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The Distributional Impacts of an Energy Boom in Western Canada

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Abstract

In the energy-rich region 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 measures of inequality and poverty across local labor markets that vary in energy extraction intensity to identify these distributional impacts. The evidence shows that, overall, the boom increased inequality and decreased poverty. There are, however, a few notable cases where these relationships are reversed. The significance and relative magnitude of growth across and between distributional segments were consistent with these findings.

JEL Codes: J31, Q33, R23.

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1 Introduction

Within a local labor market, the gains generated by the positive labor demand shock induced by an energy boom may potentially be distributed either uniformly or unevenly across the earnings distribution. In the simple 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 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 have significant wage and employment effects, the distributional impacts remain unclear due to differences in identification approaches and in the data sets used across developed and developing countries with differing time horizons.

In the earlier literature, several cross-national studies concluded that income inequality was positively correlated with a country's dependence upon its natural resources (Bourguignon and Morrison, 1990; Leamer et al., 1999; Gylfason and Zoega, 2003; Breisinger and Thurlow, 2008; Buccellato and Alessandrini, 2009). However, the recent cross-national study of Goderis and Malone (2011) offers a theoretical framework where a resource boom immediately reduces inequality in the short-run, but then returns it to its original steady state over time. According to their evidence across developing countries, only a third of the inequality reduction due to the initial shock remained after five years. Much of the present literature has instead focused on the variation in inequality and resource abundance within countries.

The papers studying developing countries provide mixed evidence regarding the impact of an energy boom on inequality, while they agree that poverty tends to be reduced. Using a general equilibrium model on Bolivia, Lay et al. (2006) found that the offsetting effects of an energy boom leave inequality unchanged but reduce poverty. For Mexico, López-Feldman et al. (2007) documented that increased resource income somewhat lowers inequality and poverty, but resource income inequality is itself relatively high. For Russia, Buccellato and Mickiewicz (2009) showed that oil and gas

abundance led to inequality at the local level. Caselli and Michaels (2009) found that oil may have reduced poverty in Brazil, but the results were not robust. Loayza et al. (2013) found that consumption inequality increased due to a boom within all districts of a Peruvian mining province. Also in Peru, Aragon and Rud (2013) found a significant poverty reduction due to gold mining, while Loayza et al. (2013) found a reduction in poverty within each district associated with commodity mining. Most recently, Howie and Atakhanova (2014) showed that a resource boom in Kazakhstan lowered inequality.

The studies on developed countries, mostly the United States, generally agree that an energy boom reduces poverty, but not much evidence exists regarding inequality. Black et al. (2005) used local labor markets within four mid-western coal states and found 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 estimated to be negative. Deaton and Niman (2012) show that a relative increase in the mining sector in Appalachia had an immediate effect that reduces poverty, while a lag effect then increases it. Partridge et al. (2012) also examined Appalachia and showed 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 the development of oil was not significantly associated with increased local income inequality in the southern states during a fifty year period. And, Bhattacharyya and Williamson (2013) examined the impact of a resource price shock in Australia to find that it increased inequality over the long run.

The current paper investigates the relationship between inequality, poverty, and energy booms for the developed country of Canada, specifically focusing on the western region containing the majority of its energy resources. In recent decades coinciding with an energy boom, the inequality and poverty trends across provinces of Western Canada seemingly correspond to the movements in its energy prices. Through the use of a local labor market approach exploiting variation in energy extraction intensity, this study asks and answers several questions regarding the

distributional impacts of an energy boom: Does an energy boom result in more or less inequality? Does an energy boom help to alleviate poverty? Where are the gains from an energy boom concentrated along the distribution? How does an energy boom impact inequality within different sectors? And, where are the gains from an energy boom concentrated along the distribution within sectors? This research contributes to the literature as a study that offers a complete investigation of the local distributional effects of an energy boom for a developed country and complements the general literature regarding whether or not an energy boom significantly alters inequality or poverty.

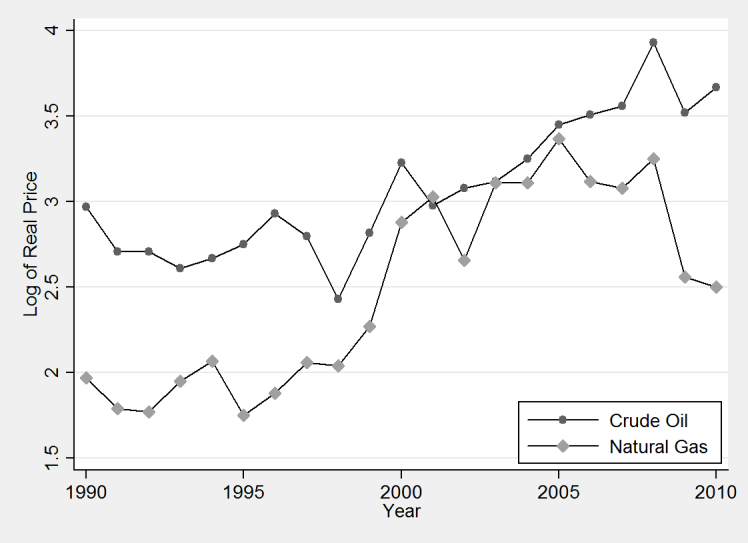
The evidence shows that the recent energy boom in Western Canada led to a modest increase in the inequality of income and earnings when using measures sensitive to changes in the middle and top of the distribution. When further disaggregated by sector, the increase in inequality was even larger in the directly-impacted energy extraction industry and there were smaller inequality increases in the indirectly-impacted local industries of construction and retail trade. This boom was also attributed to a significant reduction in low income poverty. At the same time, income inequality was seemingly reduced due to the boom using a measure sensitive to changes in the bottom of the distribution, there was a slight decline in inequality for the local industry of all services, and all measures of relative poverty modestly increased. Despite this somewhat mixed evidence, all individuals across the distribution benefited from the gains of the energy boom albeit unevenly, with significant earnings growth across all segments but relative magnitudes differing between segments, which is consistent with these results.

2 Latest Boom and Recent Trends in Western Canada

Energy prices increased rapidly in Canada over the 1990s and 2000s. 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 then experienced declines from 2008 to 2009, attributable to the Great Recession.

Figure 1: Annual Real Prices of Crude Oil and Natural Gas

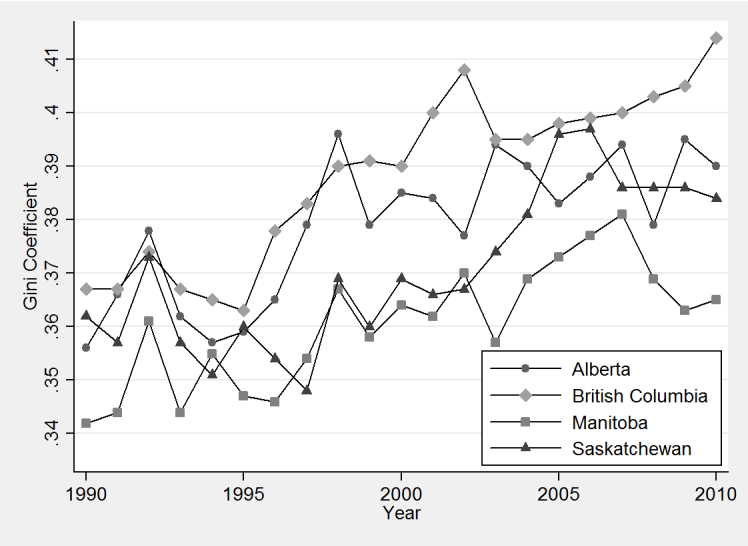


Notes: Author's calculations based on 1990 to 2010 public-use data from the Canadian Association of Petroleum Producers. The log real prices of crude oil and natural gas are based on the average wellhead/plant gate prices in dollars per cubic meter and per thousand cubic meters, respectively.

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 stemming from this energy boom, as this is the region that is 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. These provincial trends seem to mimic the greater trends in inequality and poverty happening across Canada during this time, but with important inter-provincial differences.

Figure 2: Annual Provincial Inequality Indices for Western Canada

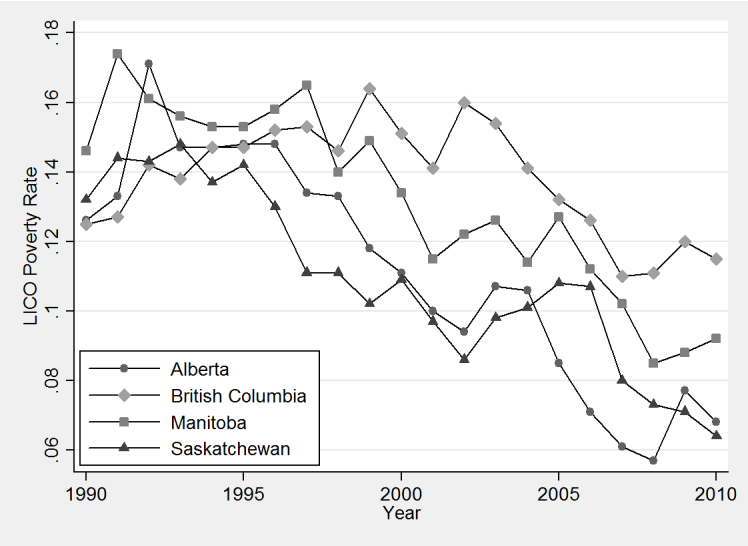


Notes: Author's calculations based on CANSIM Table 202-0705 of Statistics Canada, representing the 1990 to 2010 public-use data of the Survey of Consumer Finances and Survey of Labour and Income Dynamics. The inequality measure is the Gini coefficient of after-tax total income.

Inequality in the Western region is shown to exhibit 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, followed next by British Columbia and Saskatchewan, with no significant energy resources appearing in Manitoba. The mid-2000s once again lead to tandem increases

in inequality for all provinces except British Columbia, while the subsequent years of the Great 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.

Figure 3: Annual Provincial Poverty Rates 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 (LICO).

When energy prices and provincial inequality were increasing in Western Canada, provincial poverty rates were on the decline. In the early 1990s, poverty climbed in all four Western provinces, before stabilizing and remaining mostly equal, 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 the 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, potentially driven by the substantial differences in their traits. For example, Osberg and Xu (1999) compared the poverty intensity across the Canadian provinces in order to highlight the impact of their differences in social assistance, which then relate to changes in their poverty intensity over time. In a very recent study, Fortin and Lemieux (2014) use provincial variation within Canada in order to better understand their wage movements and how their 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 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 much in the spirit of Bartik (1996), who examined similar questions regarding the distributional effects stemming from overall changes in local labor

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

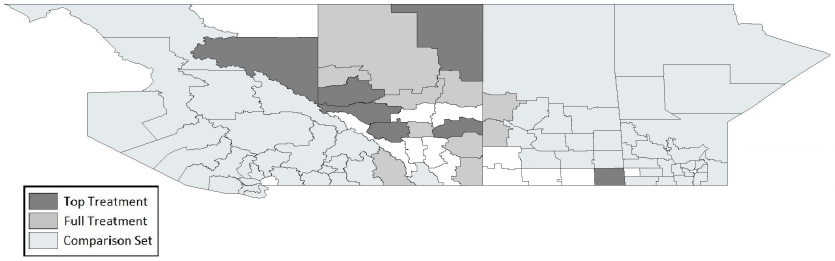
demand for the United States. Across Western Canada, some local areas contain little to no resources of crude oil, natural gas, or coal reserves, while other areas have large amounts of these energy resources. The local differences in energy extraction intensity due to the location of these resources 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 counterfactual 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 mark the start and end points of the most 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 form 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 only contained 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, pen-

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

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.

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 the energy extraction sector through the percentage of earnings that industry generates 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

[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.

[3]The inequality and within decile measures of this study drop all non-positive values and therefore only include the positive values. And, while only the positive values are used to construct the poverty cutoffs, all values are included in the poverty headcounts.

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

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 in the pre-boom period of 1995, nor exceed ten percent of their total earnings 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] The treatment sets 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 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 of the following equation:

$$ln(Outcome_{ct}) - ln(Outcome_{ct-1}) = \beta \cdot Treatment_c + \varepsilon_c \tag{1}$$

where $\Delta ln(Outcome_c)$ is the change in the natural log of the labor market outcome and $Treatment_c$ is a binary indicator for whether the Census division, *c,* is in either the full treatment set, the top treatment set, or the comparison group. Huber-White standard errors are used for these estimates. Unless otherwise stated, these differential regressions are the assumed specification. Where specified, direct change

[5]The other local industries used later on 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]The cities are Calgary, AB, Edmonton, AB, Vancouver, BC, and Winnipeg, MN. No Census divisions grow into major cities from the pre-boom to the post-boom period.

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 year 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 local labor market for this study allows for the consistent estimation of the distributional impacts of an energy boom. This examination of inequality and poverty overcomes the criticism of Tarozzi and Deaton (2009) regarding the small sample sizes within localities that tend to plague studies on developing countries. However, given that the identification of this paper relies on cross-sectional data to construct the local labor market averages, migration in and out of these labor markets over time remains an issue that affects its 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 a 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 Energy Boom Effects in Local Inequality Indices

Does an energy boom result in more or less inequality? In order to investigate this first question regarding the distributional changes attributable to the boom, inequality is summarized using three aggregate local inequality measures, where each measure varies in its sensitivity to changes in a particular part of the distribution. The Gini coefficient within each local market is more sensitive to changes in the middle of the distribution than in either of its tails, as compared with the other measures of inequality. The Theil entropy index is more sensitive to changes in the upper part of the distribution of resources.[8] And, the Atkinson index is more sensitive to changes in the lower end of the distribution, especially as the value of its aversion parameter grows, which this study sets to a value of two.[9]

The differential approach between the growth in energy and non-energy areas, using both the full and top treatment sets, are applied to each of these local inequality measures, with the results displayed in Table 1. Moving from left to right in the table, the sensitivity of the inequality measure increases from the bottom to the top of the distribution. Two columns for each inequality measure present the results of the regression estimates of equation (1), in terms of the numerical change in the outcome and the change in the natural logarithm of the outcome, which may be interpreted as a percentage change. The differential regressions of the local inequality measures are then applied separately to all three labor market outcomes of total income, total earnings, and wages & salaries.

An energy boom is associated with a modest and significant increase in the aggregate local inequality of resources, as shown by the 1.7 to 3.1 percent differential

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

[9]The results for the Atkinson index with an aversion parameter set equal to one are available upon request for the author, and in almost all cases, were lesser in magnitude than those presented with a parameter set equal to two.

Table 1: Differential Changes in Inequality Indices between Local Areas over 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 local area observations of seventy-four and sixty-five for the full and top treatment sets, with Huber-White standard errors in parentheses. Δ and Δ Log denote the numerical change and the change in the natural logarithm. Stars denote the statistical significance (* for 10%, ** for 5%, and *** for 1%).

increase in the local Gini coefficient of total income, total earnings, and wages & salaries using the full treatment. Using the top treatment, however, this result is only significant for total income, with a magnitude increase of 2.9 percent. In accordance with the previous inequality results for the entire nation of Canada (ex. Fortin et al., 2012), overall inequality is shown to be greater when using total earnings and wages & salaries than when using total income.

An equally significant but larger increase in inequality attributable to the boom is shown using the Theil entropy index, with 12.8 to 15.0 percent differential increases

using the full treatment and 19.1 to 19.8 percent differential increases using 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 unlike the results for the Gini coefficient, the boom effect remained constant in magnitude across labor market outcomes using the top treatment.

Displaying somewhat contradictory results to those of the Gini and Theil measures is the Atkinson index, with its sensitivity toward the lower end of the distribution. This measure attributes a slight equalizing effect due to the recent energy boom, with a differential reduction in total income inequality of 1.8 percent using the full treatment and 3.5 percent using the top treatment. None of these differential changes in the Atkinson index were statistically significant for the outcomes of total earnings or wages & salaries, however. Thus far in the evidence, there appears to be an equalizing effect in inequality at the lower end of the distribution, especially in terms of total income, implying that the boom does impact and benefit these particular individuals, while at the same time raising inequality in the middle and especially at the top of the distribution.

4.2 Energy Boom Effects in Local Poverty Rates

Does an energy boom help to alleviate poverty? The answer to this question begins with the construction of the local aggregate poverty measures. Although there is no official poverty measure for Canada, the low income cut off (LICO) has been continually produced by Statistics Canada since 1968 and is often used by researchers for this purpose. The LICO measure can be thought of as a partly absolute, partly relative measure of poverty, as it is based on the share of income an average family spends on the necessities of food, clothing, and shelter, plus an additional twenty percentage points. This numerical cut off of income is also differentiated by family size and urbanization, as well as adjusted over time by the consumer price index. In addition to the LICO measure, the current study also uses a purely relative poverty measure,

which is calculated at half of the median value of the labor market outcome.[10]

Both types of local aggregate poverty measures are based on the headcount of individuals living below the established poverty thresholds, which is then divided by the size of the local population.[11] The effects from the energy boom upon poverty are similarly estimated as in the previous section for the inequality impacts, using the differential change specification in equation (1). Table 2 displays these differential estimates across the various poverty measures. While the LICO definition used here is most similar to being based on the outcome of total income, the half of the median measures are calculated for all of the respective outcomes of total income, total earnings, and wages & salaries.[12] And, each effect of the energy boom on a poverty measure is calculated as both a percentage point change, as well as a log change.

The most recent energy boom is associated with a 4.9 percentage point decline in the poverty rate of individuals living below the low income cut off. This drastic reduction of 45.2 percent, an almost halving of the initial poverty rate, is statistically significant at the one percent level. This reduction is even more notable considering that this is the differential reduction between energy and non-energy areas that were both experiencing overall poverty reductions, as partly shown by the provincial poverty aggregates in Figure 3. It is only somewhat lower than the average local labor market reduction of 5.2 percentage points for the province of Alberta. The percentage point reduction associated with the boom was very similar in magnitude for the top treatment set, although it yielded a slightly larger percentage reduction of 47.6 percent.

The results based on the purely relative poverty measure show that the number of individuals living below half of the median modestly increased due to the boom.

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

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

[12]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.

Table 2: Differential Changes in Poverty Rates between Local Areas over 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 local area observations of seventy-four and sixty-five for the full and top treatment sets, with Huber-White standard errors in parentheses. Δ and Δ Log denote the numerical change and the change in the natural logarithm. Stars denote the statistical significance (* for 10%, ** for 5%, and *** for 1%).

For total income, this is a 1.2 percentage point increase and a 6.7 percent change using the full treatment set, and a slightly higher 1.5 percentage point increase and a 7.5 percent change using the top treatment. The relative poverty effects calculated for total earnings and wages & salaries show similar estimates, both with a 1.0 percentage point increase in their rates and a 5.8 and 7.0 percent change, respectively. However, the top treatment boom estimates are actually lower in magnitude for both of the earnings outcomes than they are for total income. All of the relative poverty estimates are also statistically significant at the one percent level.

Altogether, this evidence shows that the hybrid measure of absolute and relative poverty decreases substantially, while the purely relative measure moderately increases. This can certainly be the case according to the weakly relative poverty arguments of Ravallion and Chen (2011). As they point out, 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 LICO, but not necessarily catching up with the individuals at the median in a relative sense. The relative measure also better accounts for local price differences and reflects the increase in inequality that was shown earlier in the paper, rather than just the change in absolute poverty. This mixed evidence for inequality and poverty thus far will be further enlightened by the within decile analysis in the next subsection.

4.3 Within Decile Boom Effects Across the Distribution

Where are the gains from an energy boom concentrated along the distribution? In an effort to better explain the local aggregate results for inequality with the local aggregate results for poverty, the distributional effects of an energy boom are now examined within segments of the distribution. In order to do so, a tradeoff must be taken into account between the number of distributional segments and the representativeness of the distribution across individuals within a locality. Deciles were chosen as a way to provide a sufficient number of segments while maintaining their representativeness. The numerical boundaries of these deciles are determined separately for each outcome distribution by local labor market and year.[13]

Rather than examining the changes in the decile cutoffs themselves using techniques such as quantile regression, the differential change of the summation within each decile is now used to analyze how the distribution of each outcome is affected by the energy boom. Table 3 presents these within decile estimates, differencing the

[13]If these deciles boundaries were instead held constant across geography or time, the measurement of the changes in the summation within each decile would introduce asymmetries to the distributions, hindering the accuracy of their results, as the distributions would be incomparable to one another.

changes in outcomes between the treatment and comparison areas, using equation (1) for each decile of the distribution. The columns contain only the estimates for the log change in each of the deciles of the outcome distribution, from the bottom to the top decile. The general findings from this analysis within distributional segments are presented below and then discussed in the context of the aggregate inequality and poverty findings, respectively.

The first finding if that, regardless of the outcome definition or treatment set, all deciles of the distribution experience significant differential growth, with all estimates being significant at the one percent level. This implies that all individuals gain from the local labor demand shock of the energy boom. Second, the top treatment unambiguously produces a larger differential growth estimate than the full treatment across all deciles and outcomes. Therefore, the intensity of the treatment does lead to a greater impact of the shock. The third finding is that, for any given outcome, the estimates display a U-shape across the deciles. This pattern is far clearer for total income than it is for total earnings or wages & salaries, which do not begin their U-shape until the third or fourth decile. Fourth, while the magnitude of growth in the first decile is largest for total income over total earnings and then wages & salaries, the pattern reverses for the third, fourth, eighth, ninth, and tenth deciles. There is a larger magnitude growth for wages & salaries over total earnings and then total income, for both the full and the top treatment, for these deciles.

This within decile analysis provides more information regarding the previous local aggregates for inequality. In those results, overall inequality slightly decreased or remained unchanged for the bottom-sensitive measure, slightly increased for the middle-sensitive measure, and greatly increased for the top-sensitive measure. This is consistent with the U-shape finding in the magnitudes across deciles. And, the within decile finding regarding the magnitude differences across the labor market outcomes is likely why only total income has an equalizing effect at the bottom and total earnings and why wages & salaries had a greater in-equalizing effect for the more top-sensitive measures.

With regards to the local aggregates of poverty, the first finding is the most important, in that all segments of the distribution experienced the benefits generated

Table 3: Differential Changes in Sums within Deciles between Local Areas over 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 local area observations of seventy-four and sixty-five for the full and top treatment sets, 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%).

by the energy boom. Recalling the example from Ravallion and Chen (2011), if all individuals across the distribution gained 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 purely relative measure modestly increased due to the boom. In this case, it is the third finding that is the most important, as these gains were not all of the same magnitude, displaying a U-shape across most segments of the distribution. Although this implies that the bottom of the distribution is growing 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 Boom Effects in Local Industry Sector Inequality

How does an energy boom impact inequality within different sectors? The energy boom is expected to only 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 all be used to provide a representation of the other localized impacts of an energy boom taking place outside of energy extraction.[14] Therefore, the indirect distributional effects are likely to be experienced in these particular industries. The local aggregates of the first subsection are once again used to quantify local inequality, but this time within each of these local sectors.

The direct and indirect differential changes in inequality over the boom period are now estimated separately for the energy extraction industry and each of the other local sectors. The direct changes in the energy extraction sector are examined using equation (2), before and after the latest boom, but only within the full treatment

[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.

areas, as the energy extraction industry is not well represented in the comparison areas by definition. The indirect differential growth in the local goods industries of construction, retail trade, and all services are all 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 only, as it best reflects the local labor market impacts of an energy boom, as well as exhibited the largest distributional effects in the previous subsection. Similar to the first table, Table 4 presents the estimates for each of the inequality measures as both a numerical change and as a change in the log. Now, however, rather than using the rows to represent the different labor market outcomes, the rows represent the different local sectors, with energy extraction followed by each of the other local industries.

Table 4: Differential Changes in Inequality Indices for Other Sectors between Local Areas over Boom

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 local area observations of seventy-four, with Huber-White standard errors in parentheses. The direct change regressions follow equation (2) using local treatment area-year observations of thirty-four, with standard errors clustered by locality. Δ and Δ Log denote the numerical change and the change in the natural logarithm. Stars denote the statistical significance (* for 10%, ** for 5%, and *** for 1%).

The direct changes in the inequality indices for energy extraction, in only the

local treatment areas, display large and significant increases over the boom. This is true for both the Gini coefficient, with a significant change of 18.8 percent, and the Theil entropy index, with a significant and very large change of 43.3 percent, more than twice the size of the change in the Gini coefficient. The estimates for the Atkinson index are not statistically significant, meaning that inequality is not being substantially altered among individuals at the lower end of the distribution.[15] The magnitudes of these inequality increases are much greater than that of the local aggregate differential increases found in subsection 4.1, supporting the view that an energy boom is associated with more inequality in this directly impacted sector than in the overall local population.

The indirect differential changes in the inequality indices, between treatment and comparison areas, are quite different across the other local industries. The construction and retail trade industries exhibit growth in inequality in their Gini coefficients and Theil entropy indices, with no significant changes in their Atkinson indices, similar to the energy extraction industry. For the construction industry, the increase in inequality is a 6.2 differential percentage change in the Gini coefficient and a 24.8 differential percentage in the Theil index. For the retail trade industry, the recent boom lead to a similar increase in inequality, albeit at lesser magnitudes than for construction, with inequality differentially growing by 4.3 percent in the Gini and by 16.7 percent in the Theil.

Most interestingly, whereas the boom led to an increase in inequality for the local industries of construction and retail trade, it appears to have reduced inequality in all services, with a Gini coefficient decrease of 2.0 percent and an Atkinson index decrease of 4.4 percent. Inequality changes with respect to the Theil index were insignificant, although still negative. Given that Marchand (2012) found that the greatest spillovers of employment creation from energy extraction to other local sectors during a boom were found in services, this may potentially explain why the energy boom is associated with lower inequality in this particular sector.

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

4.5 Within Decile Boom Effects by Sector

Where are the gains from an energy boom concentrated along the distribution within sectors? Inequality was found to have significantly risen in the energy extraction industry due to the boom with respect to the Gini coefficient and the Theil index, while no significant changes were found with respect to the Atkinson index. This is consistent with an increase in inequality for the middle and top portions of the distribution of wage & salaries, rather than in the lower end of the distribution. This same pattern was also found for the construction and retail trade industries, albeit at much lesser magnitudes. All services, on the other hand, experienced a reduction in inequality due to the boom with respect to the Atkinson index and Gini coefficient, with no significant change in the top-sensitive Theil index. In order to provide more insight into the distributional movements producing these boom effects in inequality, the growth in the summation of wages & salaries is once again calculated within deciles of the distribution, but now it is done by sector as well.

Similar to the transition from the local inequality and poverty aggregates in subsections 4.1 and 4.2 to the within decile analysis of subsection 4.3, the current subsection offers more detail about what is happening within segments of the distribution by sector, in order to explain the changes in the local inequality aggregates across industries in the previous subsection 4.4. The differential changes in these within decile summations, between treatment and comparison areas, are estimated for the indirectly impacted industries of construction, retail trade, and all services using equation (1). The direct changes within decile summations are estimated, before and after the boom, for the energy extraction sector in the full treatment areas only, using equation (2). This evidence is displayed in Table 5 for the wages & salaries outcome and the full treatment set.

The results show that the direct changes of inequality in the energy extraction sector are due to the monotonic magnitude increases in the boom-induced growth across the wages & salaries distribution, with more growth in the upper deciles than in the middle and bottom deciles, respectively. Given the large increase in inequality within this industry, this pattern is unsurprising. However, it is surprising that this

Table 5: Differential Changes in Sums within Deciles for Other Sectors between Local Areas over Boom

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 local area observations of seventy-four, with Huber-White standard errors in parentheses. The direct change regressions follow equation (2) using local treatment area-year observations of thirty-four, 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%).

monotonic rise in the magnitude of this growth only begins from the fourth decile, while it somewhat declined before that. This explains why there was no significant change in the bottom-sensitive inequality measure of the Atkinson index for this sector. These results also suggest that, even though the recent energy boom greatly increased inequality in this industry, individuals in all deciles of the wages & salaries distribution still benefited, as all deciles experienced statistically significant growth at the one percent level.

The indirect inequality increase in the construction sector was attributable to larger growth in the upper deciles with respect to the middle deciles, similar to energy extraction. The differential growth in this industry also exhibits almost the same magnitude and pattern in its upper deciles as the direct changes in energy extraction, but with much larger growth in the lower deciles found in construction. The pattern of wages & salaries growth across deciles in the retail trade industry was similar to that of construction and energy extraction, in that the magnitude of growth in the upper deciles was larger than that of the middle deciles, while the lower deciles grew by less for retail trade than for energy extraction or construction.

The decile growth in all services exactly follows the pattern of a reduction in inequality, as the magnitude of this growth is monotonically decreasing when moving across the deciles, with the exception of a small increasing trend for the very top decile. This equalization in services is particularly 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 or all of the inequality increases in the other local industries due to the energy boom. All of the indirect decile growth estimates are statistically significant at the one percent level.

5 Conclusion

Recent trends in inequality and poverty across Western Canada, a region known for its energy resources, seemingly correspond to movements in its energy prices, with much of the rise in inequality and decline in poverty taking place during the energy

boom from the mid-1990s to the mid-2000s. In addition, these trends are ostensibly more pronounced in the provinces containing greater energy resources than in the provinces with lesser amounts or without these resources. This study attempts to answer several questions regarding the extent to which the recent energy boom, through its positive shock to labor demand, affected this increase in inequality and decrease in poverty using a novel empirical approach based on local labor markets. Various measures of inequality and poverty are aggregated at the local level to identify these distributional boom impacts utilizing local variation in energy extraction intensity. This research is unique in its offering of a complete investigation of the local distributional effects of an energy boom for a developed country.

Overall, the evidence indicates that inequality modestly increased and poverty drastically decreased due to the recent energy boom in this region. The use of different inequality measures shows that the increase attributable to the boom was larger for measures that are more sensitive to movements in the top of the distribution, as compared with measures sensitive to changes in the middle. This inequality increase was also larger for total earnings and wages & salaries, as compared with the increase for total income, as well as larger for localities with a greater dependance on earnings from energy extraction. When the results were further disaggregated by local industries, the energy boom is shown to have induced a larger increase in the inequality of wages & salaries in the directly-impacted energy extraction sector and to have led to a moderate indirect increase in inequality of the local construction sector, followed closely in magnitude by the inequality increase for retail trade. The significant poverty reduction was found when using the standard low income cut off definition and was very close to a halving of the initial local poverty rate.

There were also a few notable cases where inequality slightly declined and poverty modestly increased. Using an inequality measure which is sensitive to changes in the bottom of the distribution induced a slight decline in inequality, but this was only of significance when assessed on total income and not on total earnings or wages & salaries. There was also a slight reduction in inequality in wages & salaries for the local services sector, which was significant not only for the bottom-sensitive measure but also for the measure sensitive to changes in the middle of the distribution. This

is quite interesting given that the service industry employs the majority of the work force, and in light of Fortin and Lemieux (2014), who find lower inequality associated with the boom in their inter-provincial analysis. The modest increases in poverty were found using the relative measures of half of the median of total income, total earnings, and wages & salaries. These increases most likely reflect the increase in overall inequality, as well as the decrease in poverty under the less relative measure of the low income cut off.

The examination within segments of the distribution ties these inequality and poverty results together and helps explain the differences in the evidence. Most importantly, the gains from an energy boom are shown to be widely distributed, with statistically significant increases across all deciles in all cases. Therefore, it is only the relative magnitudes of this growth across the distribution that causes changes in inequality. In the most extreme examples, the large inequality increase in the energy extraction sector is linked to monotonic increases in the growth of wages & salaries when moving up the distribution, while the inequality decrease for the service sector is explained by monotonic decreases. For other examples, the growth within segments is not as clearly matched, but increased inequality is typically driven by increasing relative magnitudes of growth from the middle to top of the distribution, while a decline in inequality is most likely due to the decreasing magnitudes from the bottom to the middle. The drastic decrease in low income poverty is explained by the significant gains in the bottom of distribution, while the increase in relative poverty is linked to the bottom of the distribution not growing fast enough to catch up with the growth at the median. Altogether, this suggests that a rising tide may have the ability to lift all boats, although not proportionately.

This study offers one set of answers to the questions regarding whether a resource boom significantly alters inequality or poverty. Due to its reliance on a recent energy boom in a particular region of a developed country over ten years, it is difficult to generalize these results for all booms, even those based upon energy within a developed country over a similar time horizon. Despite the common distributional questions of the literature and a consensus that significant labor effects are attributable to this type of labor demand shock, differences abound in the identification approaches and

data sets used, which unsurprisingly lead to differences in their answers. One particular difference lies with the geographical variation used to identify the estimates. Is it local, provincial or state, limited to a region, looking within a country, or perhaps comparing cross countries? Are the countries involved developed or developing? What is the time horizon of interest and what time variation is used for identification? More work needs to be done linking the local results to the state, provincial, and national aggregates, and distinctions need to be drawn as to how these impacts compare by the stage of development and over the short, medium, and long run.

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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.