Long term consequences of natural resource booms for human capital accumulation

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Abstract. Theoretical and empirical work seems to support the idea that tight labour markets driven by resource booms induce young individuals to leave school for employment as the opportunity cost of schooling increases. Resource booms may have an adverse long term effect on the productivity of the labor force if workers under-invest in human capital rather than merely altering the timing of schooling. We explore the validity of this thesis using the Albertan 1973-1981 oil-boom, which created a period of rapid growth both in wages and employment in Alberta relative to the rest of Canada, and analyze the effect of this oil-boom on the long-term human capital investments and productivity for birth cohorts that were of normal schooling ages before, during and after the oil boom. Our findings suggest that resource booms may change the timing of schooling but do not seem to affect greatly the total accumulation of human capital.

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Introduction

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. While evidence to date shows that resource booms reduce school enrolment, this may or may not imply long run problems. Whether it does depends on whether the short run reduction in enrolment 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 1973-1981 oil-boom. The 1973 to 1981 OPEC oil crises generated high oil prices in Alberta which created a period of rapid growth both in wages and employment in Alberta relative to the rest of Canada.[3]

A series of papers investigate the immediate impact of resource booms and changes in labour 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 mining states in the US. 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. Their analysis of the effect of changes in skill premia on high school enrolment during the boom and subsequent crash suggests that persistent shocks to skilled wage differentials substantially reduce high school enrolment. More generally, 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 favourable economic conditions reduce high school enrolment (Neumark and Wascher 1995, Rees and Mocan 1997, Beaudry, Lemiuex and Parent 2000), and high school completions (Goldin and Katz 1998).

[3] The idea that resource booms 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. Calgary Herald April 23, 2006, and Globe and Mail, July 29, 2008.

Whether sharp changes in short run economic conditions have longer term impacts on educational outcomes, however, remains an open question. [4] 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".[5] That short and long run outcomes might diverge, though, gains credibility when one considers the literature that shows that transitory resource booms do not appear to have permanent effects on labour market outcomes. Carrington (1996) investigates the adjustment of the Alaskan labour market between 1974 and 1977 when the Trans-Alaska Pipeline was under construction. He finds that flexible wages and elastic labour 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 spans the oil price shocks of the 1970s and 1980s, find no evidence that regional labour demand shocks result in permanent changes in relative real wages across provincial labour markets in Canada for building trades. As Lemieux and Card (2000) suggest, given that people can go back to school later in life, these temporary shocks may not have an effect on ultimate educational choices. Conversely, 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 enrolment 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 paper, 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 immediate impacts on enrolment. Further, the possibility of returning to school after the boom also changes the focus of our analysis from high school related outcomes along (i.e., enrolment and graduation rates) to higher levels of educational

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

[5] Gylfason et al. (1999) and Gylfason (2001) and 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 enrolment rates are inversely related to natural resource abundance.

attainment. Once we consider the possibility that earnings in a resource boom could be used to finance post-secondary education, the impact of the boom on high school graduation rates becomes complex. Hence, it is of interest to consider 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 post-secondary education at the time of the boom. Indeed, our main results show that more males dropped out of high school during the boom but that the proportion attending post-secondary 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 to 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 Census data to construct synthetic cohorts which we follow over time to track the evolution of their schooling achievement over the years and 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 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 following section provides background information on the Alberta oil boom. Section 3 describes the data we use for analysis. Section 4 discusses our results and section 5 concludes.

2. 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 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 Canadian price of oil was mandated to be half of the world price (Emery 2006). That this policy was not implemented until after world oil prices were declining reflected lags in policy making.

It has been well documented that the Alberta economy's boom in the 1970s and early 1980s, and subsequent bust, resulted in dramatic changes in its labour market and incomes relative to the rest of Canada and the other western Canadian provinces.[6] 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 neighbouring 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 capital 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 3a). Employment rates in Alberta for males aged 16 and over were over 80% during the late 1970s until 1981 - 6% points higher than Ontario, which had the next highest employment rate. By 1983 Alberta's employment rate was at similar levels to Ontario's. 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 3b). Figure 4 shows that personal incomes in Alberta increased relative to the Canadian average and in comparison to the other prairie provinces of Manitoba and

[6] 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 to oil producing states in the US. Alberta accounts for nearly 80% of Canada's oil production and even today, Alberta remains remarkably dependent on energy exports compared to 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 US (The Canada West Foundation (2010, chapters 10 and 11) http://cwf.ca/CustomContentRetrieve.aspx?ID=1207055).

Saskatchewan. Reflecting the collapse of oil prices and investment spending in Alberta after 1980, Alberta's income advantage relative to the other provinces was gone by the mid-1980s.[7,8]

Our interest is in the impact of this boom on post secondary education trends. In Canada, students complete high school after 12 grades of school which is for the most part publicly funded.[9] 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 post-secondary education systems comprised of colleges that provide technical/vocational education, and universities. In Figure 5, we present post-secondary enrolment 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 post-secondary enrolment rates compared to Ontario. Second, during the second OPEC oil price shock, 1978-1982, post-secondary enrolment in Alberta was lower than in the other western Canadian provinces. With the end of the boom after 1982, the level of enrolment in post-secondary education returned to a level comparable to the other western provinces.

The negative relationship between post-secondary enrolment in Alberta and oil prices is made apparent in figure 6, which shows oil prices on the left hand axis and the difference in post secondary enrolment between Alberta and the rest of Canada on the right hand axis. In rough terms, the peaks of the oil price series correspond to the valleys in the enrolment gap, suggesting that, similar to the case of coal prices in the US, Alberta's oil boom had an impact on enrolment rates.[10]

3. Data Description

[7] 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 in Saskatchewan (Prince Albert) and 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 the adjacent province to Alberta and, apart from the oil boom the two provinces share many similarities.

[8] The increased pressure on Alberta's labour demand 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).

[9] 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 typically 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.

[10] The correlation coefficient is -0.28

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. The literacy questions are designed to elicit competencies in cognitive tasks related to everyday life and work rather than just being measures 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.[11] 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 post secondary 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 different degrees and the respondent's answer on when he or she was last in school. We define an indicator of "Interrupted schooling-Completed Education" that takes value 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" that takes value 1 if a person attended PS schooling *without completing a degree* and was last in school at an age above the "typical" age to complete that degree.

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 Censuses of Canada (1976, 1981, 1986, 1991, 1996 and 2001) to study the evolution of the education attainment of the cohorts affected by the oil boom.[12] Census years are pooled together to

[11] 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 Green, Ferrer and Riddell (2005).

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

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.[13] 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 non-university post-secondary category into different levels based on years of post-secondary 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.[14]

We restrict the IALS sample to include non-Aboriginal, non-immigrant 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 cut 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.[15] The Census sample has about 800,000 observations for each gender.

We define birth cohorts using 4-year groupings to ensure sufficient sample size in each cohort. Using the oil price changes discussed in section 2, and the timing for when a given 4 year birth cohort would have been attending high school, we define five birth cohorts of interest:

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[13] The fraction of Alberta born individuals, younger than 19 that reside in Alberta in a given census year (Appendix Table 2) is 85% which is close to the 83.3% fraction of individuals born in Alberta that 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.
https://webdisk.ucalgary.ca/~aferrer/the%20long%20term%20consequences%20of%20resource%20booms-appendix/Appendix.pdf

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

[15] Educational categories correspond to the highest level of education attained (less than high school graduation, high school graduates, non-university post-secondary graduates, and Bachelor's or higher university degree).

- The Pre-boom cohort includes individuals born between 1953 and 1956 who turned 17 between 1970 and 1973.
- The Early-boom cohort includes those born between 1957 and 1960 who turned 17 between 1974 and 1977 during the first OPEC oil shock.
- The Boom cohort includes those born between1961 and 1964, who turned 17 between 1978 and 1981 during the second OPEC oil shock.
- 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.
- The Collapse cohort includes those born between 1969 and 1972 who turned 17 between 1986 and1989 when the OPEC price agreement collapsed.
- 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.

4. The long run educational attainment of the Alberta oil boom cohorts

4.1. Evidence from IALS

We begin by using the IALS data to examine differences in literacy and educational achievement for the cohort who 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 snap shot 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 non-university post-secondary degrees rather than university degrees relative to those in the rest of Canada, and a higher fraction report some (unfinished) post-secondary 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) PS schooling after the average age of completion (61.5% versus 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 post secondary education, a higher fraction have university education than in the rest of Canada.[16]

To investigate the long term effect of the boom on educational attainment, we perform a simple difference in difference (DD) exercise on the effect of the Boom in Alberta. We restrict our attention only to 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,

$$(1) \quad Ed.level_{icp} = \alpha_0 + \alpha_1 P + \alpha_2 CohBoom + \alpha_3 \sum_p P \; x \; CohBoom + \alpha_4 X_{icp} + e_{icp}$$

where, *i* indexes individuals, c indexes cohort (boom and preboom) and *p* indexes province. *P* is a vector of 8 provinces of high school indicators (British Columbia, Alberta, Manitoba, Saskatchewan, Ontario, Quebec, Maritimes –Nova Scotia, New Brunswick, Prince Edward Island– and Newfoundland and the North Western Territories), *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*) which includes mother's level of post secondary education and whether the father worked when the respondent was 16.

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 there is small number of groups (province-cohorts in our case) 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

[16] 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 PS education at a faster rate than in other provinces in Canada (CANSIM Table 4770006)

equation (1) using a linear probability model, in two steps.[17] 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 by 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.[18] We perform the estimation with and without the individual covariates in the first stage to check the robustness of our results.[19] Since we only consider the pre-boom and boom cohorts, we effectively use the approach suggested by Bertrand et al. (2004) to avoid issues related to serial correlation.

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 which takes a value of one for that outcome and zero for all other educational outcomes). In column (II) we repeat the estimation adding other controls to the first step regression (mother's post secondary 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 non-university post-secondary 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

[17] 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.

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

[19] 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 where 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.

seem that the long term school achievement of males in the Alberta boom cohort did not decline when compared to 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 labour market conditions seem to affect young males more than young females (Parent, 2006).

One advantage of the IALS data is that it provides a direct measure of cognitive skills through the literacy score. To check if there were any potential long term effects in skill achievement as a result of the boom, we use the average literacy score as an additional outcome in equation (1).[20] The results are presented in the last row of Table 2. The interaction 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 $1/10^{th}$ of the average literacy score). Importantly, though, the estimated effects are positive. Thus, there is no evidence that Alberta males who were about high school leaving 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 PS education during the ensuing bust. Although there is no information that 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., and indicator for whether a person completed their highest level of education at an age higher than the typical age). Rows 8 and 9 of Table 2 show that males born in Alberta had a higher fraction of school interruption, 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 post secondary 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 post secondary 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 remain similar in the rest of Canada for the pre-boom and boom cohorts. Females in Alberta and the rest

[20] We estimate in two stages as before.

of Canada, on the other hand, show similar levels of graduation from post secondary degrees for the boom and pre-boom cohorts.

4.2. Evidence from Census Data

We turn now to the 1976-2001 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 snap shot 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.[21] The Canadian Census is conducted every 5 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 a cohort indicator and census year indicator variables (Yr_t), an indicator for Alberta born (*AB)*, and the interaction of cohort, census year indicators and the Alberta born indicator.[22] 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.

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

[21] For the 1976 Census year, we use province of residence instead of province of birth as province of birth is not provided in the 1976 Census. We find no evidence that there were substantial changes in mobility rates between province of birth and province of residence across censuses. 85% of young individuals (up to 24 years of age) reside in the province of birth. See Electronic Appendix table 1 and footnote 9.

[22] Note that not all cohorts are present in every year of the census. There are 6 census years, 8 cohorts and 2 regions (AB and the rest of Canada). In each region, the omitted cohort (i.e., those born between 1942 and 1952) , pre-boom and early 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 for 2 census years (4 observations), bringing the number of cell groups to 74.

where *j* corresponds to the cohorts specified in section 3 (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 Rest of Canada). The year indicators control for trends in the educational levels over time, the province indicator controls for permanent differences between Alberta and the Rest of Canada and the year times 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 x 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.[23] The full set of estimates can be found in tables 3a and 3b (for males and females respectively).[24]

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 post secondary education, 2 years of post secondary education, 3-4 years of post secondary 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.

[23] 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 upon request.

[24] 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.

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 drop out rate offset by more high school graduation. This difference is not statistically significant, however. Moreover, there is no clear pattern of changes in differences between the two regions as the cohort ages.

For the boom cohorts, a more nuanced pattern emerges. In contrast to the pre-boom cohort, the Alberta boom cohort has relatively high drop-out 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 a story in which some cohort members drop-out of high school during the boom but return to complete their education 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 post-secondary achievement, especially in the 3-4 years post-secondary, below a 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 labour 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 post-secondary 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 a different pattern again. Alberta males in those cohorts tend to be more likely to be high school drop-outs (though not statistically significantly so), more likely to be high school graduates, and less likely to attend post-secondary 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 does seem to be the case. The Early Boom cohort has a relatively high proportion of high school graduates but not 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 post-secondary attainment. For the post-boom cohorts, females show a similar pattern to males, with the high school graduate category being disproportionately high and upper post-secondary attainment being disproportionately low. Thus, it appears that 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 differences in education category definitions Nevertheless, we can approximate the IALS difference-in-difference exercise by focusing just on the pre-boom and boom cohorts 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 post secondary achievement and high school graduation that disappear as the cohort ages. For females, the census shows a different result for non-university post secondary degrees. By the time they are in their 30s, females of the boom cohort achieve similar or slightly lower levels of non-university post secondary education relative to the pre-boom cohort in Alberta compared to the rest of Canada. We believe this may reflect sampling error in the IALS where the sample size is smaller, particularly for non-university post secondary 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 (2000). Assuming a model where 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 to 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 labour 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.

4.3. 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 versus 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 times province of schooling interaction variables. We run 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 just captures 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 restrict our sample to individuals with positive weekly earnings. As in our previous estimation, we form fitted values at the province times 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 to 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 to the rest of Canada (56% versus 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. [25] 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 it either.

4.4. 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 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.[26] If the oil boom caused large fractions of young individuals to move to Alberta from other provinces before completing high school, we may be

[25] The estimates from the wage regressions are reported in the electronic appendix table 4.

[26] See Carrington (1985), and Coe and Emery (2004). This seemed 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

overestimating the school achievement of the Alberta born cohort as these movers may have reduced their schooling as a result of the boom.[27] 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 Appendix table 2). We checked 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 versus 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 upon 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. However, as the cohort ages, 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) HS graduates to 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 HS graduates leave the province. While we are aware of this possibility, two facts induce us to believe that this may not be an important factor. First, we do not see unusually large movements of Albertans out of the province (electronic appendix Table 3). Second, the similarity between the estimates of 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 in which an individual attended high school.

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

[27] 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. 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)

evidence we found suggests that provincial governments were cutting expenses in all fronts, particularly on education (Decore, and Pannu, 1989). Through the 1970s oil boom, the Alberta government increased spending on post-secondary 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 post-secondary education. In terms of tuition fees, by the early 1980s, Alberta had university tuition fees that were low compared to the rest of the country but these fees quickly increased towards 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.

5. Conclusion

Using two complementary data sets, we examine the long term educational achievement of Albertans during the 1970s 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 post-secondary 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 labour demand shocks associated with a resource boom were not a long run source of harm as alleged in the `resource curse' literature. 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 post-secondary education access costs in the provinces. However, we find 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 where 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 Alberta's case, this process seems to apply to the province as a whole since provincial government spending on post-secondary education was cut back during the bust. This is of relevance when thinking of educational policies to finance public education. Offering easy access to post secondary 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 in a bust is associated with worsening educational outcomes.

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

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Table 1. Mean school achievement by province of high school. IALS (2003)

	Male			Female		
	AB	**Rest of Canada**		**AB**	**Rest of Canada**	
Less than HS	24.9	26.5		20.9	24.9	*
High School	19.1	20.4		25.2	23.4	
Some PS	12.8	9.0	*	10.9	9.1	
Post Secondary	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 (1)						
Finished school late	54.0	52.6		47.6	49.1	
Did not finish Post Secondary	61.5	53.9	*	54.2	52.9	
Literacy						
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	9891		565	11847	

Source: Author's tabulations using the IALS

School interruption-completed Education 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 post secondary, 23 for BA and 25 for graduate degrees). School interruption-uncompleted Education includes those who did not finish a post secondary degree.

Indicates that the difference is statistically significant at 5%

Table 2. Effect of Oil Shock on education. Alberta v. the rest of Canada, IALS, 2003

(2 step weighted least squared estimation. Robust standard errors in parenthesis)[1]

	Males		Females	
	(I)	(II)	(I)	(II)
Dependent variable [(2)]				
Less than HS	-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 PS [(3)]	0.21	0.25	-0.14	-0.11
	(0.19)	(0.21)	(0.17)	(0.18)
Interruption-Uncompleted PS [(3)]	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			

[(1)] Data is 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

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

[(3)]School interruption-completed Education 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 post secondary, 23 for BA and 25 for graduate degrees). School interruption-uncompleted Education includes those who did not finish a post secondary degree

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

Table 3 a. Differences in MALE School Achievement. AB versus Rest of Canada (Census 1976-2001)
(2 step weighted least squared estimation. Robust P-values in parenthesis)[1]

	Low Skill		Medium skill		High Skill	
	HS dropout	High School	1 yr PS	2 yrs PS	3-4 yrs PS	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

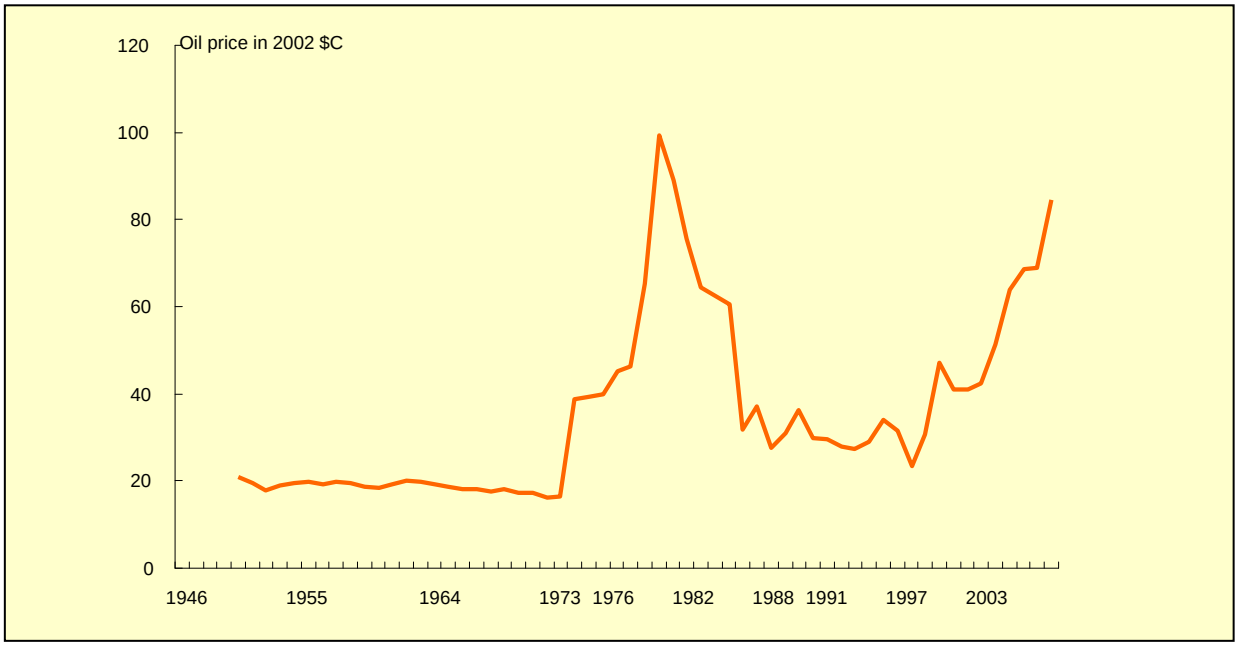
(1) Data is aggregated at the cohort-province-year level. Estimated using 2 step weighted least squares, where the weights are the mean number of observations in the relevant cohort-province-year cell.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3 b. Differences in FEMALE School Achievement. AB versus Rest of Canada (Census 1976-2001)
(2 step weighted least squared estimation. Robust P-values in parenthesis)[1]

	Low Skill		Medium skill		High Skill	
	HS dropout	High School	1 yr PS	2 yrs PS	3-4 yrs PS	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

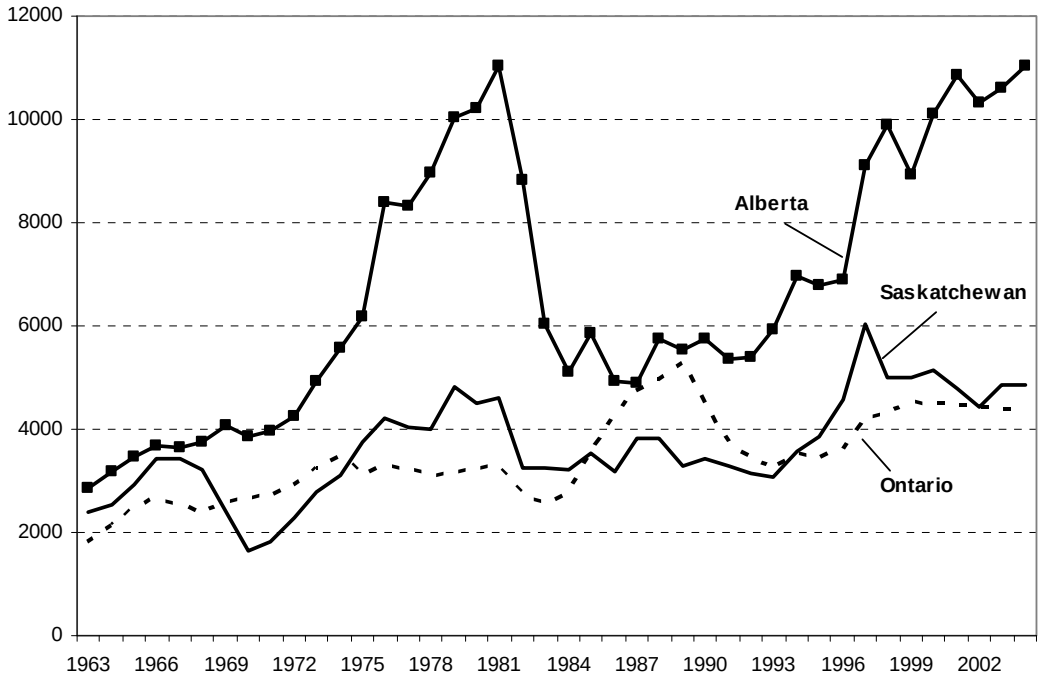
(1) Data is aggregated at the cohort-province-year level. Estimated using 2 step weighted least squares, where the weights are the mean number of observations in the relevant cohort-province-year cell.
* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1. World Oil Prices



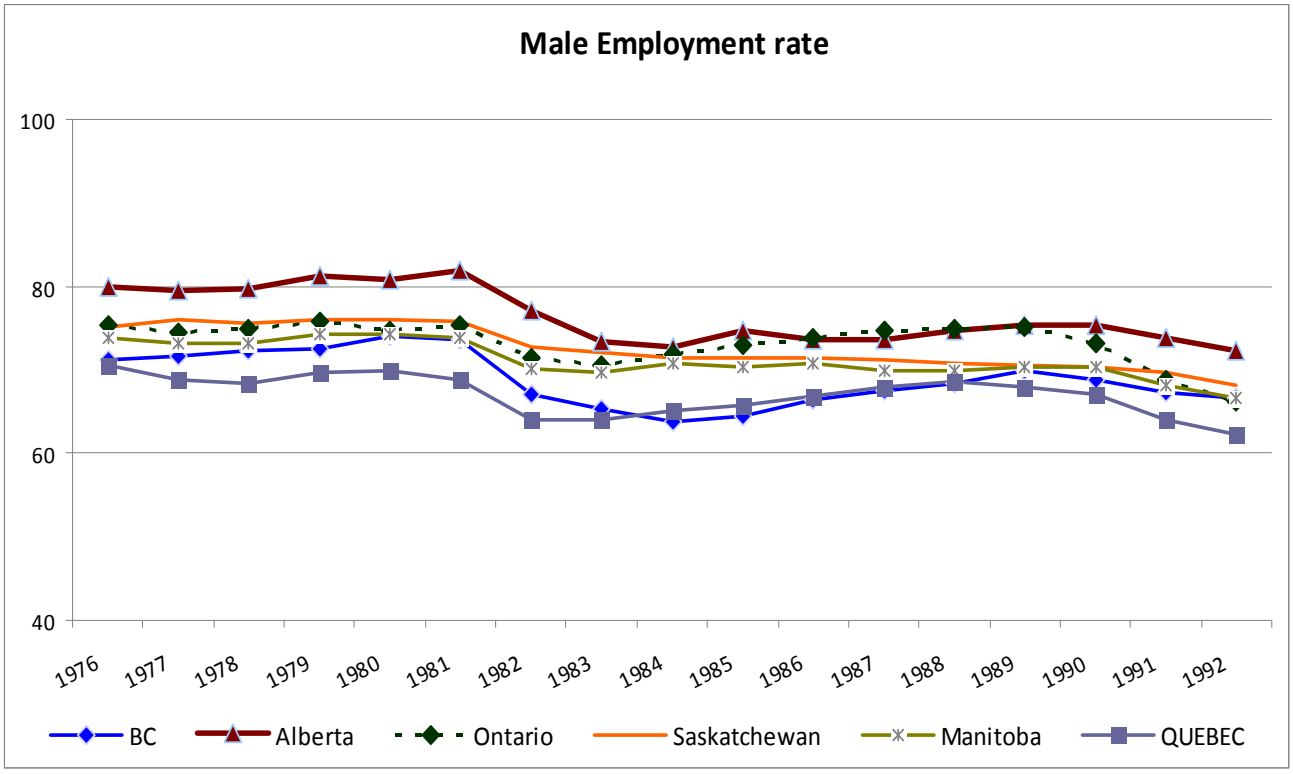
Source: Author's calculations using Historical Statistics of Canada, Series Q20

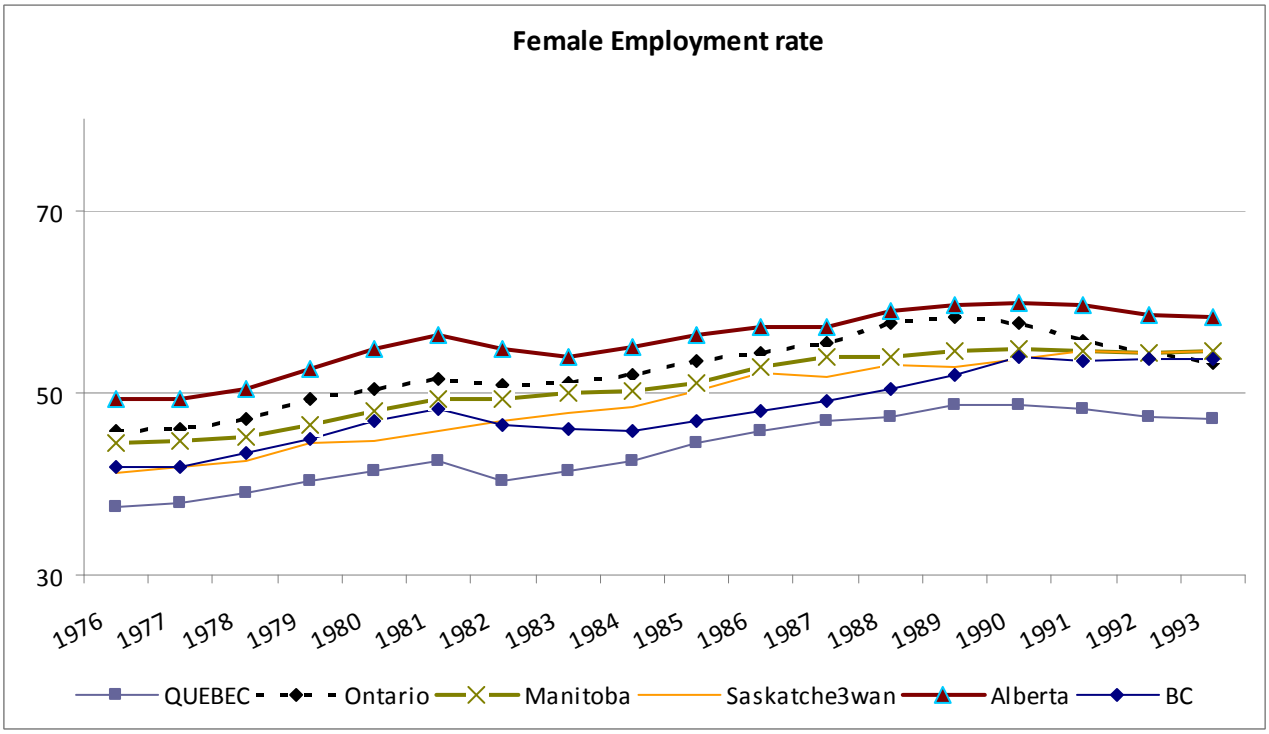
Figure 2: Per Capita Private Sector Investment,
Saskatchewan, Alberta, and Ontario (1992 dollars)



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**.**

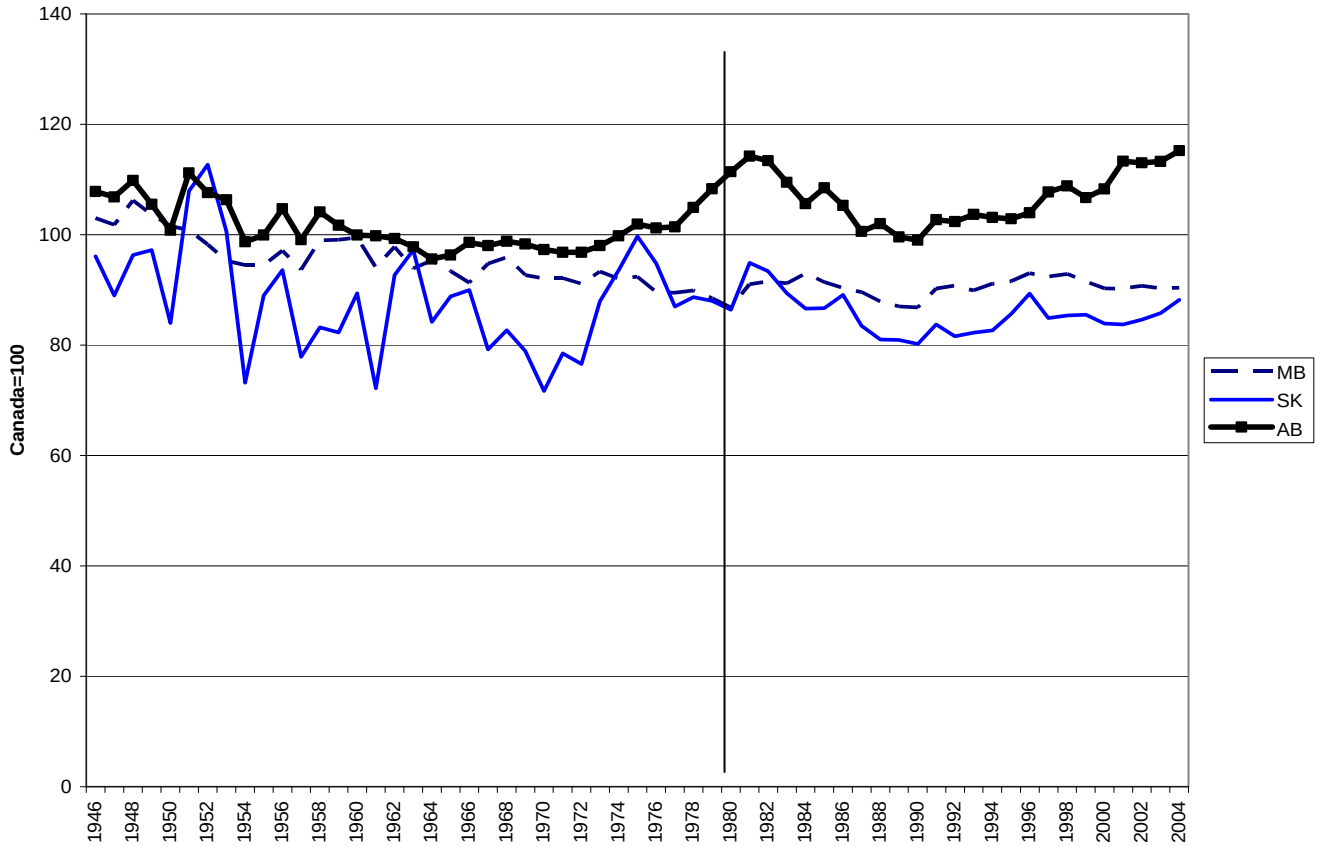
Figure 3. Employment rates by Province 1976-1992





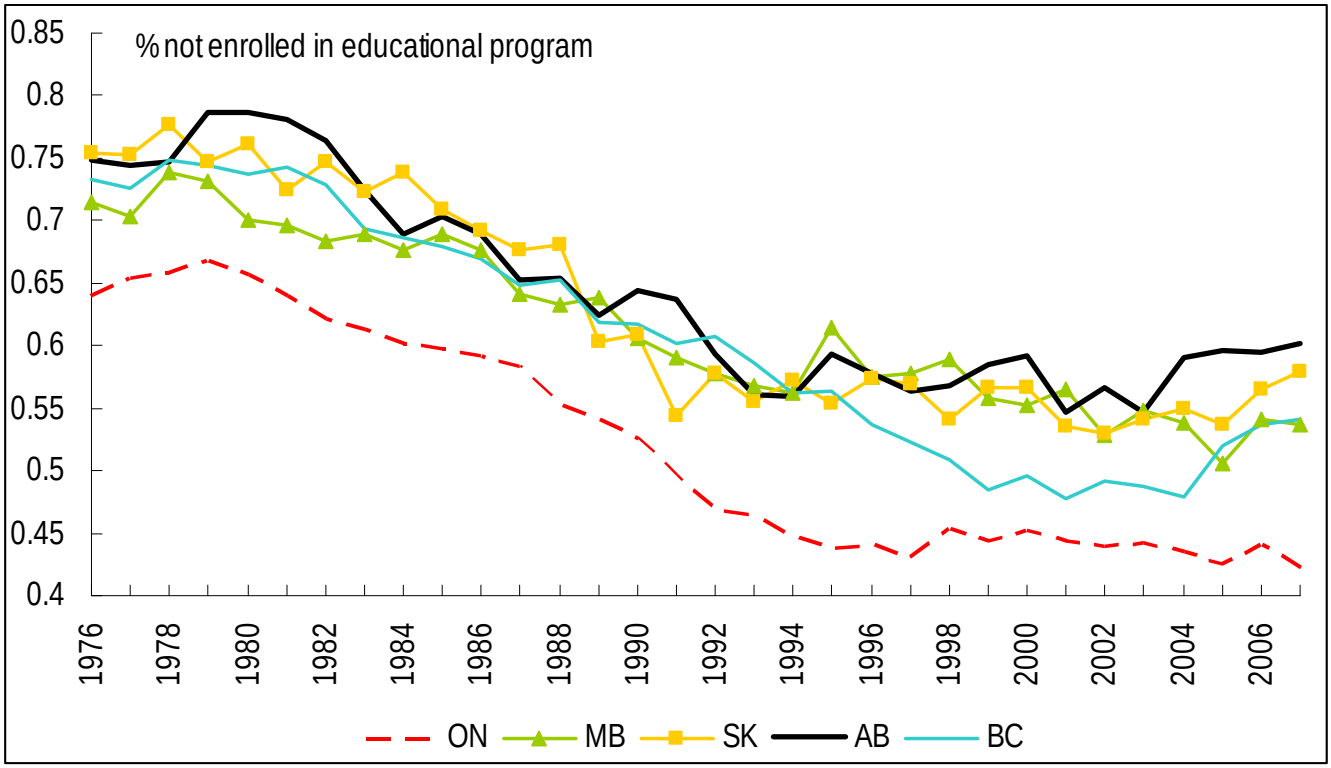
Source: CANSIM series v2461476.. v2467987

Figure 4: Personal Income Per Capita Relative the Canadian Average, 1946-2004



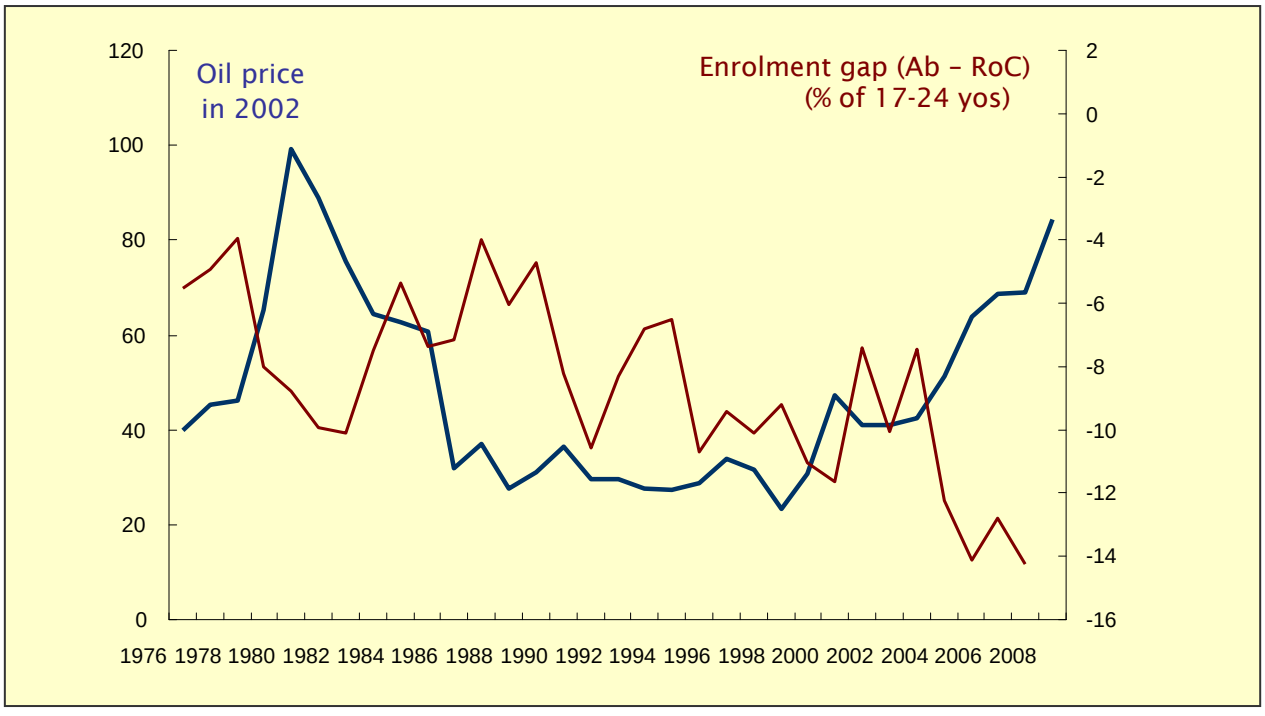
Source: Provincial incomes are divided by the value of Canada in a given year. (Sources: Personal Income Per Person 1946-1980, Average Personal Income: *Economic Reference Tables* (1991), Published by Government of Canada, Department of Finance (Table 16). Personal Incomes Per Person 1981-2004 from Cansim Table 3840013; Canada, CANSIM II SERIES V691802, Manitoba, CANSIM II SERIES V691963, Saskatchewan, CANSIM II SERIES V691986, Alberta, CANSIM II SERIES V692009)

Figure 5. Percentage of individuals 17-24 years old not enrolled in a post-secondary program



Source: Labour Force Survey (1976-2006)

Figure 6. Oil Prices and the Enrolment Gap (Alberta vs the rest of Canada**)**



Author's calculation using the Labor Force Survey and Historical Statistics of Canada, Series Q20.
RoC includes Ontario, Manitoba, Saskatchewan and BC

Figure 7a Distribution of Age at Graduation of post secondary degrees (except graduate degrees).
Males in Alberta

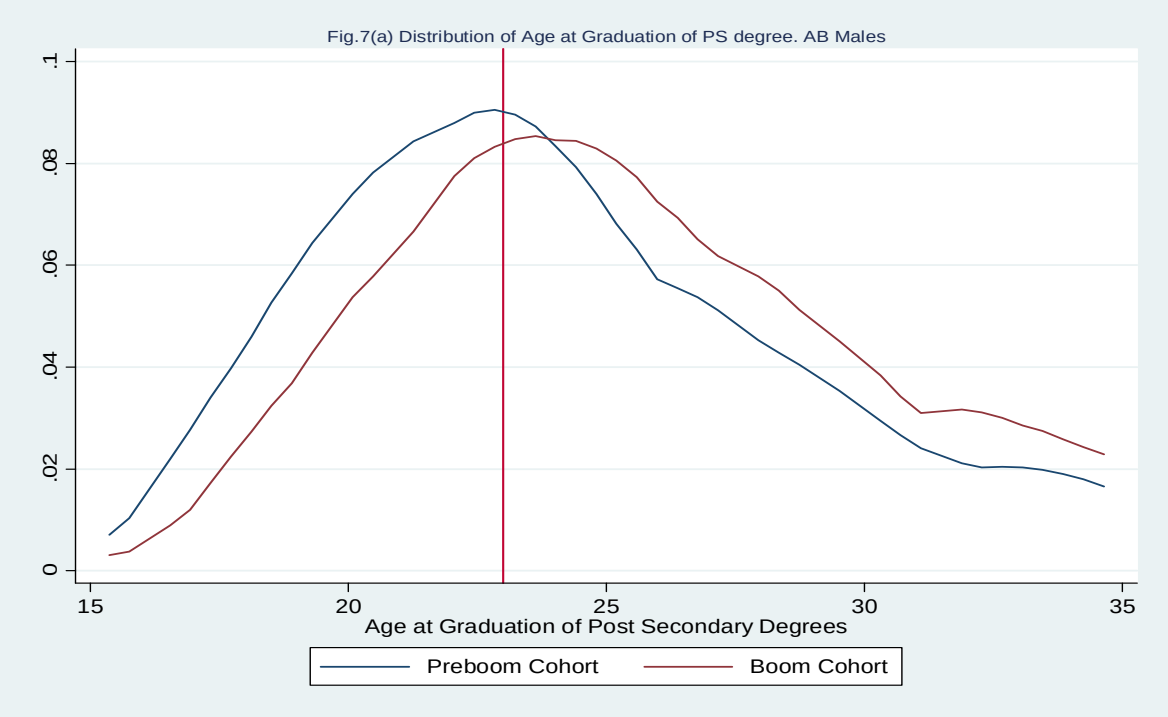
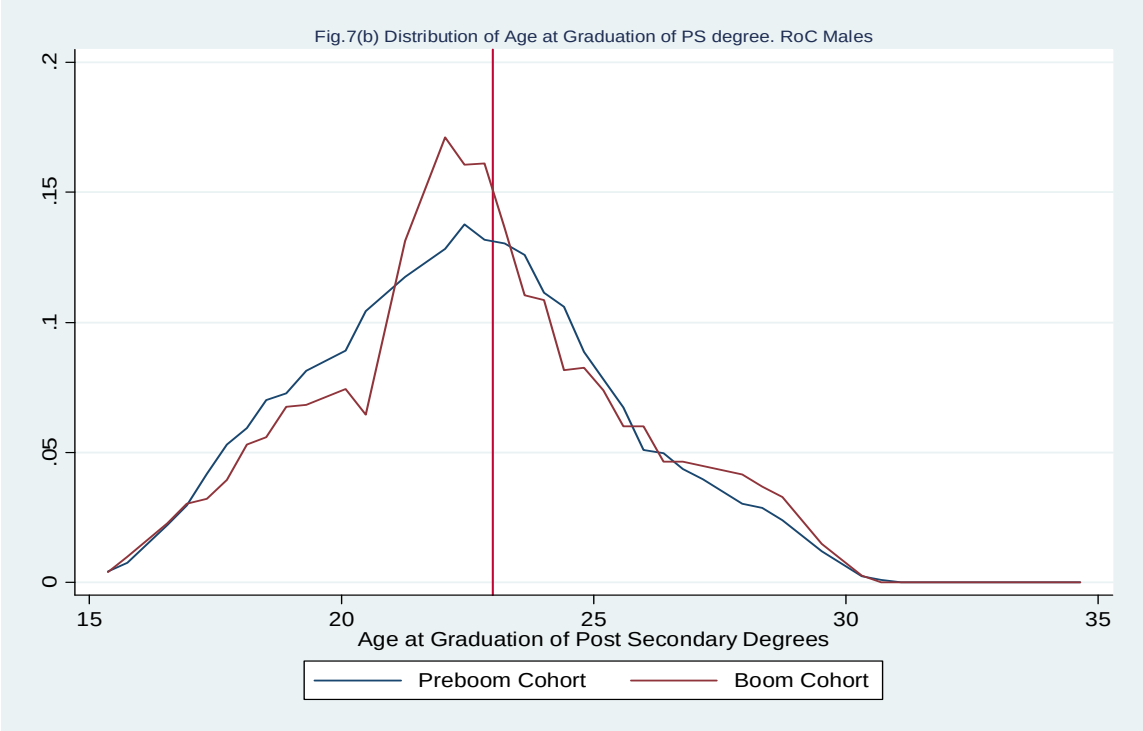


Figure 7b Distribution of Age at Graduation of Post secondary degrees (except graduate degrees).
Males in the rest of Canada**.**



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

Appendix

Appendix Table 1. Comparison of Educational Achievement between Census and IALS

	IALS 2003	CENSUS 2001
Less than High School	5,841.71	87,092
%	25.36	24.65
High School	7,172.32	94,610
%	31.13	29.39
Non university-Postsecondary	4,941.55	80,993
%	21.45	22.93
Postsecondary (> 1 yr)		26,759
%		7.57
Postsecondary (2 yrs)		25,531
%		7.23
Postsecondary (3+ yrs)		28,703
%		8.12
University	5,082.42	80,423
%	22.06	22.76
Total	23,038	353,294

Source: Authors tabulations using the Census and the IALS

Appendix Table 2. Fraction of Alberta born residing in Alberta

	All	0-18	19-24	25-35
Year				
1971	**0.80**	0.87	-	0.77
1981	0.78	**0.84**	0.84	0.77
1986	0.78	0.84	**0.84**	0.79
1991	0.78	0.86	0.84	0.78
1996	0.78	0.82	0.83	0.79
2001	0.79	0.83	0.83	0.81
Overall	0.79	0.85	0.85	0.79

Authors'tabulation using Census (1971-2001)

Appendix Table 3. Mobility between Province of Birth and province of High School (2003)

	Province of High School						
	Atlantic	QB	ON	Prairies	AB	BC	Total
Province of birth							
Atlantic	**93.5**	0.6	1.2	0.8	1.4	1.3	8.47
QB	1.3	**97. 4**	2.5	0.5	0.8	0.7	22.38
ON	3.3	1.3	**91.8**	2.6	2.6	3.8	24.07
Prairies	0.7	0.6	1.5	**92.7**	7.9	6.7	8.88
AB	0.8	0.1	1.6	2.4	**83.3**	8.3	6.57
BC	0.3	0.1	1.5	1.00	3.7	**78.6**	6.74
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Authors'tabulation using IALS (2003)

Table 4. Long run Effect on Weekly Earning. Males (IALS,2003)
(2 step weighted least squared estimation. Robust standard errors in parenthesis) [1]

	(I) Age	(II) Skill
Model [(2)]		
1. Basic	-0.050	-0.067
	(0.279)	(0.302)
2. Selection	-0.028	-0.069
	(0.289)	(0.295)
Probability of positive earnings		
Presence of others in household	-0.045 ***	-0.035 **
	(0.017)	(0.015)
Presence of child 0-5	-0.008	0.144***
	(0.018)	(0.016)
Presence of child 6-12	-0.037 **	0.153 ***
	(0.019)	(0.016)
Inverse Mills ratio	-3.085***	-0.647**
	(1.209)	(0.308)
Observations	16	16

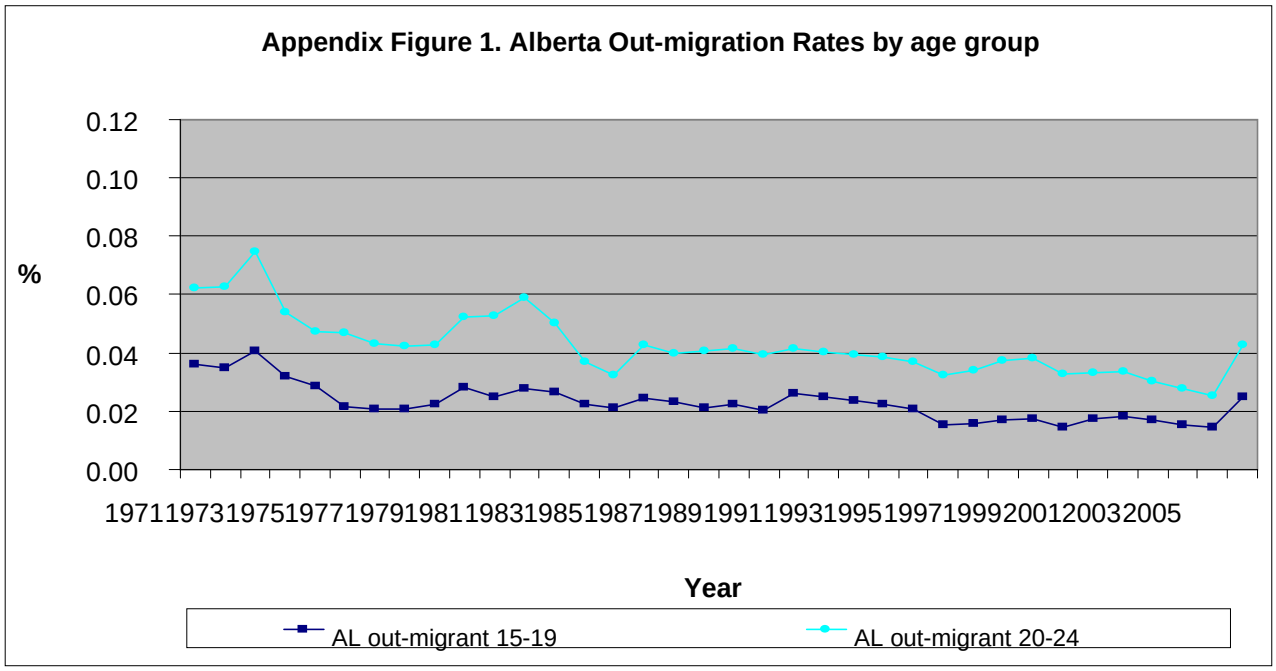
[(1)] Data is aggregated at the cohort-province level. Estimated using 2 step weighted least squares, where the weights are the man number of observations in the relevant cohort-province cell

[(2)] Column labeled (I) shows the coefficient of a difference in difference estimation of the effect of the boom (1961-1964) versus the pre-boom cohort (1953-1956), in Alberta versus the rest of Canada, controlling for age and age squared. In addition:

1. Includes, in the first step of the estimation, controls for province of residence and immigrant status
2. Includes, in the first step of the estimation, the inverse Mills ratio from a probit estimation of positive earnings where family background variables (presence of children, age of youngest child and presence of other household members) are used as exclusion restriction

Column II replaces age and age squared with skill controls (experience, experience squared and educational attainment indicators)

(**) indicates significance at 10%, (***) indicates significance at 5%


Appendix Figure 1. Alberta Out-migration Rates by age group
0.12
0.10
0.08
0.06
0.04
0.02
0.00
%
1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005
Year
AL out-migrant 15-19
AL out-migrant 20-24