515***	0.395***	0.357***	0.380***	0.371***	0.331***	0.605***
	(0.158)	(0.111)	(0.115)	(0.091)	(0.103)	(0.101)	(0.087)	(0.089)	(0.077)	(0.098)

Notes: Author's calculations of 1996 and 2006 Canadian Census data. These differential growth regressions follow equation (1) using seventy-four and sixty-five local area observations for the full and top treatment sets respectively, with Huber-White standard errors in parentheses. Δ Log denotes the change in the natural logarithm. Stars denote the statistical significance (* for 10%, ** for 5%, and *** for 1%).

Table 2: Differential Changes in Local Inequality Aggregates over the Boom

	Atkinson Index (e=2)		Gini Coefficient		Theil Entropy Index	
Total Income	Δ	Δ Log	Δ	Δ Log	Δ	Δ Log
Full Treatment	-0.016**	-0.018**	0.008*	0.017*	0.064***	0.128***
	(0.008)	(0.009)	(0.004)	(0.008)	(0.023)	(0.037)
Top Treatment	-0.032**	-0.035**	0.014	0.029*	0.104**	0.198***
	(0.015)	(0.016)	(0.008)	(0.017)	(0.048)	(0.072)
Total Earnings						
Full Treatment	-0.004	-0.005	0.015***	0.029***	0.077***	0.150***
	(0.007)	(0.007)	(0.004)	(0.009)	(0.025)	(0.039)
Top Treatment	-0.015	-0.016	0.016	0.032	0.110*	0.198**
	(0.011)	(0.012)	(0.010)	(0.020)	(0.058)	(0.085)
Wages & Salaries						
Full Treatment	-0.004	-0.004	0.015***	0.031***	0.076***	0.150***
	(0.008)	(0.009)	(0.004)	(0.009)	(0.025)	(0.039)
Top Treatment	-0.011	-0.012	0.017	0.033	0.106*	0.191**
	(0.016)	(0.017)	(0.010)	(0.020)	(0.058)	(0.087)

Notes: Author's calculations of 1996 and 2006 Canadian Census data. These differential growth regressions follow equation (1) using seventy-four and sixty-five local area observations for the full and top treatment sets respectively, with Huber-White standard errors in parentheses. Δ and Δ Log denote the numeric and logarithmic changes. Stars denote the statistical significance (* for 10%, ** for 5%, and *** for 1%).

Table 3: Differential Changes in Local Poverty Aggregates over the Boom

	% Below LICO		% Below Half of Median	
Total Income	Δ	Δ Log	Δ	Δ Log
Full Treatment	-0.049***	-0.452***	0.012***	0.067***
	(0.004)	(0.036)	(0.002)	(0.010)
Top Treatment	-0.048***	-0.476***	0.015***	0.075***
	(0.005)	(0.050)	(0.003)	(0.018)
Total Earnings				
Full Treatment	-	-	0.010***	0.058***
			(0.001)	(0.009)
Top Treatment	-	-	0.008***	0.048***
			(0.002)	(0.012)
Wages & Salaries				
Full Treatment	-	-	0.010***	0.070***
			(0.001)	(0.009)
Top Treatment	-	-	0.007***	0.044***
			(0.001)	(0.012)

Notes: Author's calculations of 1996 and 2006 Canadian Census data. These differential growth regressions follow equation (1) using seventy-four and sixty-five local area observations for the full and top treatment sets respectively, with Huber-White standard errors in parentheses. Δ and Δ Log denote the numeric and logarithmic changes. Stars denote the statistical significance (* for 10%, ** for 5%, and *** for 1%).

Table 4: Differential Changes in Local Sums within Deciles over the Boom by Sector

Wages & Salaries	Δ in Logs of Local Sums within Deciles									
Full Treatment	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Energy Extraction	0.557***	0.518***	0.494***	0.459***	0.545***	0.646***	0.601***	0.693***	0.691***	0.954***
(Treatment Areas)	(0.133)	(0.107)	(0.098)	(0.103)	(0.110)	(0.090)	(0.095)	(0.086)	(0.084)	(0.097)
Construction	0.757***	0.867***	0.737***	0.708***	0.658***	0.712***	0.681***	0.717***	0.752***	0.957***
	(0.134)	(0.099)	(0.099)	(0.090)	(0.098)	(0.087)	(0.107)	(0.082)	(0.144)	(0.145)
Retail Trade	0.395***	0.307***	0.216***	0.216***	0.198***	0.252***	0.233***	0.186***	0.205***	0.409***
	(0.114)	(0.074)	(0.084)	(0.073)	(0.066)	(0.056)	(0.048)	(0.049)	(0.049)	(0.076)
All Services	0.694***	0.610***	0.580***	0.567***	0.532***	0.485***	0.474***	0.423***	0.454***	0.485***
	(0.069)	(0.060)	(0.052)	(0.044)	(0.043)	(0.053)	(0.039)	(0.041)	(0.039)	(0.048)

Notes: Author's calculations of 1996 and 2006 Canadian Census data. The differential change regressions follow equation (1) using seventy-four local area observations, with Huber-White standard errors in parentheses. The direct change regressions follow equation (2) using thirty-four local treatment area-year observations, with standard errors clustered by locality. Δ Log denotes the change in the natural logarithm. Stars denote the statistical significance (* for 10%, ** for 5%, and *** for 1%).

Table 5: Differential Changes in Local Inequality Aggregates over the Boom by Sector

Wages & Salaries	Atkinson Index (e=2)		Gini Coefficient		Theil Entropy Index	
Full Treatment	Δ	Δ Log	Δ	Δ Log	Δ	Δ Log
Energy Extraction	0.020	0.021	0.066***	0.188***	0.108***	0.433***
(Treatment Areas)	(0.055)	(0.074)	(0.008)	(0.023)	(0.020)	(0.068)
Construction	-0.001	0.008	0.030*	0.062*	0.150*	0.248**
	(0.032)	(0.044)	(0.016)	(0.032)	(0.084)	(0.109)
Retail Trade	-0.036	-0.039	0.021**	0.043**	0.083**	0.167**
	(0.023)	(0.029)	(0.009)	(0.018)	(0.039)	(0.064)
All Services	-0.039***	-0.044***	-0.013***	-0.027***	-0.005	-0.013
	(0.010)	(0.012)	(0.003)	(0.006)	(0.015)	(0.031)

Notes: Author's calculations of 1996 and 2006 Canadian Census data. The differential change regressions follow equation (1) using seventy-four local area observations, with Huber-White standard errors in parentheses. The direct change regressions follow equation (2) using thirty-four local treatment area-year observations, with standard errors clustered by locality. Δ and Δ Log denote the numeric and logarithmic changes. Stars denote the statistical significance (* for 10%, ** for 5%, and *** for 1%).

Table A1: Census Divisions of the Treatment Sets in the Base Year

Rank	CD No.	Province	Main City / Town	Fraction of Wages & Salaries from Energy Extraction
1	4816	AB	Fort McMurray	0.540
2	4818	AB	Grande Cache	0.391
3	4809	AB	Rocky Mtn. House	0.265
4	4814	AB	Edson	0.250
5	4807	AB	Stettler	0.194
6	4701	SK	Estevan	0.183
7	5955	BC	Peace River	0.174
8	4713	SK	Kindersley	0.169
9	4717	SK	Lloydminster	0.153
10	5901	BC	East Kootenay	0.141
11	4817	AB	Slave Lake	0.139
12	4804	AB	Hanna	0.139
13	4808	AB	Red Deer	0.130
14	4812	AB	St. Paul	0.123
15	4819	AB	Grande Prairie	0.112
16	4813	AB	Athabasca	0.108
17	4801	AB	Medicine Hat	0.107

Notes: Author's calculations based on wages & salaries in the 1996 Census data using the 2006 Census division boundaries. The locations of the Census divisions within the full and top treatment sets are shown in Figure 4.

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