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Abstract
Tight labor markets driven by resource booms could increase the opportunity cost of schooling and crowd out human capital formation. For oil-producing economies such as the Province of Alberta, the OPEC oil shocks during the period from 1973 to 1981 may have had an adverse long-term effect on the productivity of the labor force if the oil boom resulted in workers reducing their ultimate investment in human capital rather than merely altering the timing of schooling. The authors analyze the effect of this decade-long oil boom on the long-term human capital investments and productivity for Alberta birth cohorts that were of normal schooling ages before, during, and after the oil boom. Their findings suggest that resource booms may change the timing of schooling but they do not reduce the total accumulation of human capital.

Keywords
post-secondary enrollment, natural resource booms

LONG-TERM CONSEQUENCES OF NATURAL RESOURCE BOOMS FOR HUMAN CAPITAL ACCUMULATION

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Tight labor markets driven by resource booms could increase the opportunity cost of schooling and crowd out human capital formation. For oil-producing economies such as the Province of Alberta, the OPEC oil shocks during the period from 1973 to 1981 may have had an adverse long-term effect on the productivity of the labor force if the oil boom resulted in workers reducing their ultimate investment in human capital rather than merely altering the timing of schooling. The authors analyze the effect of this decade-long oil boom on the long-term human capital investments and productivity for Alberta birth cohorts that were of normal schooling ages before, during, and after the oil boom. Their findings suggest that resource booms may change the timing of schooling but they do not reduce the total accumulation of human capital.

Does natural resource wealth reduce future income levels by crowding out human capital formation? Standard models of human capital acquisition predict that a decline in the relative skill premium will induce individuals to leave school since the opportunity cost of schooling rises. This effect may be even more pronounced in the case of resource booms. Because resource industries traditionally employ low-skilled workers, high wages arising from resource booms may crowd out human capital formation by pulling young individuals out of school. Although evidence to date shows that resource booms reduce school enrollment, this may or may not imply long-run problems. Whether problems arise depends on if the short-run reduction in enrollment reflects permanently lower levels of school attainment, a mere interruption to schooling that does not change ultimate educational attainment, or access to a source of finance that could ultimately lead to higher levels of schooling. We explore the long-term effects on human capital formation of natural resource booms using the Alberta 1973 to 1981 oil boom. The 1973 to 1981 OPEC oil crises generated high prices

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Copies of the data and computer programs used to generate the results presented in the article are available from Ana Ferrer at aferrer@ucalgary.ca.

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for the oil that could be extracted in Alberta, which created a period of rapid growth both in wages and employment in Alberta relative to the rest of Canada.[1]

A series of papers investigate the immediate impact of resource booms and changes in labor market conditions more generally on education choices in developed economies. Black, McKinnish, and Sanders (2005b) examine the impact of the 1973 OPEC oil crisis on coal prices in two coal mining states in the United States. The oil embargo created a prolonged boom in the coal industry that increased the opportunity cost of education among low-skill youth in these states. Black et al.'s analysis of the effect of changes in skill premia on high school enrollment during the boom and subsequent crash suggests that persistent shocks to skilled wage differentials substantially reduce high school enrollment. Several studies have looked at the effect of economic conditions in general and unemployment rates in particular on high school drop-out rates. Although earlier studies by Duncan (1965) and Rumberger (1983) found contradictory evidence in this regard, a general consensus has emerged that favorable economic conditions reduce high school enrollment (Neumark and Wascher 1996; Rees and Mocan 1997; Beaudry, Lemieux, and Parent 2000) and high school completions (Goldin and Katz 1998).

Whether sharp changes in short-run economic conditions have longer term impacts on educational outcomes, however, remains an open question.[2] On first consideration, it appears that large, sudden changes in the price of natural resources will have long-term impacts on education by raising the opportunity cost of schooling. This, in fact, is one of the claimed channels for "resource curses."[3] That short- and long-run outcomes might diverge, though, gains credibility when one considers the literature that shows transitory resource booms do not appear to have permanent effects on labor market outcomes. Carrington (1996) investigates the adjustment of the Alaskan labor market between 1974 and 1977 when the Trans-Alaska Pipeline was under construction. He finds that flexible wages and elastic labor supplies implied that this particular short-run demand shock had no long-run impacts. Coe and Emery (2004), using wage data for 13 Canadian cities that span the oil price shocks of the 1970s and 1980s, find no evidence that regional labor demand shocks result in permanent changes in relative real wages across provincial labor markets in Canada for building trades. As Card and Lemieux (2001) suggest, given that people can go back to school

[1]That resource booms may affect human capital investment in Alberta seems supported by casual observation: in Alberta, males are opting to "drop out" of high school to work in the oil patch during the recent boom. Howell in *Calgary Herald*, April 23, 2006, and Valpy in *Globe and Mail*, July 29, 2008.

[2]Other types of short-run shocks (e.g., famines or war) are likely to have long-lasting effects (Meng and Qian 2009).

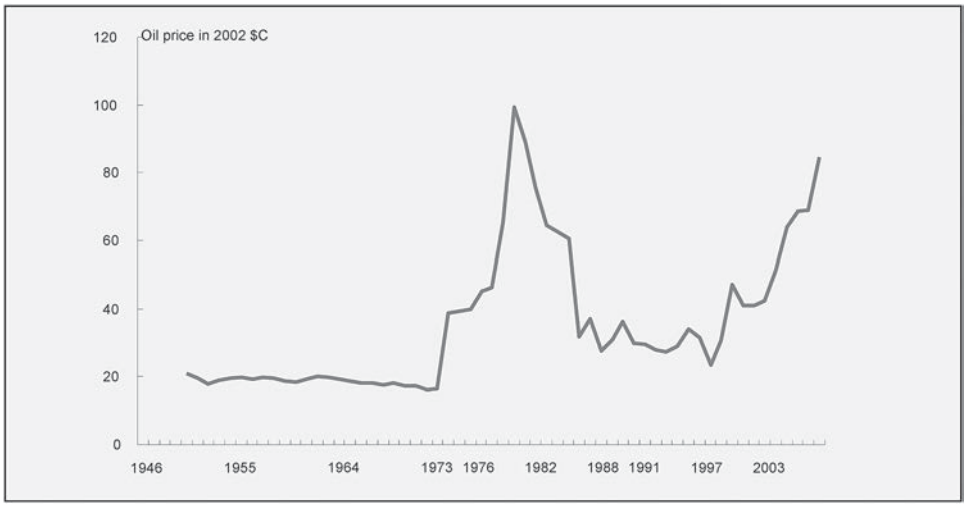
[3]Gylfason, Herbertsson, and Zoega (1999) and Gylfason (2001) argue that low growth and income levels in resource-abundant economies could be due to low human capital accumulation. They observe that public expenditures on school and school enrollment rates are inversely related to natural resource abundance.

later in life, these temporary shocks may not have an effect on ultimate educational choices. Moreover, in a world in which students face financial constraints on educational investment, a temporary resource boom could allow some individuals to finance more education than would otherwise have been possible for them. In that case, we could observe short-run reductions in enrollment as the individuals work during the resource boom to accumulate savings, but longer term increases in educational outcomes relative to the counterfactual case with no resource boom.

In this article, we use the same resource boom episode as Carrington (1996) and Black, McKinnish, and Sanders (2005b) (the 1970s oil crises) to explore the impact of a resource boom on long-run educational outcomes. Our focus is on education outcomes in the province of Alberta, which has the large majority of Canada's oil reserves. Our analysis differs from that in Black et al. (2005a,b) primarily because we focus on impacts on ultimate educational attainment as measured by levels of school completion rather than on immediate impacts on enrollment. Further, the possibility of returning to school after the boom also changes the focus of our analysis from high school related outcomes (e.g., enrollment and graduation rates) to higher levels of educational attainment. Once we consider the possibility that earnings in a resource boom could be used to finance postsecondary education, the impact of the boom on high school graduation rates becomes complex. Hence, considering not only people who are at the margin of graduating or not graduating from high school but also people who may have decided not to continue on to postsecondary education at the time of the boom is of interest. Indeed, our main results show that more males dropped out of high school during the boom but that the proportion attending postsecondary education also fell, implying that the proportion listing their highest level of education as "high school graduate" at the time did not change. Only by considering higher levels of educational attainment can we make sense of the apparent lack of response in high school graduation to the boom.

We use a variety of data to assess the human capital accumulation of the cohorts of Albertans most affected by the oil boom. The 2003 International Adult Literacy Survey (IALS) allows us to look at the schooling attainment and literacy achievement of these cohorts compared with the rest of Canada. The IALS offers an in-depth look into skills accumulation because of the inclusion of a direct measure of cognitive skills through literacy tests. Moreover, the IALS includes a question on where the individual attended high school, which is very useful for our investigation. We also use Canadian Census data to construct synthetic cohorts that we follow to track the evolution of their schooling achievement over the years and to assess the long-term consequences of the oil boom. Overall, our results indicate that resource booms may change the timing of human capital accumulation, but they do not have negative consequences on ultimate levels of schooling. If anything, it appears that resource busts are the problem for resource-

Figure 1. World Oil Prices



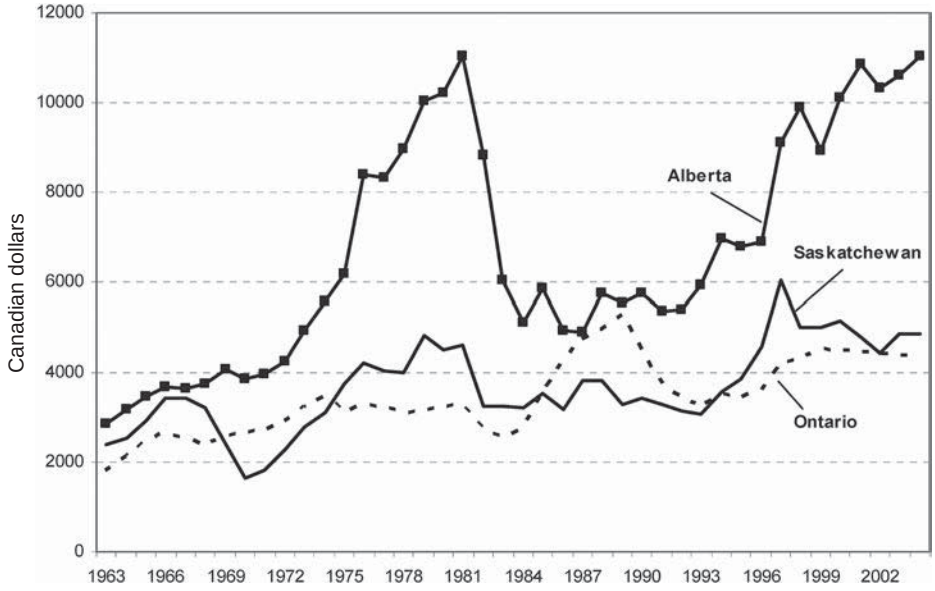
Sources: Price per barrel for 1947 to 1975 calculated from Historical Statistics of Canada, "Quantity of Crude Petroleum Produced, thousands of barrels," Series Q19 and "Value of Crude Petroleum Produced, thousands of dollars," Series Q20, available at http://www.statcan.gc.ca/pub/11-516-x/sectionq/4057756-eng.htm. Price per barrel for the period 1970 to 2009 from Crude Oil, $/barrel at Edmonton, Energy in Canada, Natural Resources Canada; available at http://nrcan.gc.ca/eneene/sources/pripri/crubru07-eng.php. The GDP price deflator, 2002 = 100 to convert current dollars to 2002 purchasing power is from CANSIM (v1997756) for 1961 to the present. The deflator values for 1947 to 1960 are from Historical Canadian Macroeconomics Dataset; available at http://library.queensu.ca/webdoc/ssdc/HistoricalMacroEconomicData.

abundant economies as we find that following the collapse of oil prices, human capital formation in Alberta fell behind that of the rest of Canada.

The Alberta Oil Boom

During the 1970s, world oil prices increased as a result of what have been called the first and second OPEC oil crises (Figure 1). In 2002 purchasing power terms, the price of crude oil increased from $16 per barrel in 1972 to $99 per barrel in 1980. Prices started to fall after 1981 reaching $75 per barrel in 1982, and $60 per barrel in 1985. World oil prices collapsed to $30 per barrel in 1986 when OPEC's pricing agreement unwound. In Canada, the decline in oil prices was accentuated by the federal government's National Energy Program (NEP), introduced in 1982. The NEP was an attempt to shield consumers and the Canadian manufacturing sector from the effects of higher oil prices, effectively sharing the resource rents from Alberta oil with the rest of the country. To do this, under the NEP the price of oil in Canada was mandated to be half of the world price (Emery 2006). This policy was not implemented until after world oil prices were declining, which reflected lags in policymaking.

Figure 2. Per Capita Private Sector Investment: Saskatchewan, Alberta, and Ontario (1992 dollars)



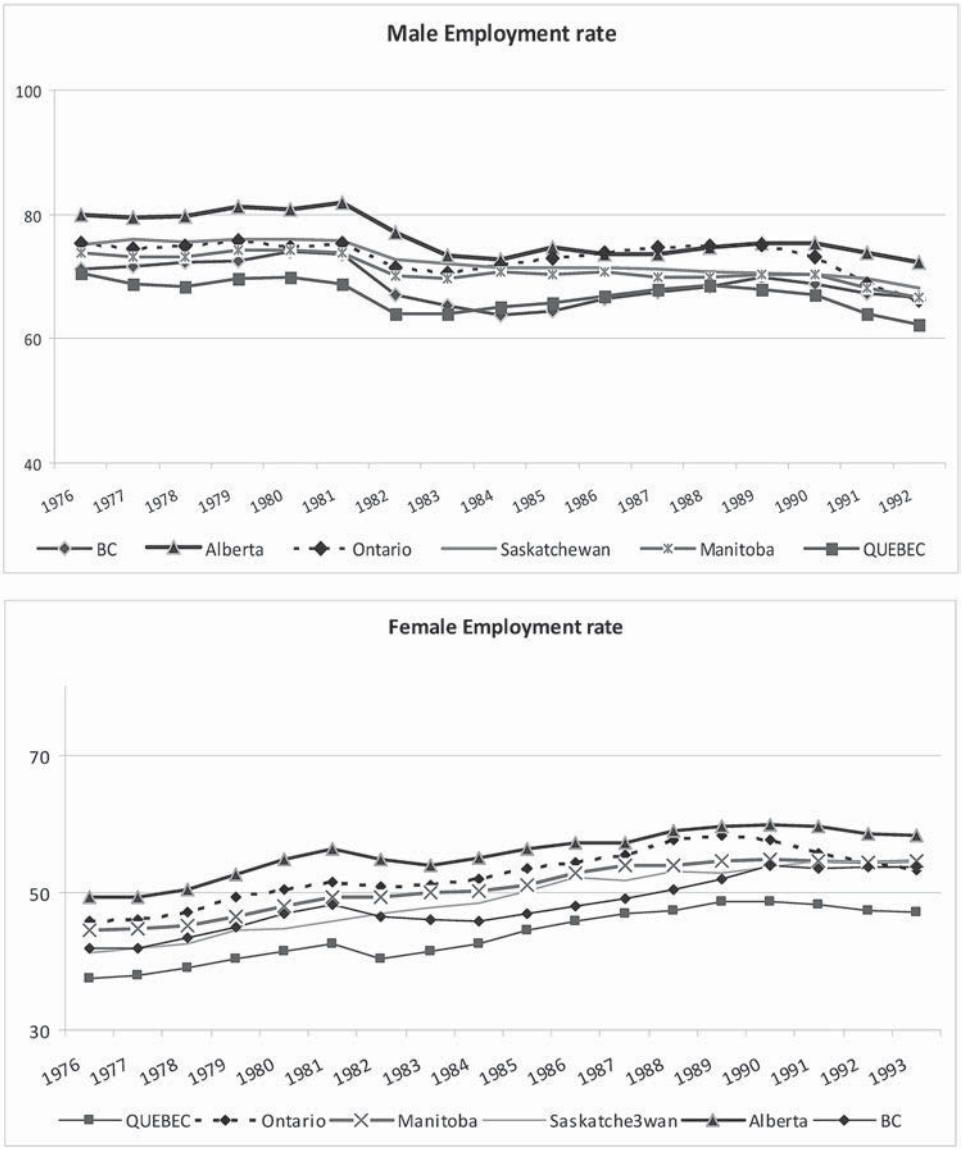
Sources: Capital Expenditures, Total Private Investment, 1963–1990: CANSIM v50545, v50326, v49778. Capital Expenditures, Private, 1991–2004: CANSIM v759375, v759368, v759354. Population: CANSIM v469503, v469188, v468558. Consumer Price Index, all-items, Canada: CANSIM v737344.

That the boom in the economy of Alberta during the 1970s and early 1980s, and then its subsequent bust, resulted in dramatic changes in its labor market and incomes relative to the rest of Canada and the other western Canadian provinces has been well documented.[4] One reason the oil boom was particularly influential for Alberta was the level of investment that followed the rising oil price. As Figure 2 shows, at the height of the oil boom, on a per capita basis, investment expenditures in Alberta were more than double those in Ontario and the neighboring province of Saskatchewan. With falling oil prices after 1980, the announcement of the NEP and a sharp recession, investment in Alberta plummeted back to the per capita levels of the other provinces.

The boom translated into increasing employment opportunities in Alberta relative to the rest of Canada, particularly for males (see Figure 3). Employment rates in Alberta for males aged 16 and over were over 80% during the late 1970s until 1981—6 percentage points higher than Ontario,

[4]See Emery (2006) and Emery and Kneebone (2008). Mansell and Percy (1990) showed that the boom and bust conditions in Alberta were more pronounced than in the rest of Canada and in comparison with oil-producing states in the United States. Alberta accounts for nearly 80% of Canada's oil production and even today, Alberta remains remarkably dependent on energy exports compared with the other provinces. In 2009, exports from Alberta were 40% of the provincial GDP, two-thirds from mining and oil and gas extraction. Over 80% of these exports go to the United States (The Canada West Foundation [2010, chapters 10 and 11], accessed at http://cwf.ca/CustomContentRetrieve.aspx?ID=1207055).

Figure 3. Employment Rates by Province, 1976–1992



Source: CANSIM series v2461476, v2467987.

which had the next highest employment rate. By 1983 the employment rate in Alberta was at a level similar to that found in Ontario. Employment rates for females were higher than in the rest of Canada as well, but they remained higher after the boom, suggesting that this is part of a long-term pattern rather than an effect of the boom (Figure 3).[5] Figure 4 shows that personal

[5]The increased pressure on labor demand in Alberta was not restricted to the oil and gas sector. Construction, for instance, was also a major contributor to the upward wage movements in the boom economy (Mansell and Percy 1990).

Figure 4. Personal Income Per Capita Relative to the Canadian Average, 1946–2004

Sources: Personal Income Per Person 1946–1980; Average Personal Income: *Economic Reference Tables* (1991), Published by Government of Canada, Department of Finance (Table 16). Personal Incomes Per Person 1981–2004 from CANSIM Table 3840013; Canada, CANSIM II SERIES v691802, Manitoba, CANSIM II SERIES v691963, Saskatchewan, CANSIM II SERIES v691986, Alberta, CANSIM II SERIES v692009.

Note: Provincial incomes are divided by the value of Canada in a given year.

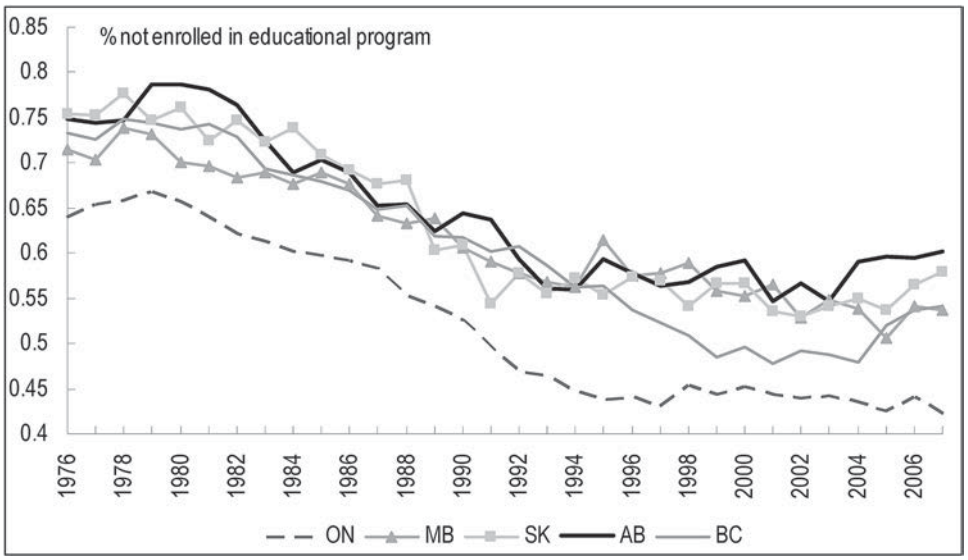
incomes in Alberta increased relative to the Canadian average and in comparison with the other prairie provinces of Manitoba and Saskatchewan. Reflecting the collapse of oil prices and investment spending in Alberta after 1980, the income advantage of Alberta relative to the other provinces was gone by the mid-1980s.[6]

We are interested in the impact of this boom on postsecondary education trends. In Canada, students complete school after 12 grades, which for the most part are publicly funded.[7] Since 1954, all provinces set the minimum age for leaving school at 15 or 16 (Oreopoulos 2006). After the basic 12 years of education, provinces have similar postsecondary education systems that comprise technical/vocational colleges and universities. In Figure 5, we

[6]Weekly wages were also higher in Alberta. Figure 4 in Emery, Ferrer, and Green (2011) shows weekly wages in Medicine Hat (Alberta) and two other similar sized towns, one in Saskatchewan (Prince Albert) and the other in Ontario (Pembroke). Medicine Hat weekly wages spike during the oil boom relative to the other two cities. This is particularly striking in the comparison with Prince Albert since Saskatchewan is a province adjacent to Alberta and, apart from the oil boom, the two provinces share many similarities.

[7]The exceptions are Quebec, where high school ended at grade 11, and Ontario prior to the 1990s, where students could graduate either after grade 12 or 13 (the latter being typical for those going on to university). Students in Quebec intending to attend university typically attend a preparatory college, CEGEP, which is a universally public-funded, two-year college program.

Figure 5. Percentage of Individuals 17 to 24 Years Old Not Enrolled in a Postsecondary Program



Source: Labour Force Survey (1976–2006).

present postsecondary enrollment rates by province. Two points are readily apparent from this figure. One, Alberta and the other western Canadian provinces (British Columbia, Saskatchewan, and Manitoba), which are all resource abundant, have persistently lower postsecondary enrollment rates compared with Ontario. Second, during the second OPEC oil price shock, 1978 to 1982, postsecondary enrollment in Alberta was lower than in the other western Canadian provinces. With the end of the boom after 1982, the level of enrollment in postsecondary education returned to a level comparable with the other western provinces.

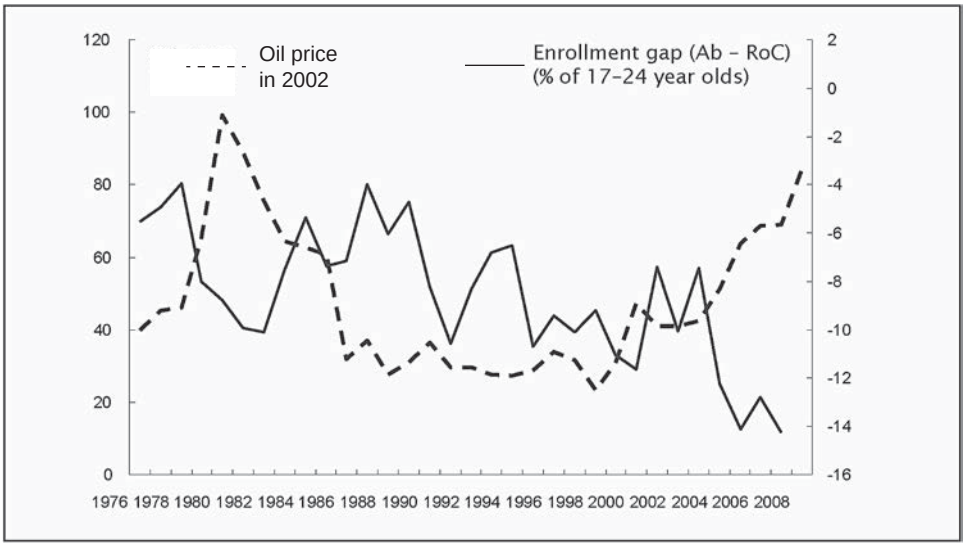
The negative relationship between postsecondary enrollment in Alberta and oil prices is made apparent in Figure 6, which shows oil prices on the left axis and the difference in postsecondary enrollment between Alberta and the rest of Canada on the right axis. In rough terms, the peaks of the oil price series correspond to the valleys in the enrollment gap, suggesting that, similar to the case of coal prices in the United States, Alberta's oil boom had an impact on enrollment rates.[8]

Data Description

The 2003 IALS is based on the Labour Force Survey (LFS, Canada's equivalent to the US CPS) sampling frame and contains both standard survey questions and the results of literacy tests completed by the respondents.

[8]The correlation coefficient is –0.28.

Figure 6. Oil Prices and the Enrollment Gap: Alberta and the Rest of Canada



Source: Authors' calculation using the Labor Force Survey and Historical Statistics of Canada, Series Q20. RoC includes Ontario, Manitoba, Saskatchewan, and British Columbia.

The literacy questions are designed to elicit competencies in cognitive tasks related to everyday life and work rather than being measures solely of whether a person can read. As such, they can be seen as providing measures of cognitive skills possessed by the respondent at the time of the survey. The literacy tests were administered on three domains (prose and document comprehension, numeracy, and problem solving). We use the average of the scores on the three domains of the tests as our measure of literacy.[9] A further advantage of the IALS is that in addition to province of birth, it identifies the province in which a respondent attended high school. This allows us to be more precise about the identification of cohorts that were affected by the Alberta oil boom specifically at the time they were making high school completion and postsecondary schooling decisions.

To measure long-term educational attainment in the IALS data, we use the highest degree attained. We also construct two rough measures of school interruption based on the average number of years that it takes to complete various degrees and the respondent's answer on when he or she was last in school. We define an indicator of "Interrupted Schooling–Completed Education" with a value of 1 if a person *obtained a degree* and was last in school at an age above the typical age at which a student would complete that degree if he or she were in school continuously. Similarly, we define an indicator of "Interrupted Schooling–Uncompleted Education" with a value of 1 if a person attended postsecondary schooling *without completing a degree* and was last

[9]The three measures are highly correlated. We use the average of the three measures to avoid multicollinearity issues, as in Green and Riddell (2003) and Ferrer, Green, and Riddell (2006).

in school at an age above the typical age to complete that degree. The reference category is to complete a postsecondary degree at the average time.

Despite the advantages of the IALS for defining the cohorts of interest and providing better measures of skill than are usually available, it has the disadvantage of being a relatively small, one-time, cross-sectional survey. Therefore, in addition to the IALS, we use data from six of the Canadian Censuses (1976, 1981, 1986, 1991, 1996, and 2001) to study the evolution of the educational attainment of the cohorts affected by the oil boom.[10] Census years are pooled together to construct a pseudo panel that follows birth cohorts over time. An additional advantage of the census is the larger number of observations.

The census reports province of birth rather than the province where the individual was in high school, and we use this variable together with age as the closest way to identify the cohorts affected by the Alberta oil boom.[11] The highest level of education achievement variable is defined in the same broad way as for the IALS data but we are able to take advantage of greater detail and sample size to create more refined educational categories. In particular, we are able to separate the nonuniversity postsecondary category into different levels based on years of postsecondary schooling (less than one year, 1 to 2 years, and 3 to 4 years). University degrees are all considered together as they involve a relatively small number of observations.[12]

We restrict the IALS sample to include non-Aboriginal, nonimmigrant individuals aged 16 to 55 who answer the relevant questions on educational attainment and province of high school. We eliminate Aboriginal respondents because many were involved in a separate education system, and we exclude immigrants to make sure we are following people actually affected by the boom. We truncate our sample at age 55 to avoid issues relating to early retirement. Our final sample from the IALS has 10,369 male and 12,412 female observations. Survey weights are used through the analysis. With census data, we similarly restrict the sample to include non-Aboriginal, Canadian-born individuals aged 16 to 55 for whom we have reported age, education, and province of birth.[13] The census sample has about 800,000 observations for each gender.

[10]Although the 1971 census is available, the questions on education are too different to construct measures comparable to census data for following years.

[11]The fraction of Alberta-born individuals who are younger than 19 and who reside in Alberta in a given census year (Electronic Appendix Table 2) is 85%, which is close to the 83.3% fraction of individuals born in Alberta who attended high school in Alberta, according to the IALS (Electronic Appendix Table 3). Therefore, the use of province of birth rather than province of attending age for high school to define the Boom cohort is not likely to largely influence our census results. Access https://webdisk.ucalgary.ca/~aferrer/the%20long%20term%20consequences%20of%20resource%20booms-appendix/Appendix.pdf for the electronic Appendix tables mentioned here and throughout article.

[12]Electronic Appendix Table 1 provides a comparison between the fractions of individuals in each education level across the two data sets.

[13]Educational categories correspond to the highest level of education attained (less than high school graduation, high school graduates, nonuniversity postsecondary graduates, and Bachelor's or higher university degree).

We define birth cohorts using 4-year groupings to ensure sufficient sample size in each cohort. Using the oil price changes discussed earlier and depicted in Figure 1, and the timing for when a given 4-year birth cohort would have been attending high school, we define six birth cohorts of interest:

1. The Pre-Boom cohort includes individuals born between 1953 and 1956 who turned 17 between 1970 and 1973.
2. The Early Boom cohort includes those born between 1957 and 1960 who turned 17 between 1974 and 1977 during the first OPEC oil shock.
3. The Boom cohort includes those born between1961 and 1964 who turned 17 between 1978 and 1981 during the second OPEC oil shock.
4. The Slow-Down cohort includes those born between 1965 and 1968 who turned 17 between 1982 and 1985 when the federal government set the Canadian price of oil at half of the world price.
5. The Collapse cohort includes those born between 1969 and 1972 who turned 17 between 1986 and 1989 when the OPEC price agreement collapsed.
6. The Post–oil shock cohort includes those born between 1973 and 1978 who turned 17 between 1990 and 1995 when oil prices remained low.

In addition to the birth cohorts of interest, we include a dummy for those born after 1978. Individuals born between 1942 and 1952 are also included in the sample as the reference group. We drop those born before 1942 to avoid changing the composition of the sample as these individuals age and retire.

The Long-Run Educational Attainment of the Alberta Oil Boom Cohorts

Evidence from the IALS

We begin by using the IALS data to examine differences in literacy and educational achievement for the cohort that attended high school in Alberta during the oil boom relative to the same birth cohort attending high school in the "rest of Canada." To provide context, Table 1 shows a cross-sectional snapshot of levels of school achievement and literacy levels for Alberta and the rest of Canada in 2003 (i.e., for all cohorts combined). According to these figures, Alberta males are not significantly different from males in the rest of Canada in terms of high school dropout or graduation rates. They are more likely to have nonuniversity postsecondary degrees than university degrees relative to those in the rest of Canada, and a higher fraction report some (unfinished) postsecondary education. Male literacy levels are generally higher in Alberta than in the rest of Canada. Among those with completed education, a similar fraction completed their degree after the average age of completion in Alberta and the rest of Canada; however, a higher fraction of Alberta males returned to (but did not finish) postsecondary school-

Table 1. Mean School Achievement by Province of High School

	Male		*Female*	
	Alberta	*Rest of Canada*	*Alberta*	*Rest of Canada*
		Percentages		
Less than high school	24.9	26.5	20.9	24.9*
High school	19.1	20.4	25.2	23.4
Some postsecondary	12.8	9.0*	10.9	9.1
Postsecondary	43.2	44.1	42.9	42.6
Non-University	26.4	21.3*	17.3	21.8*
University	16.8	22.8*	25.6	20.8*
Bachelor	14.5	16.3	20.7	17.1*
Graduate	2.3	6.5*	5.0	3.7
School interruption[a]				
Finished school late	54.0	52.6	47.6	49.1
Did not finish postsecondary	61.5	53.9*	54.2	52.9
Literacy		**Number of Observations**		
Average literacy	289	272*	286	264*
Document literacy	292	274*	289	267*
P literacy	287	270*	294	273*
Numeracy literacy	286	272*	275	253.7*
Problem-solving literacy	281	266*	283	263.7*
Observations	478	9,891	565	11,847

Source: Author's tabulations using the IALS data (2003).

[a]School interruption–Finished school late indicates that the respondent completed the degree after the average age the degree would be completed if school was taken continuously (18 for high school, 21 for non-university postsecondary, 23 for BA, and 25 for graduate degrees). School interruption–Uncompleted schooling includes those who did not finish a postsecondary degree.

*Indicates that the difference is statistically significant at 5%.

ing after the average age of completion (61.5% compared with 54% in the rest of Canada). The figures for females, in contrast, indicate that Albertan females are better educated than other Canadians. In particular, although Alberta females show similar overall levels of postsecondary education, a higher fraction have university education than in the rest of Canada.[14]

To investigate the long-term effect of the boom on educational attainment in Alberta, we perform a simple difference-in-difference (DD) exercise. We restrict our attention to only the Pre-Boom and Boom cohorts. This provides the cleanest measure since the remaining cohorts faced partial boom or bust conditions. Our specification is, then,

$$(1)\quad Ed.level_{icp} = \alpha_0 + \alpha_1 P_i + \alpha_2\, CohBoom_i + \alpha_3 \Sigma_p P_i \; x\; CohBoom_i + \alpha_4 X_{icp} + e_{icp}$$

where, i indexes individuals, c indexes cohort (Boom and Pre-Boom), and p indexes province. P is a vector of eight provinces of high school indicators (British Columbia, Alberta, Manitoba, Saskatchewan, Ontario, Quebec,

[14]This fact, although not well documented in the literature, fits with other descriptive statistics of female educational attainment in Alberta. Since the middle 1970s, Alberta females have been graduating from postsecondary education at a rate faster than in other provinces in Canada (CANSIM Table 4770006).

Maritimes—Nova Scotia, New Brunswick, Prince Edward Island, and Newfoundland—and the Northwest Territories), and *CohBoom* is an indicator corresponding to whether the individual belongs to the Boom cohort (born between 1961 and 1964). In some specifications we add a vector of individual characteristics (X) that includes mother's level of postsecondary education and whether the father worked when the respondent was 16 years old.

The province indicators control for other factors at the provincial level that may have affected educational attainment, whereas the boom indicator controls for changes in educational attainment specific to the Boom cohort. The interaction between the provinces and the Boom cohort reflect the changes in educational attainment that are specific to the cohort in that province.

Estimation of an equation such as (1) naturally raises issues about getting appropriate standard errors in the presence of clustering. Recent work has emphasized that simple clustering methods do not necessarily provide a solution when a small number of groups (province–cohorts in our case) are involved, even if the number of observations within a group is large (see Bertrand, Duflo, and Mullainathan [2004] and Donald and Lang [2007]). We follow Wooldridge (2003) and estimate Equation (1) using a linear probability model, in two steps.[15] First, we regress an indicator for an individual level education outcome (e.g., an indicator for whether the person dropped out of high school) on a complete set of province x cohort interaction dummy variables (in additional specifications we also include the individual characteristics). We obtain predicted education levels for all cohort–province interactions using the coefficients on the interaction dummies and setting the X vector variables to their mean values. We then run weighted least squares using these predicted levels as the dependent variable in the second step. This approach reduces the number of observations to the number of groups effectively available for estimation and provides conservative standard errors.[16] We perform the estimation with and without the individual covariates in the first stage to check the robustness of our results.[17] Since we consider only the Pre-Boom and Boom cohorts, we effectively use the approach suggested by Bertrand et al. (2004) to avoid issues related to serial correlation.

[15]We use a linear probability model to estimate education levels because, as we are aggregating data, the use of a nonlinear model would introduce additional correlation issues in the estimation. Results in Cameron and Trivedi (2005) indicate that using a linear probability model to estimate the probability of achieving a certain education level in Alberta during the boom is acceptable as long as we are not interested in individual level parameters.

[16]That is, eight provinces times two periods (16 observations).

[17]When we include individual level covariates in the first stage, the weights used in the second stage regression are the inverse of the variance of the predicted education levels obtained in the first step. Note that in the case in which there are no covariates ($X = 0$), the weights are the number of observations in the province–cohort cell, and the first step is reduced to computing the aggregate means by group. We actually go further and compute White robust standard errors in the second stage regression in order to account for potential heteroskedasticity of other types.

Table 2. Effect of Oil Shock on Education: Alberta and the Rest of Canada[a]

	Males		*Females*	
Variable	*(I)*	*(II)*	*(I)*	*(II)*
Dependent variable[b]				
Less than high school	–0.10	–0.06	–0.06	–0.02
	(0.12)	(0.11)	(0.12)	(0.10)
High school	–0.09	–0.07	–0.03	0.04
	(0.06)	(0.08)	(0.11)	(0.10)
Non-University	0.21**	0.22***	0.20	0.18
	(0.11)	(0.10)	(0.18)	(0.20)
University	0.11	–0.08	–0.01	–0.08
	(0.18)	(0.10)	(0.11)	(0.14)
Bachelor	0.12	0.06	–0.06	–0.13
	(0.14)	(0.08)	(0.10)	(0.11)
Graduate	–0.01	–0.09**	0.04	0.06
	(0.06)	(0.04)	(0.06)	(0.07)
Interruption–Completed postsecondary[c]	0.21	0.25	–0.14	–0.11
	(0.19)	(0.21)	(0.17)	(0.18)
Interruption–Uncompleted postsecondary[c]	0.46**	0.42**	–0.32	–0.32
	(0.24)	(0.21)	(0.25)	(0.24)
Literacy	24.81	15.74	9.56	1.88
	(26.31)	(21.12)	(35.05)	(24.13)
Observations	16			

Source: IALS (2003).

[a]Data are aggregated at the cohort–province level. Estimated using 2 step weighted least squares, where the weights are the mean number of observations in the relevant cohort-province cell. Robust standard errors in parentheses.

[b]Each row in column labeled (I) shows the coefficient of a difference-in-difference estimation of the effect of the boom (1961–1964) compared with the pre-boom cohort (1953–1956), in Alberta compared with the rest of Canada for the dependent variable listed in the first column. Column II adds indicators for foreign born, mother's postsecondary education, and for whether the father worked when respondent was 16 years old.

[c]School Interruption–Completed schooling indicates that the respondent completed the degree after the average age the degree would have been completed if school were taken continuously (18 for high school, 21 for nonuniversity postsecondary, 23 for BA, and 25 for graduate degrees). School Interruption–Uncompleted schooling includes those who did not finish a postsecondary degree.

*Indicates the coefficient is significant at 15%, **indicates the coefficient is significant at 10%, ***indicates the coefficient is significant at 5%.

The results from estimating Equation (1) are presented in Table 2. Each cell in the column labeled (I) corresponds to coefficient α_3, the coefficient on the interaction between belonging to the Boom cohort (1961–1964) and attending high school in Alberta in a regression in which the dependent variable is an indicator corresponding to the education level listed in the first column (i.e., an indicator that takes a value of one (1) for that outcome and zero (0) for all other educational outcomes). In column (II) we repeat the estimation adding other controls to the first step regression (mother's postsecondary education, and whether the father worked when the respondent was 16). With or without the controls, the difference-in-difference estimation indicates that high school and university degree completion was *not lower* among the Albertans of the Boom cohort. Rather, this group shows

significantly higher levels of completion in nonuniversity postsecondary education with the point estimates suggesting this is offset mainly by lower rates of high school dropping out and high school graduation. The latter effects, however, are not statistically significant. It would seem that the long-term school achievement of males in the Alberta Boom cohort did not decline when compared with previous cohorts. For females, the effect for the Boom cohort in most levels of education is much smaller than for males and never significant. This difference in the effects by gender fits with the idea that resource booms (particularly in the 1970s) should have a stronger effect on the returns to schooling for males than for females. This result also fits with other evidence that finds that tight labor-market conditions seem to affect young males more than young females (Parent 2006).

One advantage of the IALS data is that they provide a direct measure of cognitive skills through the literacy score. To check if there were any potential long-term effects on skill achievement as a result of the boom, we use the average literacy score as an additional outcome in Equation (1).[18] The results are presented in the last row of Table 2. The interactions between the indicator for graduating from high school in Alberta and indicators of birth cohort are never significant, though the point estimates for males are somewhat sizeable (being as large as 1/10th of the average literacy score). Of importance though, the estimated effects are positive. Thus, no evidence confirms that Alberta males who were about high school graduation age during the 1970s oil boom have lower levels of literacy skills than the rest of the Boom cohort in Canada.

One possibility that we pointed out in the introduction is that, for males, money earned during the boom could have been saved and used to fund postsecondary education during the ensuing bust. Although no information permits us to assess this possibility directly, we find some support for this hypothesis in estimates using as a dependent variable our measure of school interruption (i.e., an indicator for whether a person completed their highest level of education at an older age than is typical). Rows 8 and 9 of Table 2 show that males born in Alberta had a higher fraction of school interruptions, whereas females show less school interruption for the Boom cohort. In support of this idea, we have examined the distribution of age at graduation of postsecondary degrees (except for graduate degrees) for males and females of the Pre-Boom and Boom cohorts in Alberta (Figure 7a) and the rest of Canada (Figure 7b). A lower fraction of Alberta males graduated from postsecondary degrees before the normal age of 23 (indicated by the vertical line) in the Boom cohort versus the Pre-Boom cohort. In contrast, age at graduation of postsecondary degrees remains similar in the rest of Canada for the Pre-Boom and Boom cohorts. Females in Alberta and the rest of Canada, on the other hand, show similar levels of graduation from postsecondary degrees for the Boom and Pre-Boom cohorts.

[18]We estimate in two stages as before.

Figure 7a. Distribution of Age at Graduation of Postsecondary Degrees (except Graduate Degrees): Males in Alberta

Figure 7b. Distribution of Age at Graduation of Postsecondary Degrees (except Graduate Degrees): Males in the Rest of Canada

Source: Authors' calculations using the IALS.
Note: The 50-point estimate Epanechnikov kernel function with optimal width is used.

Evidence from Census Data

We turn now to the 1976 to 2001 Canadian censuses to investigate the level and evolution of school achievement of Alberta-born individuals who were young during the oil boom. The purpose of this analysis is twofold. First, it allows us to assess whether the timing of educational attainment for the Alberta oil Boom cohort differed from that of contemporaneous cohorts from other regions in Canada. Second, it offers a robustness check for our previous results, which are based on a one-time snapshot of the population and on a much smaller sample than the census. We use six census files from 1976 to 2001 to follow the various cohorts.[19] The Canadian Census is conducted every five years, which lets us identify the cohorts at the peak of the boom (1980 and 1985) and follow them at five-year intervals. By the time of the 2001 census, the boom-affected cohorts are in their late 30s and are likely to have completed their educational process.

We estimate a parsimonious model of school attainment, where education is a function of the interaction of cohort indicators and census year indicators (Yr_t). We also include an indicator for Alberta born (AB), and the interaction of cohort, census year indicators, and the Alberta-born indicator.[20] As before, we aggregate the data to the cohort–province–year level to avoid issues relating to clustering of standard errors with small numbers of groups. In this case, since the census does not provide information about individual characteristics that we can use in determining education levels, we simply compute the group cell means and use weighted least squares, with the weights being the number of observations in the relevant data cell.

$$E_{pjt} = \beta_0 + \beta_1 \sum_j \sum_t C_j Yr_t \text{'} + \beta_3 \sum_j \sum_t C_j Yr_t \text{'}* AB + \beta_4 AB + \beta_5 \sum_t Yr_i + \beta_6 \sum_j C_j + \varepsilon_{pjt} \quad (2)$$

where j corresponds to the specified cohorts (Pre-Boom, Early Boom, Boom, Slow-Down, Collapse, Post-oil shock) plus the groups born before and after these, t corresponds to the six survey years, and p corresponds to the province (Alberta or the rest of Canada). The year indicators control for trends in the educational levels over time, the province indicator controls for

[19]Because province of birth is not provided in the 1976 census year, we use province of residence instead for that year. We find no evidence that there were substantial changes in mobility rates between province of birth and province of residence across censuses. Eighty-five percent of young individuals (up to 24 years of age) reside in the province of birth. See Electronic Appendix Table 1 and footnote 9.

[20]Note that not all cohorts are present in every year of the census. There are 6 census years, 8 cohorts, and 2 regions (Alberta and the rest of Canada). In each region, the omitted cohort (i.e., those born between 1942 and 1952), Pre-Boom, and Early Boom cohort can be observed in each of the census years (36 groups) The Boom and Slow-Down cohort are observed for 5 census years (20 groups), the Collapse cohort is observed for 4 census years (8 groups), the Post–oil shock cohort during 3 census years (6 groups), and those born after 1978 are observed for 2 census years (4 observations), bringing the number of cell groups to 74.

permanent differences between Alberta and the rest of Canada, and the year x cohort interactions account for changes in educational attainment that are specific to each cohort as it ages. The parameters of interest are those contained in the $t \times j$ matrix β_3.

We estimate Equation (2) using a linear probability model (see footnote 13) and provide estimates of the difference between Alberta-born cohorts and the rest of Canada cohorts.[21] The full set of estimates can be found in Tables 3a and 3b (for males and females, respectively).[22]

If human capital formation is adversely influenced by natural resource booms then we should see that during the period of high oil prices, young Albertans had lower educational attainment than comparable individuals outside of Alberta, with those differences persisting later in life. Conversely, in the low oil price period, Alberta teenagers should be making similar educational choices to those made by their cohort elsewhere in the country. In contrast, if human capital formation is improved by resource booms then we should see Albertans of school age during the boom ultimately attaining higher levels of human capital, and Albertans of school age when prices fall not faring as well.

Table 3a shows the coefficients for males of the Alberta-cohort indicators in six regressions, each with a different education attainment level as the dependent variable (high school dropouts, high school graduates, 1 year of postsecondary education, 2 years of postsecondary education, 3 to 4 years of postsecondary education, and university education). To parse out the apparent impact of the resource boom, we will focus our attention on three broad groups of cohorts: Pre-Boom, Boom (including what we have called the Early Boom and Boom cohorts), and Post-Boom.

For the Pre-Boom cohort, educational outcomes are very similar between Alberta and the rest of Canada, with the possible exception that Alberta shows a slightly lower high school dropout rate offset by more high school graduation. This difference is not statistically significant, however. Moreover, no clear pattern of changes in differences between the two regions as the cohort ages is apparent.

For the Boom cohorts, a more nuanced pattern emerges. In contrast to the Pre-Boom cohort, the Alberta Boom cohort has relatively high dropout rates at young ages. These differences are not statistically significant but they do show an interesting pattern of declining as the cohorts age. Thus, the point estimates fit with the supposition that some cohort members drop out of high school during the boom but return to complete their education

[21]Selecting alternative comparison groups does not affect the qualitative results. For example, we performed the same estimation excluding British Columbia from the comparison group on the grounds that that province also has oil and gas reserves. The results from these alternative estimations are similar to those presented here and are available from the authors on request.

[22]The reported standard errors are White robust standard errors. We also obtained standard errors clustering at the provincial and province x cohort level to allow for general forms of serial correlation. These standard errors, however, were much smaller than those reported here, and we decided to report the more conservative standard errors.

Table 3a. Differences in School Achievement for Males: Alberta and the Rest of Canada[a]

	Low skill		*Medium skill*		*High skill*	
	High school dropout	*High school*	*1 year postsecondary*	*2 years postsecondary*	*3–4 years postsecondary*	*University*
Pre-Boom (born 1953–1956)						
1976 (20–23)	–0.04	0.03**	0.01**	0.01	–0.04**	0.00
	(0.066)	(0.000)	(0.002)	(0.100)	(0.001)	(0.784)
1981 (25–28)	–0.01	0.00	–0.01*	–0.00	–0.02	0.00
	(0.645)	(0.556)	(0.011)	(0.452)	(0.139)	(0.653)
1986 (30–33)	–0.01	0.02*	–0.00	0.02**	0.00	–0.00
	(0.522)	(0.010)	(0.942)	(0.006)	(0.899)	(0.686)
Early Boom (born 1957–1960)						
1976 (16–19)	0.04	0.06**	0.01**	–0.01*	–0.05**	–0.01
	(0.061)	(0.000)	(0.002)	(0.021)	(0.000)	(0.490)
1981 (21–24)	–0.01	0.04**	0.00	–0.01	–0.05**	–0.01
	(0.609)	(0.000)	(0.734)	(0.238)	(0.000)	(0.199)
1986 (26–29)	–0.02	0.01*	–0.00	–0.01*	0.01	0.01
	(0.252)	(0.038)	(0.687)	(0.047)	(0.448)	(0.414)
1991 (31–34)	–0.00	0.01	0.01	–0.01	–0.00	–0.01
	(0.830)	(0.123)	(0.053)	(0.321)	(0.727)	(0.470)
Boom (born 1961–1964)						
1981 (17–20)	0.07**	0.05**	–0.01	–0.03**	–0.05**	–0.01
	(0.002)	(0.000)	(0.068)	(0.000)	(0.000)	(0.422)
1986 (22–25)	0.02	0.02**	–0.00	–0.01	–0.05**	–0.02**
	(0.254)	(0.005)	(0.461)	(0.088)	(0.000)	(0.010)
1991 (27–30)	0.05*	0.02**	–0.01**	–0.01	–0.02	–0.02**
	(0.021)	(0.003)	(0.004)	(0.278)	(0.069)	(0.005)
1996 (32–35)	0.02	0.00	–0.00	0.00	–0.01	–0.02*
	(0.316)	(0.644)	(0.734)	(0.451)	(0.469)	(0.020)
Slow Down (born 1965–1968)						
1986 (18–21)	0.04	0.04**	0.00	–0.01*	–0.06**	–0.01
	(0.072)	(0.000)	(0.301)	(0.036)	(0.000)	(0.311)
1991 (23–26)	0.02	0.03**	–0.00	0.01	–0.05**	–0.03**
	(0.341)	(0.000)	(0.998)	(0.205)	(0.000)	(0.004)
1996 (28–31)	0.03	–0.01	–0.00	–0.00	–0.03*	–0.01
	(0.153)	(0.190)	(0.600)	(0.871)	(0.020)	(0.171)
Collapse (born 1969–1972)						
1991 (19–22)	0.03	0.06**	0.01*	–0.01	–0.06**	–0.03**
	(0.125)	(0.000)	(0.037)	(0.079)	(0.000)	(0.003)
1996 (24–27)	0.04*	0.04**	0.00	–0.01*	–0.05**	–0.03**
	(0.035)	(0.000)	(0.808)	(0.036)	(0.000)	(0.002)
2001 (29–32)	0.05*	0.03**	–0.00	–0.01	–0.03**	–0.02
	(0.018)	(0.000)	(0.144)	(0.054)	(0.007)	(0.059)
Post–oil shock (born 1973–1978)						
1996 (18–23)	0.08**	0.05**	–0.01	–0.03**	–0.07**	–0.03**
	(0.001)	(0.000)	(0.118)	(0.000)	(0.000)	(0.004)
2001 (23–28)	0.05*	0.03**	–0.01*	0.00	–0.07**	–0.02*
	(0.025)	(0.000)	(0.034)	(0.949)	(0.000)	(0.027)
Observations	74	74	74	74	74	74

Source: Canadian Census (1976–2001).

[a]Data are aggregated at the cohort–province–year level. Estimated using 2 step weighted least squares, where the weights are the mean number of observations in the relevant cohort–province–year cell. Robust P-values in parentheses.

*significant at 10%, **significant at 5%, ***significant at 1%.

Table 3b. Differences in School Achievement for Females: Alberta and the Rest of Canada[a]

	Low skill		*Medium skill*		*High skill*	
	High school dropout	*High school*	*1 year postsecondary*	*2 years postsecondary*	*3–4 years postsecondary*	*University*
Pre-Boom (born 1953–1956)						
1976 (20–23)	–0.02	0.03*	–0.00	–0.02**	0.00	–0.02**
	(0.359)	(0.039)	(0.790)	(0.003)	(0.875)	(0.002)
1981 (25–28)	0.01	0.02	–0.01	–0.03**	–0.01	–0.00
	(0.720)	(0.117)	(0.453)	(0.000)	(0.532)	(0.673)
1986 (30–33)	–0.03	0.03*	–0.01	–0.01	–0.01	0.01
	(0.211)	(0.044)	(0.651)	(0.231)	(0.353)	(0.094)
Early Boom (born 1957–1960)						
1976 (16–19)	0.05	0.03*	–0.02	–0.02*	0.00	–0.02*
	(0.061)	(0.010)	(0.151)	(0.013)	(0.632)	(0.015)
1981 (21–24)	0.02	0.05**	–0.01	–0.01	–0.02	–0.01
	(0.327)	(0.001)	(0.256)	(0.059)	(0.058)	(0.150)
1986 (26–29)	0.00	0.03*	–0.01	–0.00	–0.02	–0.03**
	(0.981)	(0.042)	(0.243)	(0.696)	(0.053)	(0.000)
1991 (31–34)	0.01	0.04**	–0.00	–0.01*	–0.02	–0.03**
	(0.811)	(0.004)	(0.674)	(0.034)	(0.074)	(0.000)
Boom (born 1961–1964)						
1981 (17–20)	0.04	0.07**	–0.03*	–0.02**	–0.01	–0.01*
	(0.090)	(0.000)	(0.011)	(0.002)	(0.398)	(0.033)
1986 (22–25)	0.02	0.04**	–0.01	–0.00	–0.04**	–0.03**
	(0.298)	(0.003)	(0.231)	(0.698)	(0.001)	(0.000)
1991 (27–30)	0.01	0.03*	–0.01	0.00	–0.03**	–0.02*
	(0.552)	(0.013)	(0.194)	(0.561)	(0.004)	(0.019)
1996 (32–35)	0.04	0.02	–0.02	0.01	–0.03**	–0.02**
	(0.081)	(0.124)	(0.133)	(0.060)	(0.004)	(0.001)
Slow Down (born 1965–1968)						
1986 (18–21)	0.04	0.03*	–0.01	–0.02**	–0.02	–0.03**
	(0.113)	(0.044)	(0.589)	(0.001)	(0.066)	(0.000)
1991 (23–26)	0.03	0.03*	0.01	0.02**	–0.05**	–0.06**
	(0.169)	(0.047)	(0.442)	(0.003)	(0.000)	(0.000)
1996 (28–31)	0.03	0.02	–0.00	0.02**	–0.03**	–0.05**
	(0.184)	(0.156)	(0.817)	(0.000)	(0.008)	(0.000)
Collapse (born 1969–1972)						
1991 (19–22)	0.05	0.05**	–0.01	–0.02**	–0.03**	–0.04**
	(0.057)	(0.001)	(0.332)	(0.006)	(0.002)	(0.000)
1996 (24–27)	0.04	0.03*	–0.00	0.01	–0.03**	–0.05**
	(0.141)	(0.010)	(0.884)	(0.177)	(0.003)	(0.000)
2001 (29–32)	0.02	0.02	–0.00	0.00	–0.04**	–0.04**
	(0.321)	(0.087)	(0.880)	(0.463)	(0.000)	(0.000)
Post–oil shock (born 1973–1978)						
1996 (18–23)	0.06*	0.06**	–0.01	–0.01*	–0.03**	–0.04**
	(0.014)	(0.000)	(0.337)	(0.020)	(0.006)	(0.000)
2001 (23–28)	0.06*	0.04**	–0.00	–0.02*	–0.05**	–0.06**
	(0.015)	(0.002)	(0.828)	(0.013)	(0.000)	(0.000)
Observations	74	74	74	74	74	74

Source: Canadian Census (1976–2001).

[a]Data are aggregated at the cohort–province–year level. Estimated using 2 step weighted least squares, where the weights are the mean number of observations in the relevant cohort–province–year cell. Robust P-values in parentheses.

*significant at 10%, **significant at 5%, ***significant at 1%.

later. If the whole story were just about high school completion, one would expect to see an inverse pattern for the high school graduate category (i.e., Alberta Boom cohorts being disproportionately low in the category as teenagers but rising to equality with the rest of Canada as the cohorts age). Instead, we see that the Alberta Boom cohorts were statistically significantly over-represented as high school graduates at young ages, with that difference declining to zero in both economic and statistical terms as the cohorts age. This pattern is mirrored in their postsecondary achievement, especially in the three to four years of postsecondary, less than bachelor's degree (BA) category. For that category, a statistically significant negative gap in attainment for Albertans at young ages dissipates to zero as the cohorts age. Thus, while there is some evidence that Boom cohort Alberta males responded to the labor-market opportunities associated with the resource boom by dropping out of high school and returning to graduate later, there is stronger evidence that these cohorts put off their postsecondary education in response to the boom. Strikingly, and fitting with the IALS results, Albertans in these cohorts are no different from their compatriots in the rest of Canada in terms of their levels of educational attainment by the time they reach their early 30s. Thus, the resource boom appears to have changed the timing but not the ultimate level of education for the cohorts coming of age during the boom.

The Post-Boom cohorts show another pattern. Alberta males in those cohorts tend to be more likely to be high school dropouts (though not statistically significantly so), more likely to be high school graduates, and less likely to attend postsecondary education. These are all patterns evident at young ages for the Boom cohorts. The difference is that the gaps relative to the rest of Canada do not dissipate with age, and by the time they reach their late 20s or early 30s they remain behind the rest of Canada in terms of education (statistically significantly so for the Slow-Down cohort). This could fit with cohorts having relative difficulty in funding their education, though we cannot provide any direct proof of this surmise.

Table 3b shows the differences in education attainment between Alberta females and females in the rest of Canada. Here we would not expect to see as strong an effect of the oil boom on schooling decisions, as females were less likely to work in the primary sector or in construction, two prominent areas of employment directly affected by the oil boom. This expectation does seem to be fulfilled. The Early Boom cohort has a relatively high proportion of high school graduates but no statistically significant or economically substantial differences elsewhere and no apparent patterns with age. The Boom cohort shows a high proportion of high school graduates that declines with age, as for males, but no offsetting age-related pattern in postsecondary attainment. For the Post-Boom cohorts, females show a similar pattern to males, with the high school graduate category being disproportionately high and the upper postsecondary attainment being disproportionately low. Thus, it appears there was a detrimental change in education for Post-Boom cohorts in general but that for males the boom had an effect in changing the timing of education that was not present for females.

The results from the IALS and the census are essentially similar, although the comparison between the two sets of results is not straightforward because of small definitional differences in education categories. Nevertheless, we can approximate the IALS difference-in-difference exercise by focusing just on the Pre-Boom and Boom cohorts, as shown in Table 3. This exercise reveals very similar results for males in the two data sets; that is, differences between the Pre-Boom and Boom cohorts in terms of postsecondary achievement and high school graduation that disappear as the cohort ages. For females, the census shows a different result: by the time they are in their 30s, females of the Boom cohort achieve similar or slightly lower levels of nonuniversity postsecondary education relative to the Pre-Boom cohort in Alberta compared with the rest of Canada. We believe this may reflect sampling error in the IALS for which the sample size is smaller, particularly for nonuniversity postsecondary education, which was a much less common choice for females than for males.

Our results are consistent with the simple framework proposed by Card and Lemieux (2001). Assuming a model in which schooling decisions are not permanent, individuals who leave school during a resource boom may have the chance to use the accumulated earnings to go back to school later on, but those who leave school during a recession may not have the same resources to do so. This would explain why the male Boom cohorts eventually achieve similar levels of education compared with men in the same cohorts in the rest of Canada, but the Alberta bust cohorts show a relative detriment in education. From this perspective, transitory labor-demand shocks arising from a resource boom generate economic rents that are capitalized in part in the human resources of the province. This positive influence on human capital formation does persist beyond the boom.

Long-Term Wage Effects of the Oil Boom

To this point, we have observed limited (or possibly slightly positive) effects of the Alberta oil boom on long-run education and cognitive skills attainment for males. These, of course, are not the only relevant skills for the long-run performance of an economy. Even individuals who chose oil sector jobs over continued schooling may have been acquiring skills from on-the-job training. The ultimate impact of this on the economy will depend both on the extent of skill generation on these types of jobs and on the transferability of the skills to other sectors once the boom is over. We do not have a direct measure of such skills but we can get an indirect assessment of their importance by examining wages in a future year, again investigating whether they differ between the cohort of Alberta youth directly affected by the boom as compared with others. More specifically, we again estimate a specification based on Equation (1) in two stages, using IALS data.

In the first stage, we regress individual log weekly wages on the birth cohort, province of high school attendance, and cohort x province of schooling interaction variables. We estimate specifications both with and without education dummies and standard Mincer experience variables. For the

estimation without these variables, the Boom cohort x Alberta interaction captures all potential productivity effects including those that arise through any generated differences in schooling. For the estimation including the human capital variables in the first stage, the interaction captures just productivity effects over and above schooling impacts. We used the log of weekly earnings as a measure of productivity since a coherent measure of hourly earnings is not available for the majority of the observations in the IALS, and we restrict our sample to individuals with positive weekly earnings. As in our previous estimation, we form fitted values at the province x cohort level and use those as the dependent variable in the second stage. Although not reported here for brevity, the basic estimates show that males of the Boom cohort who went to high school in Alberta have insignificantly lower earnings compared with males from the rest of Canada. (The coefficient for the effect on wages of being from the Alberta Boom cohort is –0.05, with robust standard error of 0.279.) When we include controls for acquired skills (experience and education indicators), the returns remain insignificant. (The effect on wages of being from the Alberta Boom cohort is –.07, with robust standard error of 0.302.)

There could be considerable bias due to the fact that we are selecting people with positive wages for the analysis. Indeed, a simple tabulation of the proportion reporting positive earnings by province of high school for the Boom cohort reveals that a lower fraction of people who completed high school in Alberta had positive earnings compared with the rest of Canada (56% compared with 64%). A probit regression of the probability of being employed shows that the Alberta Boom cohort has a significantly lower probability of being employed. The implication is that selection is a potentially important issue in our wage regression estimation. We responded to this using a standard Heckman two-step approach, with marital status and number of children entering the process determining employment but being excluded from the wage equation. Accounting for selection into employment in this way does not change the basic result that the boom does not seem to have had a long-run effect on the wages of the cohorts coming of age at that time. The estimates of the effect on wages of being from the Alberta Boom cohort increase slightly to –0.03 (standard error 0.289) in the basic case and remain the same (–0.07 with standard error 0.295) when including controls for basic skills.[23] While we recognize that conclusions from the wage regression exercise must come with numerous caveats, we view the results as supportive of the conclusion that the resource boom did not have long-term negative effects on skill accumulation. If such effects did arise and we failed to pick them up, the market does not seem to recognize them either.

Robustness

The validity of the results on the evolution of skill achievement depends crucially on the assumption that the Alberta oil boom had distinctive impacts

[23]The estimates from the wage regressions are reported in the Electronic Appendix Table 4.

across Canadian provinces. This is not necessarily true as wage differentials (due to differences in economic activity across regions) often induce population flows within a country.[24] If the oil boom caused large fractions of young individuals to move to Alberta from other provinces before completing high school, we may be overestimating the school achievement of the Alberta-born cohort as these movers may have reduced their schooling as a result of the boom.[25] In this sense, the above estimates would provide an upper bound on the long-term effects of oil booms on skill accumulation.

Approximately 85% of young individuals reside in their province of birth (see Electronic Appendix Table 2). We check the robustness of our estimates to population movements by restricting the sample to non-movers. That is, we compare differences in educational achievement over the years for those born *and residing* in Alberta with those born and residing somewhere else in Canada. This provides a tighter definition of the cohort affected (or not) by the oil boom. Hence, these estimates provide a lower bound on the long-term effects of oil booms on skills accumulation, when using census data. The results (available from the authors on request) show no significant difference from those discussed above.

A word of caution should be introduced regarding these latter estimates. As mentioned, the above sample restriction provides a more accurate definition of the cohorts affected by the boom at the time schooling decisions are made. Therefore our initial point estimate for each cohort should be free of mobility bias introduced by population movements between birth and the age of high school graduation. As the cohort ages, however, we may be introducing a different bias coming from mobility after high school graduation age. For instance, if we see the fraction of Alberta-born (and residing) high school graduates diminish as the cohorts age, it could be due to the fact that Albertans are coming back to school to finish high school degrees at a later age, but it could also imply that as cohorts grow older, more Alberta high school graduates leave the province. While we are aware of this possibility, two facts lead us to believe that this may not be important. First, we do not see unusually large movements of Albertans out of the province (Electronic Appendix Table 3). Second, the similarity between the estimates from the census and the IALS makes this possibility less likely. Note that in the IALS data, mobility is not an issue since we know the province where an individual attended high school.

Finally, our results could have been affected if Alberta had introduced policy initiatives that encouraged displaced workers to go back to school during the bust. As far as we have been able to check, there were no such policies addressing training of displaced workers in Alberta. What evidence

[24]See Carrington (1996), and Coe and Emery (2004). This seems to be the case in Alberta during the oil boom. Population flows out of Alberta for young individuals are reported in Electronic Appendix Figure 1.

[25]Alternatively, large movements of Albertans out of the province would also reduce our estimates as they would not be affected by the oil boom, and we are assuming they are affected. However, this possibility is less worrisome as there is no evidence of significantly large movements out of Alberta for the relevant age group. (See Electronic Appendix Figure 1.)

we found suggests that provincial governments were cutting expenses on all fronts, particularly on education (Decore and Pannu 1989). Through the 1970's oil boom, the Alberta government increased spending on postsecondary education and by 1985 had the highest per capita and per student postsecondary education spending. After 1985, the Alberta government allowed these spending levels to approach the 10-province average by 1992 (Emery 1997). Since that time, Alberta has remained an average spender on postsecondary education. In terms of tuition fees, during the early 1980s Alberta had university tuition fees that were low compared with the rest of the country, but these fees quickly increased toward those levied in other provinces by the early 1990s. This may have had an effect on the decline in educational achievement observed for the Collapse and Post–oil boom cohort. Hence, it seems unlikely that supply side considerations that are idiosyncratic to Alberta are affecting our estimates.

Conclusion

Using two complementary data sets, we examine the long-term educational achievement of Albertans during the 1970's oil boom and its collapse in the 1980s. Our findings support a conclusion that economic booms may change the timing of schooling rather than having long-term negative effects on the total accumulation of human capital. In particular, we find that youth entering their late teens during the boom period in Alberta were more likely to stop their schooling with high school graduation and less likely to pursue a postsecondary education during the boom. Over time, though, this cohort caught up with the educational level of youth in other parts of Canada. Ultimately, there was little difference in skills for Alberta youth who came of age during the resource boom relative to those from other parts of Canada regardless of whether we measure skills by education levels, literacy scores, or wages. This implies that, at least in this instance, transitory labor demand shocks associated with a resource boom were not a long-run source of harm as alleged in the literature that examines resources as a curse. One might expect these benefits to spill over to Post-Boom cohorts as well if the rents from the boom had been invested in permanently lowering postsecondary education access costs in the provinces. We find, however, that the cohorts coming of age in the Collapse period of the late 1980s in Alberta actually had lower educational attainment than their counterparts in other parts of Canada.

The results potentially fit with a model in which educational choices are not permanent and individuals may come back to school at a later date if they decide to leave at the time of the resource boom. Assuming that schooling decisions are not permanent also explains the result that while the boom seems not to have long-lasting effects on educational attainment, the subsequent bust does. Individuals who leave school during a resource boom may have the chance to use the accumulated earnings to go back to school later on, but those who leave school during a recession may not have the same

resources to do so. In the case of Alberta, this process seems to apply to the province as a whole since provincial government spending on postsecondary education was cut back during the bust. The apparent long-lasting effects of the bust are relevant when thinking of educational policies to finance public education. Offering easy access to postsecondary education or high school completion for individuals affected by a resource bust may be helpful as part of a comprehensive package to help displaced workers. Certainly, cutting such investment during a bust is associated with worsening educational outcomes.

Our study calls for further research on the long-run impact of resource shocks on labor market and other outcomes. Similar effects of the most recent boom on the Alberta labor market regarding postsecondary enrollment and high school graduation have already been noted in the media. If the economic downturn will have similar effects, and if policies facilitating access to postsecondary education are in order, are yet to be determined.

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