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Local Labor Market Impacts of Energy Boom-Bust-Boom in Western Canada

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Abstract

The impacts of energy price boom and bust are analyzed through the differential growth in employment and earnings between local labor markets with and without energy resources in Western Canada. The estimated differentials attributed to the boom-induced labor demand shocks show significant direct and indirect impacts on the earnings and employment within the energy extraction and other non-energy local sectors respectively. The local job multipliers indicate that job creation within the energy extraction sector leads to modest job creation within the non-energy local sectors during boom periods. For every ten energy extraction jobs created during a boom period, approximately three construction jobs, two retail jobs, and four and a half service jobs are created.

Keywords: boom and bust, energy, job multipliers, labor demand shocks, local labor markets. JEL Codes: J2, R23.

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1 Introduction

Drastic movements in the prices of energy-related goods can generate labor demand shocks to the local labor markets which have these resources readily available for extraction. As the prices of oil, natural gas, or coal increase, positive labor demand shocks may occur within the resource-rich geographical areas, expanding employment opportunities and earnings for the local energy extraction industry. The expansion may also spillover into other local sectors outside of energy, such as construction or services, creating new jobs within those sectors. This described boom period can be followed by a subsequent bust with its negative shock to labor demand, again particularly felt in those local labor markets with resources, lowering employment and earnings not only for those workers in the energy extraction sector but perhaps in other industries as well.

Determining the labor market impacts of each of these types of periods is important in order to understand just how good a boom or how bad a bust can be on a local economy. This measurement is problematic, however, due to the lack of the counter-factual: What would have happen to a resource-rich area had the boom or bust not occurred? This research addresses this issue by measuring the differential impacts experienced by local Western Canadian labor markets which have significant energy resources compared with similar local markets without such resources, during a period from 1971 to 2006 when two booms and a bust occurred.

While there has been great interest in identifying the local effects of these types of shocks, this remains an understudied area with only a handful of published studies, like that of Blanchard and Katz (1992) and Black, McKinnish, and Sanders (2005). Following the methods used in their work, this study identifies the effects of oil and natural gas shocks on employment and earnings outcomes across the industries which were directly and indirectly impacted. In addition, this study estimates how much of the job creation within the directed impacted industry spills over into further job creation in the indirectly impacted industries, if there are in fact any significant spillovers.

The evidence presented within this study shows that the direct impacts upon the energy extraction industry are large: total employment and earnings are found to have risen dramatically during the 1971-81 and 1996-06 boom periods, while no significant changes in its labor outcomes are shown for the 1981-91 bust. The indirect spillover effects of these booms and bust to non-energy industries are shown to be smaller but significant during each of these shocks. Once the local job multipliers are calculated, it becomes clear that jobs created in the energy extraction sector during the boom periods do indeed spillover into further job creation in the construction, retail trade, and service industries.

In the literature, there are no previous studies that have applied these quasi-experimental techniques using the particular resources of oil and natural gas, nor to the region of Western Canada. This is somewhat surprising given the greater reliance of the economy on energy resource production, as well as the relative global importance of the energy resources produced in this region. This is also the first study that was able to generalize the localized impacts of energy price shocks by analyzing over more than one historical boom event within the same region. This paper aims to contribute to the literature by using this unique experiment in its valuable setting in order to better understand the labor market consequences of shocks to the resource sector.

The structure of this paper is as follows. Section 2 provides a brief review of the relevant literature and contains the background on the recent historical price trends in oil and natural gas. Section 3 displays where the resources are contained within Western Canada and discusses the methodology of the study and the data sources. Section 4 presents all of the results of this study, including the differential earnings and employment effects, the differential population effects, and the local job multiplier evidence. Section 5 concludes the paper. Acknowledgments, references and appendix tables then follow.

2 Background

2.1 Labor Demand Shocks

The measurement of the effects of local labor demand shocks is an important and elusive area of research. These labor demand shocks can take many forms, but they are often difficult to isolate. Consider first some of the non-energy-related examples. One such example is the impact of a policy such as an enterprise or empowerment zone that is used to stimulate an economically-depressed local economy by offering a favorable tax or subsidy environment to businesses within the area. Some of this research finds that these policies have a positive effect upon employment. O'Keefe (2004) shows evidence that enterprise zones in California have positively stimulated employment in the short-term, growing by about 3 percent more per year over six years. She uses propensity score matching methods for her measurement and focuses on census-tract and establishment-level data. In another study, Busso and Kline (2007) use rejected applicants to the program as a comparison group and find a 4 percent increase in local employment for zone recipients.

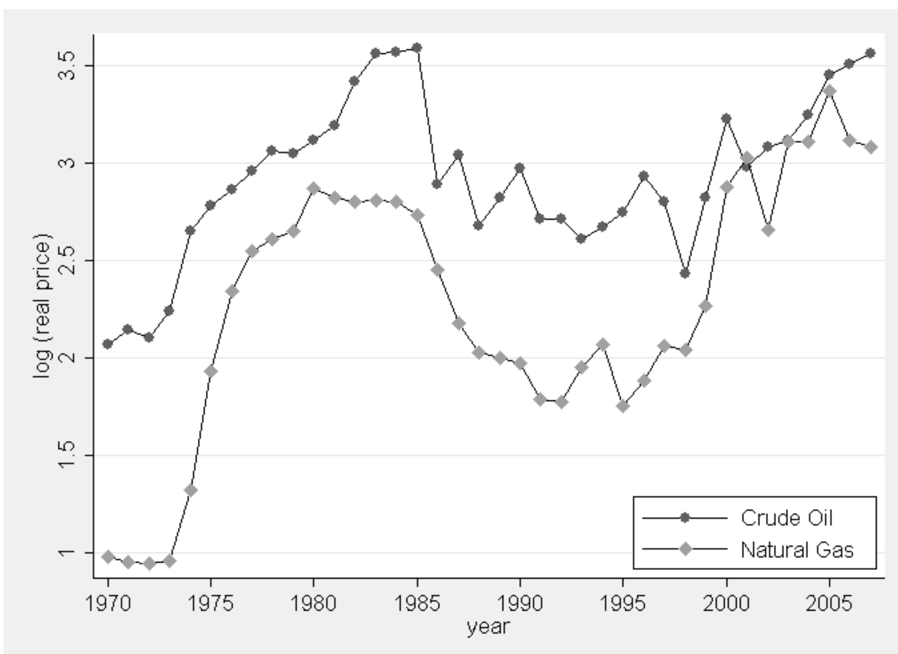
However, there are also studies that find no employment effect of these policies. A pair of studies, Kolko and Neumark (2010) and Neumark and Kolko (2010), provide examinations of enterprise zones (again in California) using establishment-level data and methods which greatly scrutinize the geographical boundaries of such zones. Their findings suggest that the policy is ineffective at achieving any new job development, but may be more favorable for zones with less of a focus on manufacturing. And Hanson (2009), controlling for endogeneity bias which many other studies ignore, also finds that there is no significant employment effect of these policies.

A second example of a non-energy-related labor demand shock is the introduction of a large plant to a local labor market. Greenstone and Moretti (2004) measure this type of impact by comparing the outcomes of a community that receives a bid to build a large plant relative to the communities that lost the bid. They find a 1.5 percent increase in the earnings trend within the new plant's industry for the community that ends up winning the bid.

2.2 Energy-Specific Shocks

More relevant to the current topic are the several papers which focus on labor demand shocks related to spikes in energy prices. These studies use the turbulent movements in the prices of energy-related goods, such as crude oil and natural gas, that have occurred over the past forty years. These price changes reflect significant historical events which lead to direct shocks to the world supply and demand of these goods. Figure 1 displays the logged real price trends of crude oil and natural gas over the 1970 to 2007 period based on data collected from the Canadian Association of Petroleum Producers. This time period contains one full boom and bust cycle in crude oil and natural gas over the 1970s and 1980s, as well as the boom period of the late 1990s through the mid-2000s.

Figure 1: Log Real Price Trends in Crude Oil and Natural Gas, 1970-2007



Notes: Author's calculations of 1970-2007 public-use Canadian Association of Petroleum Producers data. The log real price of crude oil is based on the average wellhead price in dollars per cubic meter. The log real price for natural gas is based on the average wellhead/plant gate price in dollars per thousand cubic meters.

Throughout the 1950s and 1960s, energy prices were rather constant. During the 1970s, however, world energy prices were significantly impacted by two price shocks. These first arrived in 1973-74 and again in 1979-80, reflecting the strategies of the Organization of Petroleum Exporting Countries (OPEC) and overall instability within the Middle East region. Overcapacity in oil production coupled with a sharp drop in demand led to declines in nominal oil prices during the 1980s. Natural gas prices follow a similar boom and bust cycle over this period but reflect even more volatility.[1] The late 1990s and 2000s brought about a second major boom in oil prices due to significantly increased world demand especially driven by developing countries. This boom continued through the end of 2007. Similar to the previous boom and bust, natural gas prices have followed suit with even more volatility. Oil and natural gas prices were fairly correlated during this period of analysis (along with coal) so these can be thought of as reflecting a more general energy price trend.

Blanchard and Katz (1992), building upon the methodology of Topel (1986), used state-variation to examine how regional labor markets respond to various types of labor demand shocks. This study is among the first to combine the topics of local labor markets and natural resources, as one of the particular regional designations they analyze are the "oil and mineral states". These states are Alaska, Colorado, Louisiana, Montana, New Mexico, North Dakota, Oklahoma, Texas, West Virginia, and Wyoming. The classification of this region is based on oil, gas, and other minerals comprising 2 percent or more of their total earnings. This group of states seems to clearly respond in total employment to the energy boom of the 1970s and, to a lesser extent, the energy bust of the 1980s. However, this study does not particularly isolate any spillover effects that the primary sector may have had on other industries within those states.

Carrington (1996) is another study that analyzes the relationship between energy resources and local labor markets, by examining the exogenous temporary labor demand shock provided by the construction of the Trans-Alaska Pipeline System.

[1] Helliwell, MacGregor, McRae, and Plourde (1989) provide a detailed historical examination of these trends in crude oil and natural gas prices over this particular period through the 1970s and 1980s within a North American context.

Due to the low population in the state of Alaska, this project also involved a huge influx of workers to meet the increase in demand to build the project. Average earnings and employment grew by 56 and 57 percent respectively during the project's duration from 1973 to 1976. Each outcome returned to its initial equilibrium trend in the years that followed: earnings by 1979 and employment by 1981. The largest impacts were found within the construction industry given the nature of the project, but spillovers into service, trade, transport, utilities, finance, and mining were also found. Manufacturing and government services were unaffected by any spillover effects.

Further relating the topics of local labor markets to the subject of energy resources was a paper by Black, McKinnish, and Sanders (2005), which set out to examine the earnings, employment, and migration impacts of the coal boom of the 1970s and subsequent coal bust of the 1980s. The local labor markets in this study are counties within the U.S. coal-producing states of Kentucky, Ohio, Pennsylvania, and West Virginia. These are examined by calculating the differential growth between the treatment group, consisting of counties earning more than 10 percent of their total earnings from coal extraction, who are also found to contain large amounts of coal, and the comparison group, consisting of counties containing medium to low amounts of coal.

They find that total employment grew by 2 percent more annually in coal-resource counties than in non-coal counties during the boom and contracted 2.7 percent more during the bust. Earnings between these groups grew 5 percent more on an annual basis in the boom and dropped 5.5 percent in the bust. Earnings per worker had similar movements of a 3 percent gain followed by a 2.8 percent drop. When only the mining sector is examined, the employment effect is roughly three times as large as for all industries and the earnings impacts are roughly two times as large. They also identify the specific employment spillover effects from mining to other sectors by calculating local job multipliers. For every ten jobs created in the coal sector during the boom, almost two jobs were created across the local sectors of construction, retail, and services. This spillover effect was stronger during the bust, however, as more than three jobs were lost across the local sectors for every ten coal sector jobs lost. Also, no employment spillover effects were found for the traded good sector of manufacturing, implying that no crowd out had occurred.

3 Measuring the Booms and Bust in Western Canada

Canada contains large amounts of energy resources, holding as much as 1.6 billion cubic meters of crude oil and 2.8 trillion cubic meters of natural gas in remaining established reserves in recent years.[2] Much of these energy resources are located within the Western provinces of Alberta, British Columbia, Manitoba, and Saskatchewan, but these resources are not uniformly distributed across the region. The province of Alberta contains vast tracts of both oil, natural gas, and coal resources, while the provinces of British Columbia, Manitoba, and Saskatchewan only contain a few known pockets. Therefore, Western Canada provides several local economies that are largely dependent upon energy resources which would be tremendously affected by the types of energy price shocks described in the previous section.[3] The challenge is that the actual counter-factual is not available: the outcome is not observed for a given local energy-based economy if the boom or bust did not happen. This issue is resolved by using the quasi-experimental methodology provided by Black, McKinnish, and Sanders (2005). The outcomes of areas with these energy resources, the treatment group, will be compared to the outcomes of areas void of these resources, the comparison group, using the Western Canadian Census divisions as the local labor markets.

Similar to the definition used by both Blanchard and Katz (1992) and Black, McKinnish, and Sanders (2005), the resource-rich areas which form the treatment group are constructed based on those Census divisions which generate a relatively large percentage of their total earnings from the energy extraction sector in the base period prior to each boom and bust cycle. While the first study used a low cut-off

[2] Reserve estimates are based on data from the Canadian Association of Petroleum Producers.

[3] The Yukon and Northwest Territories could also be considered as a part of Western Canada and do have considerable energy resources, but are not used in this study due to inadequate samples of individuals resulting from small populations.

of two percent of total earnings from the extraction of all natural resources at the state-level, the second study used a ten percent cut-off of total earnings solely from coal extraction at the county-level. In this paper, the treatment group is constructed from Census divisions which derive ten percent or more of their total earnings from the energy extraction sector, which includes oil and gas extraction, coal mining, and support to oil, gas, and mining, all of which are subsets of the aggregate primary goods sector.[4]

The comparison group is formed by Census divisions which generate less than five percent of their total earnings from the energy extraction sector in the base period and which do not exceed ten percent of their total earnings from energy extraction in any of the post-periods. This second step was done to exclude any Census divisions which would have "switched" into the treatment group in a post-period. Therefore, any Census division which earns between five and ten percent of their total earnings from energy extraction in any of the base periods, as well as any areas which exceed ten percent in any of the post-periods, are dropped from the analysis. In addition, Census divisions which are major cities containing more than 250,000 inhabitants are not included in the analysis, because most treatment areas have relatively small populations and so major cities would not serve as a proper comparison.[5] This final set of comparison areas will serve as a proxy for the counter-factual, answering what would have happened to energy areas had these energy price shocks not occurred.[6] In an alternative specification, any remaining comparison areas that directly border any of the treatment areas are also dropped from the analysis, in order to create a buffer between the treatment and comparison groups and eliminate the impact of any geographical spillovers.

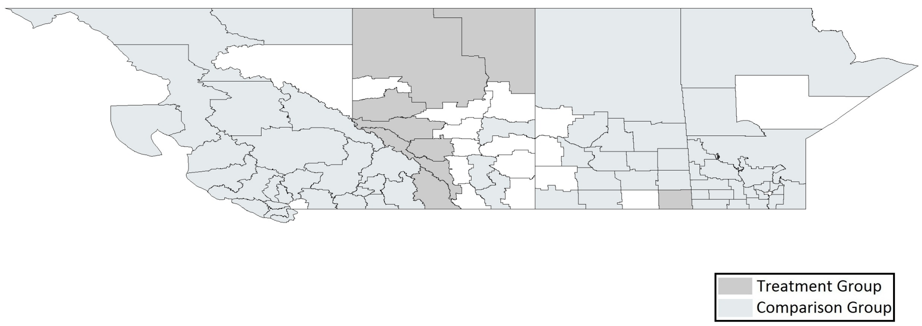
One main advantage of Black, McKinnish, and Sanders (2005) is that they have

[4]The specific Census divisions included in the treatment group for the 1971-91 and the 1996-06 periods are shown in Figures 2a and 2b and are listed in the Appendix Tables A1a and A1b respectively.

[5]These cities include Calgary and Edmonton, AB, Vancouver, BC, and Winnipeg, MN. Of these cities, only Calgary would have fit the treatment definition.

[6]The specific Census divisions included in the comparison group for the 1971-91 and the 1996-06 periods are shown and detailed in the notes sections of Figures 2a and 2b respectively.

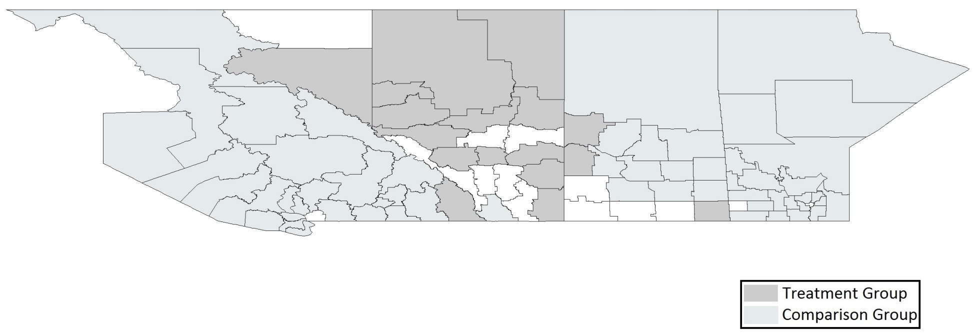
Figure 2a: Treatment and Comparison Areas of Western Canada for the First Boom and Bust, 1971-1991



Notes: Author's calculations based on 1971 Census data using 1991 Census division boundaries. Eight Census divisions form the treatment group as listed in Appendix Table A1a. Sixty-two Census divisions form the comparison group. The median fraction of total earnings received from energy extraction among the comparison group is 0.25%, with 16 Census divisions having a value of zero. Eighteen Census divisions are dropped from the analysis: 4 large cities, 9 with a fraction of total earnings from energy extraction above 5% in the pre-period, and 5 with this fraction above 10% in the post-period. An additional 10 Census divisions are dropped from the analysis for neighboring the treatment group in the alternative specification.

the data available at the local labor market level to say whether the resources within their treatment areas are in fact large. They then define their comparison group as those areas that have medium to low reserve amounts. As these resource data are not available by Census divisions for Western Canada, this study will assume that these resource amounts are highly correlated with the percentage of total earnings from energy extraction. This is a relatively safe assumption, as the high correlation has previously been shown with the U.S. data for coal mining in Black, McKinnish, and Sanders (2005), and the areas with highest percentages of total earnings from energy extraction in the current study lie over known resource deposits, such as the

Figure 2b: Treatment and Comparison Areas of Western Canada for the Second Boom, 1996-2006



Notes: Author's calculations based on 1996 Census data using 2006 Census division boundaries. Seventeen Census divisions form the treatment group as listed in Appendix Table A1b. Fifty-seven Census divisions form the comparison group. The median fraction of total earnings received from energy extraction among the comparison group is 0.4%, with 10 Census divisions having a value of zero. Fourteen Census divisions are dropped from the analysis: 4 large cities, 9 with a fraction of total earnings from energy extraction above 5% in the pre-period, and 1 with this fraction above 10% in the post-period. An additional 13 Census divisions are dropped from the analysis for neighboring the treatment group in the alternative specification.

Athabasca oil sands.

All of the data used to generate the labor outcomes for the Census divisions are provided by the Census of Population administered by Statistics Canada. Large numbers of individuals are required in order to have proper representation for all of the Census divisions, as each Census division is its own local labor market and is treated as an independent observation. Among the available surveys for Canada, the Census data offer the most individual variation of any cross-sectional data source.[7]

[7] The Labour Force Survey offers much more time variation than the Census as it is collected on a monthly basis, but it has a much smaller sample size of individuals, has no earnings reported

While the public-use version of this data does not provide the needed geographical and industry sector variation, the Restricted Data Center (RDC) version of the Census data does. Unfortunately, the RDC version of this data is only currently available back to 1991, so it could only be used to represent the latest boom from 1996 and 2006. To generate the outcomes for the previous periods, a privately commissioned version of the 1971, 1981, and 1991 Census was purchased with the needed specifications directly from Statistics Canada.

Looking back to Figure 1, these quinquennial Census years match the boom and bust trends in energy prices remarkably well. The changes in outcomes from 1971 to 1981 will represent the first boom period, the changes from 1981 to 1991 will represent the bust, and the changes in outcomes from 1996 to 2006 will represent the second boom. Given the facts that two separate boom and bust cycles are observed from 1971 to 2006 and that the boundaries of Census divisions have changed over the period, this study treats each boom and bust cycle as its own experiment. This would be analogous to two different experiments for a treatment taking place on two different sets of recipient and non-recipient groups. Figures 2a and 2b display how these Census divisions are categorized from 1971 to 1991 and from 1996 to 2006 respectively. The energy-rich treatment group of Figure 2a will have been affected by the energy boom of the 1970s, as well as the energy bust of the 1980s, while the treatment group of Figure 2b will have been affected by the energy boom of the late 1990s to the mid-2000s. The comparison Census divisions and their boundaries are also kept consistent within each of the cycles. For the estimation of the generalized boom effect, the treatment and comparison areas are kept consistent by using the group definitions from the first boom and bust across the entire boom-bust-boom sequence.

Throughout the analyses that follow, there are three different labor market outcomes of interest: total employment, total earnings, and earnings per worker. Total employment is simply the summation of all individuals who report being employed and have positive earnings. Total earnings is the summation of all earnings of em-

prior to 1996, has no Census division information prior to 1987, and is only available back to 1976 for the RDC version of the data.

ployed individuals with positive earnings. Earnings per worker is the average earnings for each worker, given by dividing total earnings by total employment. These labor outcomes are calculated over each Census division and over various industries within those divisions. All earnings variables are expressed in constant 2005 dollars.

4 Employment and Earnings Effects of the Booms and Bust

The large energy price changes of the boom and bust will generate shifts to the negatively-sloped labor demand curve along the positively-sloped labor supply curve. This exogenous labor demand shock will be positive for a boom period and will be negative for a bust period. The shock serves as the treatment, which will only be received by the resource-rich areas of the treatment group and will be not be received by the resource-poor areas of the comparison group. This quasi-experimental identification strategy provides a consistent and unbiased estimator of the impacts of boom and bust upon labor market outcomes, assuming that each the area types would have followed similar trends in the absence of these shocks.

4.1 Direct Impacts in Energy Extraction

How does the energy price boom-bust-boom in Western Canada directly affect the labor outcomes of the energy extraction industry? For these particular results, only the growth of the outcomes within the treatment areas are considered, as the energy extraction industry is not well represented within the comparison areas by definition. As shown in Table 1, the changes in total employment, total earnings, and earnings per worker for each of the boom periods in the treatment areas are all large and statistically significant, while these same effects are not statistically different from zero for the bust period.

Table 1: Growth in Employment and Earnings for Energy Extraction Industries within Treatment Areas Only, 1971-2006

Log changes in (Treatment only)	First Boom 1971 to 1981	First Bust 1981 to 1991	Second Boom 1996 to 2006	Generalized Boom 71-81 & 96-06
Energy Extraction:				
Total Employment	0.892***	-0.061	0.467**	0.566**
	(0.265)	(0.345)	(0.228)	(0.246)
Total Earnings	1.214***	0.001	0.683**	0.837**
	(0.292)	(0.400)	(0.256)	(0.306)
Earnings per worker	0.323***	0.061	0.215***	0.270***
	(0.049)	(0.073)	(0.047)	(0.081)
n	16	16	34	32

Notes: Author's calculations of 1971, 1981, 1991, 1996, and 2006 Canadian Census data. All regressions control for provincial fixed effects (AB is the omitted province and MN is dropped due to no treatment observations). Stars denote the statistical significance of the estimates (* for 10%, ** for 5%, and *** for 1%). Huber-White standard errors are in parentheses. These regressions are run on logged outcomes with a post-period indicator.

For the first boom from 1971 to 1981, total employment within the energy extraction grew 89.2 percent within the treatment areas while total earnings grew 121.4 percent. Earnings per worker also grew by 32.3 percent. For the second boom from 1996 to 2006, total employment grew 46.7 percent, total earnings grew 68.3 percent, and earnings per worker grew 21.5 percent, all within the treatment areas only. The boom impacts from 1971 to 1981 are roughly twice as large as the impacts of the 1996-06 boom for total employment and total earnings in this energy extraction industry. The generalized boom effect, shown in the last column of Table 1, is the calculated growth in labor outcomes over both boom periods within the treatment areas. For this specification, the treatment and comparison groups of the first boom-bust cycle are carried through to the second boom. Not surprisingly, these generalized estimates lie between the results for each of the booms in isolation.

Although the real energy price trends shown in Figure 1 clearly show declines during the 1981 to 1991 bust period, there are no significant negative changes found for this period among any of the labor outcomes for the energy extraction industry. The magnitudes of the estimates are close to zero and are far from being statistically significant. Therefore, the bust appears to be more of a stagnation than a decrease. It may be possible that the positive demand shock causing both employment and earnings to increase during a boom may not be temporary, as in Carrington (1996), but rather permanent. This would mean that any negative demand shock that may occur during a bust would be temporary. Given the large time period for each measurement, however, it is difficult to support this assertion. But, the evidence does seem to indicate that the gains in employment and earnings achieved in the boom are not lost during the bust. Due to this lack of a significant bust effect in the energy extraction sector, attention is only given to the two boom periods and their generalized effect when the local job multipliers are calculated later on in the analysis.

4.2 Indirect Differential Spillovers into Non-Energy Sectors

Now that the specific employment and earnings effects of the energy extraction industry have been considered, these same labor market outcomes will be viewed over all of the industries *except* for energy extraction. Each estimate is now constructed as the differential growth in labor outcomes between the treatment and comparison areas. It is this differential change that provides the unbiased effect associated with positive and negative labor demand shocks for the indirect spillovers into non-energy extraction industries. The following specification is run between two years at a given time for each of the booms and bust and over both booms for the generalized boom effect:

$$ln(E_{cpt}) - ln(E_{cpt-1}) = \beta \cdot Treat_{cp} + Prov_p \cdot \theta + \varepsilon_{cp} \quad (1)$$

where $\Delta ln(E_{cp})$ is the growth in the natural log of the labor market outcome of interest, $Treat_{cp}$ is a binary indicator for whether the Census division observation is in the treatment group or not based on the amount of total earnings from energy extraction, and $Prov_p$ represents a vector of provincial binaries. The subscripts c and p refer to Census division and province respectively.

A priori, all of the labor outcomes should exhibit greater growth for the treatment areas than in the comparison areas during a boom. They should also most likely exhibit a greater drop in outcomes for the treatment areas during a bust, as compared with the comparison areas. While boom and bust movements in the energy extraction industry are the driving force behind any employment and earnings changes that may occur here as spillovers, the heterogeneity among all of these non-energy industries may not yield any significant results in either period.

Table 2a shows statistically significant differences in the growth of total employment, total earnings, and earnings per worker between treatment and comparison areas across all non-energy industries in all periods. This implies that the strong impacts found in the energy extraction industry do spillover into other non-energy industries. Total employment grew by 47.3 percent, total earnings grew by 66.9 percent, and earnings per worker grew by 19.6 percent during the first boom. These increases continued during the bust period for total employment and total earnings, albeit at much smaller magnitudes than during the boom. However, earnings per worker displays a statistically significant decline during the bust of 6.3 percent. The differential effects in employment and earnings are smaller in the second boom than in the first boom for all outcomes except earnings per worker which was slightly larger in the second boom. Compared with the estimates for energy extraction Table 1, the magnitudes of both boom effects for the non-energy extraction industries are shown to be smaller.

This paper uses a generalized difference-in-difference method in order to produce a combined estimate for the effect of a boom. Belasen and Polachek (2008, 2009) use

Table 2a: Differential Growth in Employment and Earnings for All Non-Energy Extraction Industries Between Treatment and Comparison Areas, 1971-2006

Log changes in (Treat - Comparison)	First Boom 1971 to 1981	First Bust 1981 to 1991	Second Boom 1996 to 2006	Generalized Boom 71-81 & 96-06
Non-Energy Industries:				
Total Employment	0.473***	0.173***	0.163***	0.328***
	(0.139)	(0.042)	(0.040)	(0.085)
Total Earnings	0.669***	0.110***	0.390***	0.561***
	(0.180)	(0.040)	(0.068)	(0.113)
Earnings per worker	0.196***	-0.063***	0.226***	0.232***
	(0.045)	(0.019)	(0.035)	(0.042)
n	70	70	74	140

Notes: Author's calculations of 1971, 1981, 1991, 1996, and 2006 Canadian Census data. All regressions control for provincial fixed effects (AB is the omitted province). Stars denote the statistical significance of the estimates (* for 10%, ** for 5%, and *** for 1%). Huber-White standard errors are in parentheses.

a similar technique to identify the overall effect of hurricanes on local labor market outcomes by measuring over multiple hurricane shocks taking place in different time periods upon different areas. The method used in this paper is more straightforward than that of the hurricane study, due to the fact there are only two boom events to measure over which take place in the same geographical region. Specifically, the generalized difference-in-difference estimates are obtained by pooling the changes of the two boom periods between 1971 and 1981 and between 1996 and 2006 while using a consistent treatment and comparison group. As stated in the previous section, in this specification the initial treatment and comparison groups of the first boom and bust are also carried forward and used for the second boom. It is important to look beyond the event-specific estimate for each boom in isolation by using the generalizing method across the two events. Although each event is an energy boom and should be similar in nature, each could potentially have a different impact on the economy. As shown in the final column of Table 2a, the generalized impact of a boom period across all non-energy industries is an increase of 32.8 percent in employment, an increase of 56.1 percent in total earnings, and a 23.2 percent increase in earnings per worker. These particular generalized estimates fall between those for each event of the first and second boom in isolation.

These non-energy extraction industries can be further disaggregated in order to better identify any spillover effects. Local goods sectors can be distinguished from traded goods sectors, as local goods cannot be traded and should therefore feel any localized impact of the happenings of the energy extraction sector. The local goods sectors considered here are represented by the industries of construction, retail trade, and services. Table 2b shows that these effects become larger in magnitude with this non-energy sector disaggregation, which then translates to larger increases during the booms and larger decreases during the bust. That said, these particular estimates may reflect more than just spillovers. For this reason, the job multiplier analysis in section 4.4 is crucial to identifying the true employment spillover effects.

During the first boom from 1971 to 1981, statistically significant increases are shown among the three labor outcomes for all three local goods industries. The magnitudes between industries are also fairly similar, with retail trade exhibiting the largest employment change, services exhibiting the largest total earnings change, and construction exhibiting the largest earning per worker change. During the second boom from 1996 to 2006, all labor outcomes are again statistically significant, however, the differences in the magnitudes of those increases are much more sizable between industries. The construction industry exhibits the largest relative changes for all three labor outcomes. For example, construction has more than five times as large an employment increase as retail trade and more than twice as large an employment increase as that of services. The generalized boom effects for all local industries are shown to lie between the effects of each boom independently.

Table 2b: Differential Growth in Employment and Earnings for All Local Goods Industries Between Treatment and Comparison Areas, 1971-2006

All Local Goods Log changes in (Treat - Comparison)	First Boom 1971 to 1981	First Bust 1981 to 1991	Second Boom 1996 to 2006	Generalized Boom 71-81 & 96-06
Construction:				
Total Employment	0.529**	-0.088	0.444***	0.507***
	(0.231)	(0.133)	(0.072)	(0.129)
Total Earnings	0.718***	-0.260*	0.790***	0.800***
	(0.247)	(0.146)	(0.123)	(0.171)
Earnings per worker	0.191***	-0.168***	0.345***	0.293***
	(0.030)	(0.036)	(0.067)	(0.076)
Retail Trade:				
Total Employment	0.663***	0.101*	0.087**	0.372***
	(0.182)	(0.051)	(0.038)	(0.124)
Total Earnings	0.781***	0.053	0.272***	0.535***
	(0.206)	(0.047)	(0.064)	(0.133)
Earnings per worker	0.122**	-0.049	0.184***	0.165***
	(0.048)	(0.035)	(0.039)	(0.042)
All Services:				
Total Employment	0.619***	0.210***	0.212***	0.413***
	(0.161)	(0.059)	(0.036)	(0.103)
Total Earnings	0.800***	0.121**	0.432***	0.633***
	(0.182)	(0.058)	(0.059)	(0.115)
Earnings per worker	0.179***	-0.088***	0.219***	0.219***
	(0.041)	(0.025)	(0.026)	(0.033)
n	70	70	74	140

Notes: Author's calculations of 1971, 1981, 1991, 1996, and 2006 Canadian Census data. All regressions control for provincial fixed effects (AB is the omitted province). Stars denote the statistical significance of the estimates (* for 10%, ** for 5%, and *** for 1%). Huber-White standard errors are in parentheses.

The construction sector shows a significant drop in both total earnings and earnings per worker during the 1981-91 bust. These results would seem to agree with the study of Mansell and Percy (1990), which suggests that the bust was rather severe in the Western province of Alberta during the 1980s, especially within the construction industry. While the drop in earnings per worker is also shown for retail trade and for services, it is only statistically significant in the later and neither of their magnitudes match that of construction. Construction also appears to show a drop in employment during the bust but it is not statistically significant. In contrast, the other two local industries show gains in employment at this time. So altogether, the local industries seem to be negatively impacted more in terms of earnings than in employment during the bust.

The traded goods sector is represented by manufacturing. Given that manufactured goods can be traded internationally, its labor should not feel the localized effects of energy price shocks as found in the energy extraction and local goods sectors. That said, jobs in manufacturing may require a similar skill-level to energy extraction, and crowding out may occur. In a boom, rapid gains in jobs and their earnings in energy extraction may mean less of these gains in manufacturing, and in a bust, losses or stagnation in energy extraction could lead to gains in manufacturing jobs and earnings. Table 2c shows these results for manufacturing. No crowd out appears to be happening during the first boom between energy extraction and manufacturing, as the differential gains are positive and large for manufacturing, although not as large as the gains for energy extraction. However, given that manufacturing exhibits gains in total earnings as well as in earnings per worker during the bust, which was not occurring amongst the local good industries, this may imply some form of crowd out. The same could possibly be said for employment in manufacturing during the second boom, as large gains in jobs were happening in energy extraction at this time, while no statistically significant gains are happening in manufacturing.

Table 2c: Differential Growth in Employment and Earnings for All Traded Goods Industries Between Treatment and Comparison Areas, 1971-2006

All Traded Goods Log changes in (Treat - Comparison)	First Boom 1971 to 1981	First Bust 1981 to 1991	Second Boom 1996 to 2006	Generalized Boom 71-81 & 96-06
Manufacturing:				
Total Employment	0.360**	0.184	0.092	0.172
	(0.151)	(0.125)	(0.070)	(0.113)
Total Earnings	0.680***	0.277**	0.248***	0.435***
	(0.244)	(0.124)	(0.085)	(0.156)
Earnings per worker	0.323***	0.092**	0.156***	0.264***
	(0.098)	(0.044)	(0.041)	(0.057)
n	70	70	74	140

Notes: Author's calculations of 1971, 1981, 1991, 1996, and 2006 Canadian Census data. All regressions control for provincial fixed effects (AB is the omitted province). Stars denote the statistical significance of the estimates (* for 10%, ** for 5%, and *** for 1%). Huber-White standard errors are in parentheses.

4.3 Differential Changes in the Population

Labor outcomes have been examined in the previous sections without explicitly considering changes to the population that may also occur to these areas. This is now remedied by looking specifically at these changes. Migration into or out of a Census division may play a role in some of the effects found for employment and earnings during the booms and bust. A positive demand shock of a boom would most likely be associated with immigration to energy areas due to the expanded employment opportunities and higher relative earnings. A negative demand shock of a bust may cause emigration from energy areas as jobs disappear and wages fall.

For this analysis, the population is segmented into 10-year initial age groups ranging from 15-24 to 45-54 years of age. For any given boom or bust, the estimate for the first group will be the differential growth of those aged 15-24 in the base period, as they age together to ten years later when they are aged 25-34. The second, third, and fourth age groups work in the same manner, from the initial age bands of 25-34, 35-44, and 45-54 to the age bands of 35-44, 45-54, and 55-64 respectively. The initial specification for the differential effects from equation (1) is used for this measurement, and the differential changes in the logged age groups are displayed in Table 3.

For the first boom from 1971 to 1981, the coefficients on the youngest two age groups are positive, implying that these age groups grew differentially between treatment and comparison Census divisions. Within the same period, there are negative coefficients for the oldest two age groups, meaning that these groups decreased more within the treatment areas. This pattern is repeated for the second boom from 1996 to 2006. However, none of those sets of changes are close to being statistically significant, with the exception of the decrease in the eldest age group for the second boom which is almost significant at the ten percent level. It is somewhat surprising that the differential growth of the younger populations during these boom periods is not statistically significant, because these younger age groups were thought of as the most likely to relocate to energy areas to take advantage of boom opportunities, a priori. These results do not necessarily imply that migration did not occur, because the populations of both the treatment and comparison areas did grow during these booms. Rather, they only suggest that the populations of these age groups did not grow differentially between the two area types during these time periods.

For the bust from 1981 to 1991, the second and third age groups exhibited statistically significant, differential declines of 7.3 percent each between the treatment and comparison areas. The oldest age group, which began as 45-54 year olds in the base period, is found to significantly decrease by 13.9 percent. These differential population declines among the majority of working age individuals are in-line with the expectations of a bust. However, these population declines do not coincide with significant employment losses, as employment was shown earlier in the paper to be

Table 3: Differential Growth in Population Across Age Groups Between Treatment and Comparison Areas, 1971-2006

Age Groups Log changes in (Treat - Comparison)	First Boom 1971 to 1981	First Bust 1981 to 1991	Second Boom 1996 to 2006
Aged 15-24 (to 25-34)	0.004	-0.021	0.020
	(0.322)	(0.046)	(0.053)
Aged 25-34 (to 35-44)	0.003	-0.073**	0.040
	(0.284)	(0.029)	(0.032)
Aged 35-44 (to 45-54)	-0.016	-0.073**	-0.008
	(0.251)	(0.029)	(0.026)
Aged 45-54 (to 55-64)	-0.077	-0.139***	-0.037
	(0.315)	(0.032)	(0.024)
n	70	70	74

Notes: Author's calculations of 1971, 1981, 1991, 1996, and 2006 Canadian Census data. All regressions control for provincial fixed effects (AB is the omitted province). Stars denote the statistical significance of the estimates (* for 10%, ** for 5%, and *** for 1%). Huber-White standard errors are in parentheses.

unchanged or even increasing during this time. This could imply that the population losses are concentrated among those unemployed or already detached from the labor force. The larger decline amongst the eldest cohort may also reflect more retirement transitions away from energy areas than from non-energy areas.

4.4 Local Job Multipliers for the Boom Periods

In order to truly ascertain the magnitude of the employment spillovers from the energy extraction to the non-energy extraction sectors, a better identification strategy needs to be used to specifically measure the local job multiplier effects. This estimation strategy is provided by the work of Black, McKinnish, and Sanders (2005) and of Moretti (2010). In what follows, the bust period from 1981 to 1991 is no longer analyzed, because no significant job destruction within the energy extraction sector was exhibited, so no there would be no significant spillovers to estimate. Therefore, the following form of regression is only run for each of the booms independently, and then over both of the booms at the same time for the generalized boom effect:

$$\Delta ln(Emp_{cp}^{NE}) = \alpha + \beta \cdot [\Delta ln(Emp_{cp}^{EE}) \cdot (Emp_{cpt-1}^{EE}/Emp_{cpt-1}^{NE})] + \varepsilon_{cp} \tag{2}$$

where Emp_{cp}^{NE} is the total employment in the specific non-energy extraction sector, Emp_{cp}^{EE} is total employment in the energy extraction sector, and $(Emp_{cpt-1}^{EE}/Emp_{cpt-1}^{NE})$ is the ratio of energy extraction sector employment to the specific non-energy extraction sector employment in the base year. This base employment ratio allows the coefficient, β, to be interpreted as the number of jobs created (or lost) in a specific non-energy sector for every energy sector job created during a boom period. The variable $Treat$ is used here to instrument for the combined independent variable, so that the identified job multiplier effect is only that which is coming through the instrument. The subscripts c and p refer to Census division and province respectively.

Table 4a: Local Job Multipliers with Treatment as IV for the Boom Periods, 1971-2006

Local and Traded Goods Log changes in (with Treat as IV)	First Boom 1971 to 1981	Second Boom 1996 to 2006	Generalized Boom 71-81 & 96-06
All Local Goods:			
Construction	0.122	0.401**	0.287*
	(0.145)	(0.154)	(0.147)
	[35.26]	[33.45]	[34.62]
Retail Trade	0.171***	0.219**	0.200**
	(0.057)	(0.105)	(0.092)
	[39.23]	[24.80]	[39.56]
All Services	0.357**	0.707**	0.459**
	(0.160)	(0.279)	(0.194)
	[51.98]	[33.45]	[48.22]
All Traded Goods:			
Manufacturing	-0.000	0.094	-0.000
	(0.042)	(0.059)	(0.057)
	[25.23]	[20.04]	[33.09]
n	54	64	114

Notes: Author's calculations of 1971, 1981, 1991, 1996, and 2006 Canadian Census data. Stars denote the statistical significance of the estimates (* for 10%, ** for 5%, and *** for 1%). Huber-White standard errors are in parentheses. First-stage F-statistics are in brackets. Comparison areas with zero employment in energy extraction are automatically dropped from the regressions.

Table 4a displays the results of the local job multipliers for the 1971-1981 boom, the 1996-2006 boom, and the generalized effect of the two booms. These spillover effects in employment are shown for the local goods sectors of construction, retail trade, and services, as well as the traded goods sector of manufacturing. Overall, there is modest job creation in each of the local goods sectors attributed to jobs created in the energy extraction sector during each of the booms. The IV estimates for the 1971-81 boom state that for every ten jobs created in the energy sector, 1.2 jobs were created in construction (though this effect is insignificant), 1.7 jobs were created in retail, and 3.6 service jobs were created. For the 1996-06 boom, every ten energy extraction jobs created translated to 4.0 additional construction jobs, 2.2 additional retail trade jobs, and 7.1 additional service jobs. No spillover job creation or destruction was exhibited for manufacturing in either boom, indicating no significant crowd out in employment with the energy extraction sector. The generalized effects suggest for every ten energy extraction jobs created, 2.9 construction jobs were created, 2.0 retail trade jobs were created, and 4.6 service jobs were created. Overall, the magnitudes of these local multipliers lie between those based on coal extraction, as shown by Black, McKinnish, and Sanders (2005), and those based on manufacturing, as shown by Moretti (2010).

The robustness of these local job multiplier estimates is now considered using an alternative specification. The previous comparison group was defined as those Census divisions which generate less than five percent of their total earnings from the energy extraction sector in the base period, do not exceed ten percent of their total earnings from energy extraction in any of the post-periods, and are not major cities containing more than 250,000 inhabitants. In addition to the previous definition, comparison Census divisions which directly neighbor the treatment areas are now also dropped from the analysis. Some of these neighboring areas may actually have little to none of their total earnings coming from the energy extraction sector. However, given that this study focuses on sector spillovers rather than geographical spillovers, it is important to eliminate any possible geographical impact in order to test the sensitivity of the estimates in the main specification. This alternative specification means that a larger amount of Census divisions are dropped from the analysis and that less Census divisions now form the comparison group. For the 1971 to 1981 boom, ten more areas are now dropped from the analysis. For the 1996 to 2006 boom, thirteen areas are additional dropped. The treatment group remains unaltered.

Table 4b again displays the results of the local job multipliers for each of the boom periods, 1971-1981 and 1996-2006, as well as their generalized effect, but instead it uses this more restrictive comparison group. It should first be noted that the first stage F-statistics are somewhat lower under this specification. Interestingly, the overall multiplier results are shown to not change by much. However, there are some key differences to the estimates which should be highlighted. For example, the multiplier effect for retail trade in the second boom is now insignificant and of smaller magnitude. The multiplier for services in the second boom is also of lesser magnitude. In addition, the manufacturing multiplier is now shown to be significant in the second boom. The generalized boom effects across all local industries are shown to be slightly lower in magnitude and significance as compared with the previous specification, but the lack of any major changes indicates that the results of this paper are robust to the exclusion of neighboring areas.

Table 4b: Local Job Multipliers with Treatment as IV for the Boom Periods with an Alternative Comparison Group, 1971-2006

Local and Traded Goods Log changes in (with Alt. Treat as IV)	First Boom 1971 to 1981	Second Boom 1996 to 2006	Generalized Boom 71-81 & 96-06
All Local Goods:			
Construction	0.103	0.387**	0.256*
	(0.144)	(0.152)	(0.142)
	[30.08]	[25.82]	[29.08]
Retail Trade	0.156**	0.143	0.186*
	(0.060)	(0.111)	(0.096)
	[31.92]	[19.17]	[32.37]
All Services	0.343**	0.542**	0.434**
	(0.165)	(0.271)	(0.201)
	[42.43]	[25.09]	[39.58]
All Traded Goods:			
Manufacturing	-0.001	0.130**	0.001
	(0.042)	(0.063)	(0.057)
	[20.43]	[15.67]	[26.86]
n	45	51	95

Notes: Author's calculations of 1971, 1981, 1991, 1996, and 2006 Canadian Census data. Stars denote the statistical significance of the estimates (* for 10%, ** for 5%, and *** for 1%). Huber-White standard errors are in parentheses. First-stage F-statistics are in brackets. Comparison areas with zero employment in energy extraction are automatically dropped from the regressions.

5 Conclusion

This paper measures the local labor market impacts of energy boom and bust using a quasi-experimental methodology which has not been previously applied to the oil and natural gas sector in Canada. Each boom and bust in energy prices provides a positive or negative shock to labor demand that particularly affects the resource-rich geographical areas. Similar areas without energy resources serve as a proxy for the counter-factual: what would have occurred to the energy-rich areas in the absence of the boom or bust. The differential growth between these two area types is used to identify the impacts of these shocks upon Western Canadian local labor markets from 1971 to 2006.

The evidence presented in this paper shows that the direct impacts of each boom lead to substantial gains in total earnings and employment within energy extraction, while the bust period is one of stagnation for this industry. The indirect impacts to the employment and earnings of the non-energy sectors are smaller than that of energy extraction, but are still significant in both boom periods, and some even display growth in outcomes even during the bust period (with the exception of earnings per worker). Once these non-energy industries are disaggregated into several local sectors and a traded sector, further clarity is brought to the story.

The local industries of construction, retail trade, and services all show similar significant gains in total employment and earnings in the first boom, with the gains being significant but smaller during the second boom. That said, gains in earnings per worker are greater for the second boom than for the first. During the bust period, all of these local industries experience a loss in earnings per worker. A significant drop in total earnings for construction and small employment gains for retail and services are also shown during this period. For the traded goods industry represented by manufacturing, significant gains are reported for both booms in both earnings measures but they are smaller in magnitude than those gains shown for each of the local industries. During the bust, these gains in total earnings and earnings per worker continue for manufacturing, indicating that individuals skilled in energy extraction may be finding a place in manufacturing during the bust.

Job creation in the energy extraction sector is found to exhibit modest positive spillovers into local sectors such as construction, retail, and especially services during each boom period. Remarkably, the job multiplier estimates for each boom period were similar in magnitude or greater for the second boom, even though the first boom exhibited larger changes in energy extraction employment than the second boom. The generalized boom estimates indicate that for every ten energy extraction jobs created, a boom period creates roughly three construction jobs, two retail trade jobs, and four and a half service jobs.

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Table A1a: Census Divisions within the Treatment Group, 1971-1991

Rank	CD No.	Province	Main City / Town	Fraction of Total Earnings from Energy Extraction
1	4818	AB	Grande Cache	0.391
2	4816	AB	Fort McMurray	0.323
3	4809	AB	Rocky Mountain House	0.195
4	4815	AB	Banff	0.171
5	4701	SK	Estevan	0.141
6	4814	AB	Edson	0.114
7	4817	AB	Slave Lake	0.111
8	5901	BC	East Kootenay	0.095

Notes: Author's calculations based on 1971 Census data using the 1991 Census division boundaries. The eighth ranked Census division listed above is rounded into the treatment group.

Table A1b: Census Divisions within the Treatment Group, 1996-2006

Rank	CD No.	Province	Main City / Town	Fraction of Total Earnings from Energy Extraction
1	4816	AB	Fort McMurray	0.560
2	4818	AB	Grande Cache	0.411
3	4809	AB	Rocky Mountain House	0.267
4	4814	AB	Edson	0.264
5	4807	AB	Stettler	0.196
6	5955	BC	Peace River	0.177
7	4701	SK	Estevan	0.177
8	4713	SK	Kindersley	0.167
9	4717	SK	Lloydminster	0.158
10	5901	BC	East Kootenay	0.154
11	4817	AB	Slave Lake	0.144
12	4804	AB	Hanna	0.139
13	4812	AB	St. Paul	0.122
14	4808	AB	Red Deer	0.121
15	4819	AB	Grande Prairie	0.108
16	4813	AB	Athabasca	0.105
17	4801	AB	Medicine Hat	0.103

Notes: Author's calculations based on 1996 Census data using the 2006 Census division boundaries.