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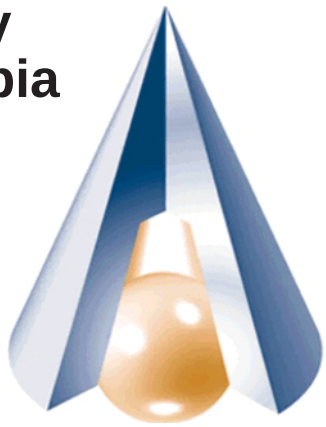
Cohort Effects in Annual Earnings by Field of Study Among British Columbia University Graduates



by Andrew Heisz

Business and Labour Market Analysis Division
24-F, R.H. Coats Building, Ottawa, K1A 0T6

Telephone: 1 800 263-1136

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Statistics Canada

How to obtain more information :
National inquiries line: 1 800 263-1136
E-Mail inquiries: infostats@statcan.ca

The paper is available on Internet: (www.statcan.ca)

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ABSTRACT

Using a dataset which combines the 1982-1997 tax records with administrative records of British Columbia bachelor's graduates from the classes of 1974-1996, this study examines the real annual earnings of graduates across 20 major fields of study for significant changes in earnings across cohorts. Male graduates in more recent cohorts had lower mean earnings after graduation but higher returns to experience. Recent cohorts of women graduates had equal earnings levels after graduation and higher returns to experience. Mean earnings differed among fields of study, favouring applied degrees in Teacher Training, Commerce, Engineering, Nursing and Medical Sciences, but cohort effects were statistically identical for graduates from all fields of study. These results show no evidence of a major change in earnings consistent with a decline in returns to a university education, or a shift in demand favouring specific degrees. This paper places these findings in an environment of increasing demand for skills resulting from technological change. While the supply of university graduates increased over the period, there were no large changes in relative supply among the 20 major fields of study examined. Hence the stability of relative earnings across cohorts is consistent with the argument that increased demand for skills has favoured graduates from academic programs in the Humanities, Social Sciences and Sciences and applied graduates equally.

Keywords: Returns to education, university education, earnings. JEL: I21, J31

1. Introduction

It is widely accepted that one important route to success in the labour market is through a university education. There are two views as to why this is the case. In one view, technological change in the form of information, computer and communications technologies has increased the demand for skilled workers relative to unskilled workers. Recognizing this, young Canadians obtain the skills necessary for future success through a university education. In the other view, a long period of adverse labour market conditions for young Canadians has resulted in employers upgrading the requirements for jobs. Here, the university degree still provides the path to a job, but the graduates' skills may be underutilized and the resources devoted to that education appear in some sense wasted[1].

A key component of this debate is the relative earnings of university graduates. Unlike the situation in the United States, it has been shown that there has been no large rise in the earnings of the university educated relative to high school educated in Canada (Riddell and Sweetman (2001); Murphy, Riddell and Romer (1998); Bar-Or et al.(1993)) although there have been absolute declines in the earnings of recent university graduates (Beaudry and Green, 2000). Murphy, Riddell and Romer (1998), investigate how the university wage premium in Canada has remained stable despite the increase in demand for skilled workers as a result of skill-biased technical change. They find evidence consistent with the view that an increasing supply of university graduates has offset the steady increase in demand for university graduates with the result that relative wages remained stable.

Less is known about a related component: changes in the relative earnings of university graduates from various fields of study. Have some fields enjoyed an increase in earnings while others have not? The answer to this question is important as it sheds light on the policy question of how to balance program funding between academic subjects, which teach general or broad-based skills, and applied, or technical/vocational studies which provide skills relevant to particular jobs. It may be that in today's labour market job-specific skills are increasingly rewarded, boosting the earnings of graduates from applied programs such as Engineering or Medical Sciences relative to academic programs. It may also be that the change has been towards a premium on general skills such as literacy and numeracy. Under this view, the relative earnings of graduates from academic disciplines in the Humanities, Social Sciences and Sciences may be increasing. Due to the lack of suitable data on the long term earnings of university graduates that also identifies the field of study from which they graduated, examination of this issue in Canada has been limited to short-run outcomes (Allen, (1998); Finnie, (2001); Boothby, (2000)).

Using administrative data this study examines the annual earnings of bachelor's graduates of British Columbia universities who graduated between 1974 and 1996 for up to 23 years after they graduate. Twenty-three graduate cohorts from 20 fields of study are examined to determine how earnings and earnings growth differed between fields and

[1] Riddell and Sweetman (2001) provide a more detailed introduction to this debate.

across cohorts. The length of post-graduation years available for analysis in this dataset offers a unique view on the long term prospects of university graduates. The approach used in this study is to first examine cohort specific experience-earnings profiles to determine if there is evidence of a significant shift up or down in earnings or earnings growth for more recent cohorts. This allows some insight into whether the earnings of more recent cohorts of B.C. university graduates have declined relative to past graduates. Then, these cohort effects are evaluated by field of study, placing a particular emphasis on identifying cross-cohort shifts in earnings that are consistent with a relative shift in demand towards academic or applied degrees.

This study finds that average real earnings for male graduates were lower for more recent cohorts than past cohorts in the first years following graduation. However, the rate of growth in earnings was higher for more recent graduates, so earnings eventually surpassed those of the earlier cohorts. Recent women graduates start out at the same earnings level as past graduates, but enjoy faster earnings growth as they gain experience[2].

This study also finds that mean earnings differed among fields of study, favouring applied degrees in Teacher Training, Commerce, Engineering, Nursing and Medical Sciences, but cohort effects were statistically identical for graduates from all fields of study. Hence, for these graduates, there was no significant relative shift in earnings favouring applied or academic degrees. Interpreting this result in terms of supply and demand shifts suggests that the labour market has been absorbing graduates from applied and academic backgrounds in a balanced manner, and that there has been no shift in demand that was not offset by a corresponding shift in supply. Overall, these results offer no evidence of a monotonic decline in the earnings profiles of university graduates or a relative decline in earnings of academic compared to applied graduates.

Stability in relative earnings by field of study can be the result of an increase in relative demand for graduates with certain skills which was offset by an increase in this type of graduate, or, in the absence of relative supply shifts, it can result from an equal increase in demand for skills associated with all types of graduates. The study finds that while the absolute supply of university graduates rose, relative supply of graduates from different fields of study was stable over the period. This supports the second explanation that technological change has increased demand for skills associated with both applied and academic disciplines.

[2] These results should be placed in the context of literature which examines changes in relative earnings for younger and older workers, and in particular the relative and absolute decline in the earnings of young men. Two proposals have emerged to explain this phenomenon: (1) that this represents an increase in returns to experience (e.g. Juhn, Murphy and Pierce, 1993; Katz and Murphy, 1992; Bound and Johnston, 1992; Davis, 1992); and (2) that this represents a shift downward in earnings across age cohorts such that earnings of more recent cohorts start out lower, and do not catch up as they age (Beaudry and Green, 2000). This study finds evidence consistent with the former explanation for British Columbia university graduates which is in contrast to national level results showing evidence for the latter explanation.

The next section reviews the literature and describes the econometric model used to decompose movement in earnings across cohorts and time. Section 3 discusses the data in detail, and section 4 discusses descriptive and econometric results. Section 5 concludes.

2. Methods and Background

This study examines the post-graduation annual earnings of university students using the human capital earnings function outlined in Beaudry and Green (2000). In this model, the log of earnings is related to the potential experience of the graduate, and the shape of this relationship is allowed to vary across cohorts. The following estimates the equation:

$$\ln(y)=\beta_0 + \beta_1 C + \beta_2 C^2 + \beta_3 T + \beta_4 T^2 + \beta_5 T^3 + \beta_6 T^4 + \beta_7 CT + \beta_8 UR. \quad (1)$$

Estimation of equation (1) provides the experience-earnings profile. Changes in the shape of this profile over time provide us with information on changes in the levels of earnings for graduates as well as changes in the rate of return to experience in the labour market. In equation (1), *ln(y)* is the log of real annual earnings, *C* is a cohort vector where *C=i* for the graduating class of *1973+i*. *C* captures the change across cohorts in earnings due to a shifting of the experience-earnings profile, with negative values for β_1 indicating that the profile is shifting down over time. C^2 captures the possibility that cohort earnings were falling at an increasing or decreasing rate. *T* measures the number of years passed since graduation, and reflects potential post-graduate experience. *T*, T^2, T^3 and T^4 together represent a quartic experience-earnings profile. The quartic provided the best fit across all models, with the 4th term usually significant. *CT* is an interaction term between cohort (*C*) and time since graduation (*T*). Positive values for β_7 indicate that the growth rate of earnings was increasing across cohorts, while negative values indicate that the growth rate was declining across cohorts. *UR* is the quadratically detrended unemployment rate for B.C. workers aged 45-54, and is included to capture cyclical effects on earnings.[3] Note that equation (1) is not estimating a causal model of earnings. It is simply a useful way of decomposing descriptive results into different components.

Beaudry and Green (2000) used successive cross sections of the Survey of Consumer Finances (SCF) to examine age-earnings profiles across synthetic cohorts and found that age-earnings profiles of male graduates had been shifting downward across cohorts since the mid-1960s, implying that at every age level, more recent graduates earned less than past graduates. For women, age-earnings profiles appeared to be pivoting. Recent women graduates also started out at a lower earnings level than past women graduates, but their

[3] The detrended unemployment rate (UR_{di}), equals $\beta_0 + \varepsilon_i$ obtained from the OLS regression $UR_i = \beta_0 + \beta_1 TIME_i + \beta_2 TIME_i^2 + \varepsilon_i$, where UR_i is the unadjusted unemployment rate for men and women aged 45-54 in year i and $TIME_i$ indexes years. Actual and detrended unemployment rates are:

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
UR	8	9.1	10.5	10.3	9.1	8.6	8.1	7.1	5.4	6.6	7.4	7.4	6.3	5.6	6.4	5.8
UR_d	8.3	9.7	11.4	11.4	10.5	10.3	10.1	9.3	7.9	9.4	10.4	10.7	9.8	9.4	10.5	10.1

earnings rose at a faster rate with age, suggesting a quick catch up and eventually higher earnings relative to past cohorts. In the terms of equation (1), Beaudry and Green found negative coefficients for β_1 for both men and women, indicating a shifting down in starting earnings, and a positive coefficient for β_7 for women but not for men, indicating an increasing return to experience for women but not men.

Allen (1998) studied census data for the years 1970, 1980 and 1990 and the SCF for 1995 for young men and women aged 25-29 in British Columbia and similarly found an erosion of real earnings for all education levels between 1980 and 1995. The decline for men was about 12% and for women it was about 5%. These declines were shared by young men and women of all education levels. While these studies examined cohort patterns of earnings of university graduates compared to non-graduates, they were not able to examine relative cohort patterns among fields of study.[4]

Riddell and Sweetman (2001) examined synthetic cohorts of university graduates using the 1971, 1981 and 1991 censuses. They concentrated on patterns in wages of higher education groups relative to the high school educated, and found that these were stable across cohorts. Altogether they conclude that there is wide-spread evidence consistent with the view that there has been a steady increase in the demand for skills in Canada.

Finnie (2001) examined earnings differentials by major field of study from the 1982, 1986 and 1990 National Graduates Surveys (NGS), and their respective two and five year follow up surveys. This set of surveys offers the possibility to examine two and five year outcomes across three cohorts of graduates by detailed field of study using longitudinal data. Finnie examines bachelor's graduates who, by two and five years out had not completed a second degree and were not enrolled in another program. Across cohorts, raw earnings were found to be falling for men (measured both two and five years out) and rising for women two years out but not five years out. Finnie also discovered substantial variation between majors, and earnings growth rates also varied by field of study, but did not make any conclusions regarding how these cohort effects might vary by field of study. Boothby (2000) examined the same data for stable differences in earnings among fields of study.[5]

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[4] These and other studies look at other outcomes (besides earnings) of university graduates as they have changed across cohorts. For example, Beaudry and Green (2001) examined employment outcomes for university graduates and found little evidence of a widespread decline in employment for men or women, however, recent cohorts of men with less education were doing much worse than past cohorts.

[5] There is also a large literature examining the relative earnings of university graduates from different fields of study in a cross sectional environment, or using single cohorts. These include Allen (1998), Côté and Sweetman (1998), Lin, Sweet, Anisef and Schuetze (2000) and Giles and Drewes (2001) in Canada, and Hecker (1995) and Black, Sanders and Taylor (2002) in the US. Heisz (2001) examines the relative market incomes of university graduates across cohorts for evidence that graduates incomes from different degrees converge as post-graduate experience is obtained. Heisz (2003) examines the distribution of annual earnings of B.C. university graduates by field of study to see which graduates rise to the top of the earnings distribution.

3. Data

The dataset used in this study consists of a large sample of bachelor's graduates from British Columbia universities drawn from two administrative data sources. Information on B.C. graduates from the years 1974 through 1996 is obtained from the University Student Information System (USIS). Annual earnings, defined as the sum of taxable earnings from employment and self-employment, is then added for all post-graduation years between 1982 and 1997 using tax information from the T1 Family File. Earnings are converted to real terms using the Consumer Price Index (CPI) (2002=100) as a deflator. These datasets are merged using the graduates' Social Insurance Number (SIN) as a matching key. The resulting datafile is longitudinal and contains graduates' earnings in each post-graduate year that they filed a T1 tax return between 1982 and 1997. While USIS is a national databank, the completeness of reporting of the matching key varies widely from province to province in that data. It is most complete for graduates from B.C. universities, prompting a focus on that province for the present study. USIS identifies graduates from diploma programs, bachelor and graduate degrees, but this study examines graduates from bachelor programs only.

The earnings of men and women are examined separately across 20 fields of study. Graduates from professional degrees in Dentistry, Medicine and Law are excluded from this analysis. Also excluded are graduates from Religious and Theological studies since these groups had low SIN reporting rates.

The use of administrative data means, in principle, we could obtain a census of B.C. graduates. Tables 1 and 2 contain basic statistics relating to the size and completeness of the data. In the first column of Table 1 are the numbers of bachelor's graduates from B.C. universities for each graduating year from 1974 to 1996 (excluding the fields listed above). The annual number of graduates has roughly doubled over this period from 4,884 to 10,330. Shortcomings in the data dictate that the SIN is not present for all graduates. The second column in Table 1 shows the fraction of graduates with a SIN identified. This rate ranges from lows of 87.8% of graduates in 1995, to highs of more than 94% in other years. Missing a SIN code on the USIS may be because (1) the student did not have a SIN code (perhaps because he or she was a foreign student), (2) the student had a SIN code, but either did not give it to the institution or the institution did not request it, or (3) the institution collected the SIN code but did not report it on the USIS survey. Other than a slight trailing off after 1990 there appears to be no strong trend in SIN reporting.[6] The third column of Table 1 shows the fraction of graduates who were successfully matched to the T1FF in at least one year between 1982 and 1997. Match rates to the T1FF are exceptionally high as long as the matching key was identified. Overall the match rate

[6] About 16% of graduation records were missing in each graduation year before 1989. For this subset of records graduates were identified as those who were fourth year students in the year before graduation and did not return to any B.C. university in a subsequent year. Results reported in the paper are robust to the exclusion of these records.

ranged between 85.1 and 93.8 percent of all graduates. In what follows, the study assumes that earnings information is matched randomly across earnings levels.[7]

Table 1: British Columbia bachelor's graduates, plus linkage rates

Graduation Year	Graduates	Rate of SIN Identification	Fraction of graduates linked
1974	4884	0.887	0.851
1975	4828	0.935	0.899
1976	4933	0.939	0.902
1977	5066	0.946	0.910
1978	5479	0.933	0.905
1979	5357	0.944	0.916
1980	5554	0.933	0.909
1981	5355	0.924	0.901
1982	5621	0.936	0.915
1983	5833	0.936	0.923
1984	6149	0.940	0.924
1985	6476	0.934	0.922
1986	6949	0.921	0.907
1987	7105	0.946	0.938
1988	7207	0.885	0.879
1989	7337	0.918	0.912
1990	8195	0.917	0.913
1991	8251	0.897	0.893
1992	9759	0.890	0.886
1993	10071	0.885	0.880
1994	10451	0.879	0.874
1995	10582	0.878	0.869
1996	10330	0.881	0.874

This incompleteness of SIN reporting prohibits investigation of education events that occur after graduation from the undergraduate program. This raises the important point that the future earnings of some graduates may derive from further study in some program other than the one in which they did their bachelor's degree. For example, some sciences graduates may later get a law degree. That graduate may earn the wages of a lawyer, but the study measured him or her as having a background in sciences. This is a pitfall inherent in the data, caused by the inability to link bachelor's graduates who go on to graduate studies in, for example, another province. Thus the results in this paper should be thought of as reflecting students at a specific point in their human capital accumulation and not as having necessarily completed their highest level of education.

In the following analysis only graduates for whom there is earnings information are examined–that is, graduates who were successfully linked to the T1 data. For this data to be representative of the population of B.C. graduates, it is important that the demographic characteristics of matched graduates resemble those of unmatched graduates. The

[7] The alternate approach would be to model the selection process using a sample selection model. However, this dataset lacks covariates which might be used to predict the probability of selection, which do not also influence the outcome in question.

minimum to be done is to show that there are no large differences in the characteristics of graduates in and out of the sample. Table 2 shows the number of graduates, averaged across graduation years by field of study. Relatively few men graduate with Nursing or Rehabilitation Medicine degrees, so the results are not reported separately for these graduates. The second column shows the fraction of graduates linked to the T1. While this varies from field to field for men and women, there does not appear to be any major under-representation of men or women for any field of study.

The final sample includes only graduates who were between the ages of 21 and 25 in the year they graduated. Two thirds of linked graduates fall into this age range. This was done to control for the life-cycle position of graduates. All graduates in this analysis had approximately equal age and potential past work experience. Also, post graduate years in which earnings were zero or negative were dropped.[8]

The final column shows the net present value of mean earnings for the 1981 cohort of graduates[9]. Annual earnings are discounted at 3% per year. As in other examinations of relative earnings by field of study this data shows there is a significant earnings premium to graduating with applied degrees in Engineering, Medical Specialties and Commerce, and a discount in earnings associated with some arts and humanities degrees. The objective of this study is to determine if this premium has changed over the panel.

[8] A total of 5.5% or graduates were dropped because they could not be assigned a field of study, they had multiple degrees in different fields, or had professional degrees. In our final analysis sample we have 88,234 graduates.

[9] To generate these values, model C from Table 7 which restricted cohort effects to be equal across fields of study, was estimated, and the net present value of predicted earnings discounted at 3% was computed. Discounting at 0% and 10% gave qualitatively similar results. Standard errors were generated using a bootstrap technique, based on 1000 replications.

Table 2: Graduates and linkage rates by field of study

	Average annual graduates	Fraction of graduates linked	Relative PDV. of annual earnings[a]
Men			
Teacher Training	267	0.917	0.021 (0.013)
Physical Education	68	0.799	-0.04* (0.012)
Kinesiology and Recreation	53	0.950	-0.107* (0.018)
Music, Fine and Applied Arts	103	0.888	-0.428* (0.011)
English	128	0.952	-0.301* (0.012)
History	140	0.924	-0.196* (0.012)
Other Humanities	107	0.800	-0.299* (0.015)
Commerce	461	0.862	0.147* (0.015)
Economics	171	0.874	
Geography	145	0.970	-0.157* (0.012)
Political Science	140	0.923	-0.14* (0.014)
Psychology	157	0.913	-0.185* (0.012)
Other Social Sciences	164	0.946	-0.18* (0.012)
Biology	195	0.949	-0.164* (0.011)
Other Biological Sciences	131	0.947	-0.128* (0.012)
Engineering and Applied Sciences	419	0.954	0.216* (0.015)
Medical Sciences	59	0.968	0.104* (0.016)
Nursing	**		
Rehabilitation Medicine	**		
Physical Sciences	340	0.876	-0.055* (0.012)
All	3262	0.910	
Women			
Teacher Training	706	0.903	-0.09~ (0.037)
Physical Education	64	0.823	-0.121* (0.037)
Kinesiology and Recreation	61	0.915	-0.142~ (0.069)
Arts	185	0.880	-0.429* (0.024)
English	247	0.966	-0.212* (0.033)
History	107	0.931	-0.114* (0.039)
Other Humanities	228	0.872	-0.183* (0.034)
Commerce	264	0.824	0.076 (0.047)
Economics	79	0.761	
Geography	85	0.962	-0.248* (0.034)
Political Science	100	0.937	0.036 (0.052)
Psychology	328	0.933	-0.174* (0.033)
Other Social Sciences	344	0.947	-0.192* (0.033)
Biology	168	0.964	-0.166* (0.035)
Other Biological Sciences	159	0.955	-0.161* (0.034)
Engineering and Applied Sciences	57	0.945	0.15* (0.058)
Medical Sciences	59	0.966	0.274* (0.053)
Nursing	201	0.964	0.014 (0.043)
Rehabilitation Medicine	51	0.937	-0.044 (0.041)
Physical Sciences	94	0.887	0.028 (0.044)
All	3588	0.911	

** less than 25, * significant at the 1% level, ~ significant at the 5% level . Standard Errors are in parenthesis. [a]: Compared to Economics, discounted at 3%.

In Murphy, Riddell and Romer (1998) the stability of the university earnings premium is explained in terms of an increase in demand for university graduates which was offset by an increased supply. Regarding earnings premiums by field of study, it may be that some fields have enjoyed the benefits of increased demand more than others, and that cohort effects were not homogeneous. Of course, increased supply of fields in high demand could offset the increased demand, keeping relative earnings stable across cohorts. Table 3 provides a descriptive look at the supply of university graduates in British Columbia, and cross cohort shifts in the share of graduates from different fields.

The top panel uses Canadian Labour Force Survey (LFS) data from 1976 to 2000 to demonstrate the availability of university graduates in B.C. and the rest of Canada. Since the data source is the LFS, caution must be exercised in comparing results from 1990 and later to earlier years because of an important change in the LFS classification of education status in January 1990. However, the data does reflect the well known increase in the fraction of the population with university degrees (top panel). For example, in B.C., the fraction of men with university degrees rose from 10.3% to 13.4% between 1976 and 1985, and then from 13.1% to 17.0% between 1990 and 2000. For women the growth appears greater, rising from 6.6% to 10% across the 1976-1985 period and 10% to 16.5% across the 1990s. B.C. has tended to have a higher fraction of its population with a university degree than Canada overall, but the gap has been slowly eroding over the time period.

A second indicator of supply of university graduates is the enrolment rate, expressed in table 3 as a fraction of those aged 20-24 that were enrolled in university full or part time during the school year (that is, excluding May to August). The fraction of 20-24 year old men enrolled in university appears to have remained stable across the period, with 10.9% enrolled in 1976, 9.9% enrolled in 1985, 14.7% enrolled in 1990 (when the new question came into use) and 14.2% in 2000. In contrast to men, B.C. women aged 20-24 increased their enrolment rates especially in the 1990s when enrolment rates rose from 9.4% to 20.2%, ending the decade with higher enrolment rates than their male counterparts. Compared to Canada overall, enrolment rates for men and women in B.C. were lower, but grew at an equal pace.

Table 4 investigates the share of graduates by field of study to examine if there was any major shift in the composition of university graduates. Shares of graduates from each field of study are averaged across 5-year periods. Comparing the first half of the 1990s to the last half of the 1970s, we see no major shifts in the field composition of graduates for men. Among the largest fields, Commerce produced 13.8% of graduates in the late 1970s, expanded its share in the 1980s, but had returned to a share of 13.1% of graduates in the early 1990s. The share of Engineering and Applied Sciences, and Physical Sciences swelled similarly in the 1980s, but returned to previous levels by 1991-1995. Other small changes occurred, with Economics increasing its share by 1.4% over the period, Physical Education decreasing its share by 2.5%, and Kinesiology and Recreation increasing its share by 2.2%.

For women, larger changes were observed, as Teacher Training graduates fell as a share of the total by 8.9 percentage points, and Commerce grew by 4.4 percent, Other fields such as Political Science, Psychology and Economics increased their shares by about 1 to 3 percentage points. Considering men and women combined, we again see a shift towards Engineering and Applied Sciences and Commerce in the 1980s, which retrenched in the 1990s. In all, comparing 1976-1980 to 1991-1995, changes in shares by field of study appear to be minor.

In sum, the data on stock of university graduates and enrolment rates suggests that the supply of university graduates rose in recent decades, and especially in the 1990s. However, this increase in supply occurred in a balanced way, yielding no major period long changes in the composition of university graduates. Given an absolute, but no relative changes in the supply of graduates from different programs, the remainder of the paper asks if there is evidence of shifts in earnings among fields of study that might be indicative of shifts in absolute demand for university graduates and/or relative demand of graduates from specific fields.

Table 3: Fraction of population with a university degree and fraction enrolled in university[1]

	Men				Women				Both			
	B.C.		Canada		B.C.		Canada		B.C.		Canada	
Age	20-24	All	20-24	All	20-24	All	20-24	All	20-24	All	20-24	All
					Percent with university degree							
Year												
1976	0.071	0.103	0.067	0.098	0.051	0.066	0.064	0.055	0.061	0.085	0.065	0.076
1980	0.051	0.125	0.059	0.108	0.053	0.080	0.065	0.067	0.052	0.103	0.062	0.088
1985	0.050	0.134	0.059	0.125	0.053	0.100	0.068	0.091	0.051	0.117	0.063	0.108
1990	0.046	0.133	0.062	0.131	0.034	0.100	0.072	0.104	0.040	0.117	0.067	0.118
1995	0.061	0.153	0.067	0.153	0.096	0.136	0.108	0.136	0.078	0.144	0.087	0.144
2000	0.065	0.175	0.063	0.170	0.109	0.165	0.106	0.166	0.087	0.170	0.084	0.168
					Percent enrolled in university full or part time							
Year												
1976	0.109	0.031	0.130	0.039	0.077	0.028	0.092	0.031	0.093	0.029	0.111	0.035
1980	0.083	0.027	0.105	0.033	0.073	0.025	0.088	0.030	0.078	0.026	0.096	0.032
1985	0.099	0.029	0.128	0.037	0.082	0.027	0.122	0.039	0.090	0.028	0.125	0.038
1990	0.147	0.030	0.164	0.038	0.094	0.030	0.167	0.045	0.121	0.030	0.165	0.041
1995	0.143	0.029	0.197	0.039	0.152	0.035	0.214	0.046	0.147	0.032	0.206	0.042
2000	0.142	0.031	0.187	0.036	0.202	0.041	0.245	0.046	0.172	0.036	0.215	0.041

1: Labour Force Survey

Table 4: Share of Graduates by Field of Study

	Men				Women				Both			
Year	76-80	81-85	86-90	91-95	76-80	81-85	86-90	91-95	76-80	81-85	86-90	91-95
Teacher Training	0.095	0.060	0.055	0.099	0.266	0.193	0.166	0.177	0.176	0.128	0.113	0.144
Physical Education	0.037	0.021	0.020	0.012	0.036	0.022	0.017	0.008	0.036	0.022	0.019	0.010
Kinesiology and Recreation	0.006	0.010	0.013	0.028	0.006	0.015	0.016	0.023	0.006	0.013	0.015	0.025
Music, Fine and Applied Arts	0.034	0.032	0.030	0.030	0.053	0.056	0.053	0.049	0.043	0.044	0.042	0.040
English	0.041	0.034	0.036	0.043	0.070	0.065	0.069	0.072	0.055	0.050	0.053	0.060
History	0.048	0.036	0.040	0.048	0.028	0.024	0.027	0.034	0.038	0.029	0.033	0.040
Other Humanities	0.026	0.033	0.032	0.036	0.056	0.065	0.064	0.067	0.041	0.049	0.049	0.054
Commerce	0.138	0.178	0.144	0.131	0.036	0.085	0.088	0.080	0.090	0.131	0.115	0.102
Economics	0.041	0.047	0.069	0.055	0.014	0.017	0.032	0.023	0.028	0.032	0.050	0.037
Geography	0.046	0.045	0.037	0.050	0.023	0.023	0.018	0.028	0.035	0.034	0.027	0.037
Political Science	0.031	0.039	0.050	0.050	0.015	0.024	0.034	0.034	0.024	0.031	0.041	0.041
Psychology	0.048	0.043	0.052	0.048	0.075	0.085	0.096	0.101	0.060	0.064	0.075	0.078
Other Social Sciences	0.043	0.048	0.063	0.051	0.084	0.095	0.104	0.098	0.062	0.072	0.085	0.078
Biology	0.068	0.050	0.058	0.060	0.044	0.038	0.044	0.052	0.056	0.044	0.050	0.056
Other Biological Sciences	0.068	0.038	0.037	0.026	0.078	0.044	0.038	0.032	0.073	0.041	0.037	0.029
Engineering and Applied Sciences	0.120	0.158	0.131	0.118	0.009	0.020	0.018	0.016	0.067	0.088	0.072	0.060
Medical Sciences	0.020	0.017	0.017	0.017	0.017	0.017	0.018	0.014	0.019	0.017	0.017	0.015
Nursing	*	*	*	*	0.052	0.061	0.059	0.055	0.025	0.031	0.031	0.031
Rehabilitation Medicine	*	*	*	*	0.017	0.020	0.011	0.013	0.008	0.010	0.006	0.007
Physical Sciences	0.090	0.112	0.116	0.097	0.020	0.031	0.028	0.024	0.057	0.070	0.070	0.056
Average graduates per year	2734	2810	3411	4180	2467	2937	3740	5434	5201	5747	7152	9615

* indicates an insufficient number available for analysis

4. Results

4.1 Results for men and women

Table 5 shows mean earnings of graduates according to the number of years that have passed since graduation. Results across graduation years are averaged by three year intervals in order to smooth the data. Looking across the rows, men's earnings two years after graduation declined between the 1979-1981 graduate cohorts and the 1990-1992 graduate cohorts from $30,999 to $26,825, which is an 10.9% drop. However, the decline only affected the early years of the experience earnings profile. By seven years after graduation, men that graduated in 1990-1992 earned $9,499 more than those in the 1979-1981 classes. More recent graduates appear to have done well in long-term earnings as well. Comparing the 1974-1976 with the 1984-1986 graduates, seven years after graduation the latter cohort earned $1,828 less while by 10 years out, they earned $5,780 more.

Table 5: Mean earnings by experience (2002 dollars)

	Graduation Year			
	1974-1976	1979-1981	1984-1986	1990-1992
Years from Graduation		Men		
2		30,099	26,856	26,825
3		33,453	31,489	31,322
4		36,314	36,263	35,694
5		39,886	40,331	41,698
7	50,113	47,441	48,285	56,940
10	56,182	59,324	61,962	
15	71,718	75,539		
		women		
2		26,732	23,963	24,721
3		28,010	26,820	27,879
4		28,579	29,345	29,795
5		29,097	31,252	33,234
7	30,484	30,867	34,138	40,861
10	29,789	33,850	36,446	
15	36,854	38,656		

Results for women, shown in the bottom panel of Table 5, are similar. Comparing the 1979-1981 graduates with the 1990-1992 graduates, women in the latter cohort earned 7.5% less, but by four years after graduation these women earned 4.3% more. Comparing long-term earnings, women in recent cohorts also earned more than earlier cohorts.

Table 6 shows the results from variations of equation (1) using OLS regression estimated for men and women separately[10]. Annual earnings are measured in log form so coefficients can be

[10] Robust standard errors were estimated using Huber/White/Sandwich method, clustering within graduates to account for the fact that observations are not independent for repeated observations on a particular graduate. This is achieved using STATA and estimating OLS with the cluster( ) option. Estimation using a random effects model

interpreted as percentage deviation from the reference group for dummy variables and percentage change per year for linear trend variables.

Table 6: Expected changes in experience-earnings profiles for men and women

	men			women		
Dependent Variable	ln(real annual earnings)	ln(real annual earnings)	ln(real annual earnings)	ln(real annual earnings)	ln(real annual earnings)	ln(real annual earnings)
Intercept	9.7837*	9.8830*	10.0575*	9.5009*	9.7921*	9.8717*
	(0.0177)	(0.0242)	(0.0317)	(0.0215)	(0.0274)	(0.0390)
Cohort (C)	0.0051	-0.5241*	-2.6705*	1.1129*	-0.3861*	-1.3351*
	(0.0607)	(0.1147)	(0.3648)	(0.070)	(0.1137)	(0.4372)
Cohort Squared (C^2)			0.0685*			0.0296+
			(0.0121)			(0.0140)
Cohort Years Since Graduation (CT)		0.0807*	0.1892*		0.2483*	0.2963*
		(0.0158)	(0.0199)		(0.0195)	(0.0243)
Years Since Graduation (T)	20.6805*	18.6034*	16.7848*	24.1010*	17.8670*	17.0758*
	(0.5360)	(0.6414)	(0.6617)	(0.5969)	(0.7225)	(0.7529)
Years Since Graduation Squared (T^2)	-1.0337*	-0.9012*	-0.8430*	-2.8192*	-2.4403*	-2.4167*
	(0.0981)	(0.0999)	(0.0997)	(0.1153)	(0.1171)	(0.1170)
Years Since Graduation Cubed (T^3)	0.0184*	0.0140+	0.0139+	0.1479*	0.1361*	0.1361*
	(0.0068)	(0.0068)	(0.0068)	(0.0082)	(0.0082)	(0.0082)
Years Since Graduation^4 (T^4)	0.0000	0.0001	0.0001	-0.0027*	-0.0025*	-0.0025*
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Unemployment Rate (UR)	-1.9175*	-2.0037*	-2.1961*	-1.6476*	-1.9371*	-2.0358*
	(0.1362)	(0.1357)	(0.1327)	(0.1759)	(0.1767)	(0.1720)
Number of Observations	391416	391416	391416	355840	355840	355840
R^2	0.167	0.167	0.167	0.036	0.038	0.038

* significant at the 1% level
\+ significant at the 5% level
~ significant at the 10% level

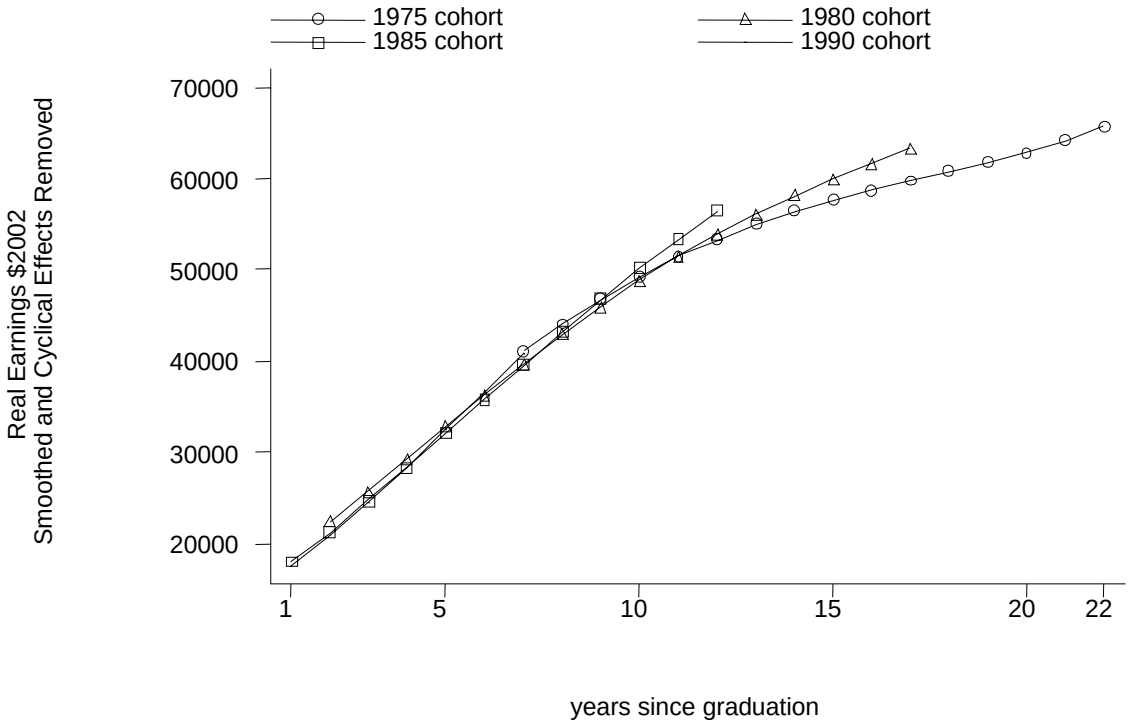
Results for men are shown in columns 1 to 3. Coefficients and standard errors are multiplied by 100. Column 1 shows a model that includes linear cohort effects only. The coefficient on the cohort term (C) in this regression is not significant indicating that there were no period long linear shifts in earnings across cohorts. Column 2 adds the cohort-experience interaction term (CT). Now the cohort term is negative and significant while the experience-interaction term is positive and significant indicating that for men, the experience-earnings profile is changing shape across cohorts, rather than shifting up or down. Results for the full model are shown in column 3.

provided highly similar results, but were not preferred because Hauseman tests typically rejected the assumption of the random effects model that the random effect is uncorrelated with the outcome measure.

A negative term for *C* indicates that cohort intercepts declined while a positive term for C^2 means that they declined at a decreasing rate. The interaction term *CT* is also positive indicating that while the intercept of the experience-earnings profile fell across time, the rate of return to experience for men was increasing. This suggests that changes in the experience-earnings profile between cohorts may be better characterized as a change in shape, rather than a downward shift. That the intercept was shifting down at a decreasing rate suggests that larger declines occurred in the late 1970s and early 1980s compared to the early 1990s.

How large are the changes implied by these coefficients? Figure 1 shows predicted results for selected cohorts of men. Earnings of recent cohorts started out lower but began to surpass those of earlier cohorts between 5 and 10 years following graduation. According to the regression results, male 1990 graduates earned 6.3% less two years after graduation than their 1980 counterparts did. However, the gap narrowed to 2.7% four years after graduation, and within five years of graduation, the gap had virtually disappeared. By 1995 the decline in earnings after two years was reduced to 4.5% indicating that the trend in recent years is towards higher earnings after two years experience.

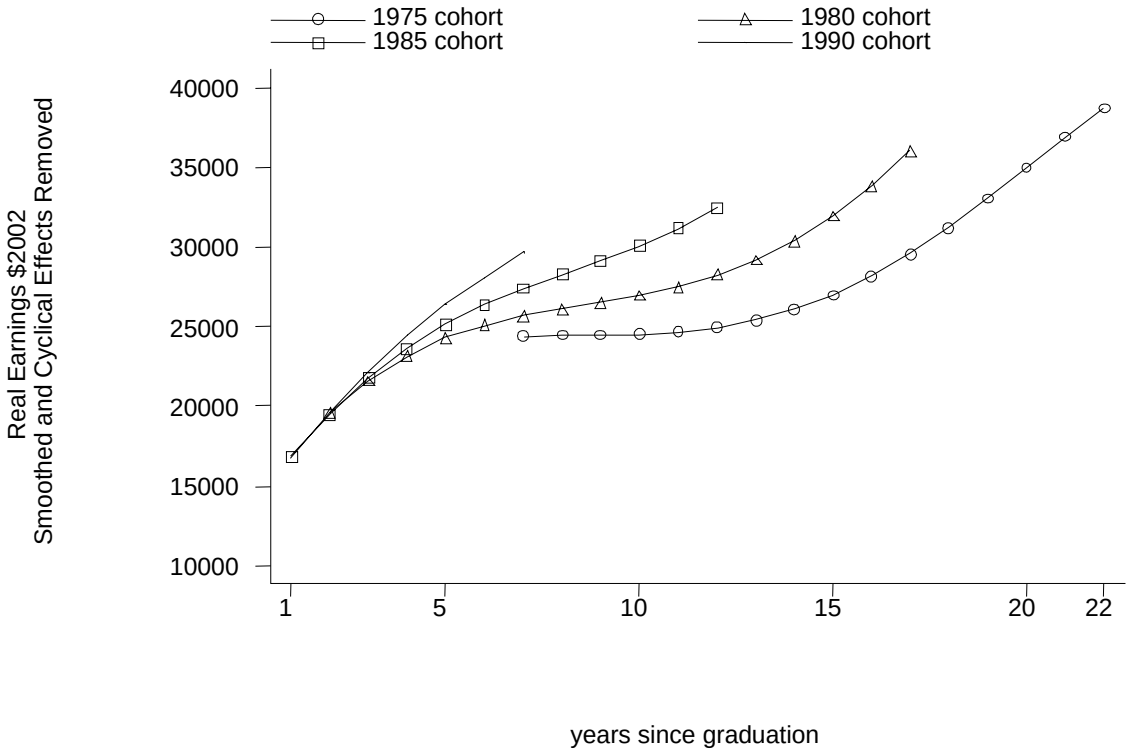
Figure 1: Predicted Experience-Earnings Profiles, Men



Columns 4 to 6 of Table 6 show results for women. Column 4 restricts cohort effects to be linear shifts in the experience earnings profile. The cohort term is positive and significant, indicating that earnings for women university graduates shifted up across cohorts by 1.1% per year across the 1970, 1980s and 1990s. The model in column 5 adds an experience interaction term. Here the upward shift across cohorts is captured entirely by the experience interaction term. For women,

the upward shift in earnings across cohorts appear to be due to increasing returns to experience. The full model is in column 6. Overall, earnings in the years immediately following graduation shifted down at a decreasing rate (coefficients on C and C^2 are negative and positive respectively) while returns to experience rose (the coefficient on CT is positive and significant). Figure 2 shows predicted values for selected cohorts of women. Any downward shift in cohort intercepts is negligible once experience effects are incorporated, while returns to experience are clearly higher for more recent cohorts. Comparing the 1980 and 1990 cohorts, by five years of experience, women in the latter cohort earned 8.9% more and 14.3% more by seven years after graduation. A slowdown in women's earnings that started about five years following graduation for earlier cohorts appears, for more recent cohorts, to have either lessened or been postponed until after more post-graduation experience was obtained.

Figure 2: Predicted Experience-Earnings Profiles, Women



To check these results, model (1) is estimated using the Survey of Consumer Finances (SCF) and a manner of constructing a sample similar to Beaudry and Green (2000) for men and women. That is, synthetic cohort data is constructed using the individual files from the 1977 and 1979-1997 SCFs, restricting individuals to the ages of 25 to 55. Age replaces experience (years from graduation) in these regressions. Regressions are conducted using weighted OLS where cell weights are given by the unweighted count of the number of observations used to make up the cell averages. The 4^{th} term from the age-earnings profile was dropped due to the limited number of observations in the data, and the desire to make the results comparable to those in the literature. As before, the coefficients and standard errors are multiplied by 100. Table 7a and 7b

show results for men and women respectively. The first column in each table shows national results using only the 1993 and earlier SCFs and the log of weekly wages as the dependent variable. These results are highly similar to those reported in Beaudry and Green Tables 2 and 4 which show a downward shift in intercept terms for men and women, and no significant rise in the slope of the age-earnings profile across cohorts for men, but a significant rise for women. Columns 2 and 3 show results using annual earnings as the dependent variable and all available cross sections. Column 2 shows national results. For men, the results for β_1 and β_7 are left substantially unchanged, whereas for women, the coefficient on β_1 is positive and significant. Column 3 shows results for university graduates living in British Columbia. These results indicate a shifting down in university graduates starting wages (negative β_1), but a significant increase in the slope of the age-earnings profiles for men. For women the direction of change is similar, but statistically insignificant. Columns 4 to 6 in each table repeat the above analysis with a restricted specification that drops the cohort squared term which was insignificant in most regressions. Here the results are more clear. Nationally, more recent male university graduates are facing lower age-earnings profiles than earlier graduates. For women, the change in profiles is better described as a change in shape—starting out at lower earnings, but enjoying faster earnings growth. The story for graduates living in B.C. is slightly different. For male recent graduates, earnings are starting out lower, and growing faster. For women, earnings started out the same but grew faster. Data in Figure 1 showed that between 1980 and 1990, predicted annual earnings declined by 6.3% two years after graduation. A close examination of Beaudry and Green's Figure 5b: "Age Earnings Profiles Allowing Differing Slopes by Cohort-Males, University Educated" shows approximately a 5% to 7% drop in weekly earnings for age 26 across the same period. Thus, in terms of the magnitude of the cohort effects, these results are similar. The main difference is in the cohort-experience interaction term. This difference is important since it reflects on the current debate regarding the factors underlying the increased earnings differential of young to older men and women. It appears that for B.C. university graduates there has been rising returns to experience, while the same cannot be said of Canadian university graduates overall.

Table 7a: Results from the Survey of Consumer Finances, Men

Population:	Canada	Canada	B.C.	Canada	Canada	B.C.
Cohorts:	1977, 1979-1993	1977, 1979-1997	1977, 1979-1997	1977, 1979-1993	1977, 1979-1997	1977, 1979-1997
Dependent Variable:	ln(Weekly Wages)	ln(Annual Wages)	ln(Annual Wages)	ln(Weekly Wages)	ln(Annual Wages)	ln(Annual Wages)
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	6.955*	10.720*	11.410*	6.839*	10.664*	10.846*
	(0.220)	(0.146)	(0.382)	(0.069)	(0.056)	(0.146)
Cohort (C)	-1.849	-1.615	-6.129~	-0.967*	-1.201*	-2.467*
	(1.616)	(1.004)	(2.820)	(0.232)	(0.171)	(0.446)
Cohort Squared (C^2)	0.017	0.007	0.066			
	(0.030)	(0.018)	(0.050)			
Cohort*Age (CT)	0.044	0.038	0.244~	0.014	0.024	0.123*
	(0.059)	(0.034)	(0.098)	(0.018)	(0.013)	(0.033)
Age (T)	5.474*	8.759*	1.712	6.284*	9.130*	5.128*
	(1.730)	(1.154)	(3.263)	(0.910)	(0.737)	(1.978)
Age Squared (T^2)	-0.212*	-0.413*	-0.274~	-0.226*	-0.419*	-0.335*
	(0.056)	(0.045)	(0.122)	(0.049)	(0.042)	(0.113)
Age Cubed (T^3)	0.002~	0.006*	0.006~	0.002~	0.006*	0.006*
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Unemployment Rate (UR)	-0.013*	-0.014*	-0.062	-0.012*	-0.014*	-0.564
	(0.005)	(0.005)	(0.794)	(0.005)	(0.005)	(0.697)
Number of Observations	198	262	262	198	262	262
R^2	0.913	0.930	0.627	0.913	0.930	0.625

* significant at the 1% level
~ significant at the 5% level

Table 7b: Results from the Survey of Consumer Finances, Women

Population:	Canada	Canada	B.C.	Canada	Canada	B.C.
Cohorts:	1977, 1979-1993	1977, 1979-1997	1977, 1979-1997	1977, 1979-1993	1977, 1979-1997	1977, 1979-1997
Dependent Variable:	ln(Weekly Wages)	ln(Annual Wages)	ln(Annual Wages)	ln(Weekly Wages)	ln(Annual Wages)	ln(Annual Wages)
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	6.496*	9.880*	10.761*	6.454*	10.318*	10.360*
	(0.260)	(0.163)	(0.488)	(0.072)	(0.058)	(0.173)
Cohort (C)	-0.428	2.732~	-3.593	-0.112	-0.415~	-0.490
	(1.884)	(1.110)	(3.571)	(0.240)	(0.172)	(0.519)
Cohort Squared (C^2)	0.006	-0.055*	0.055			
	(0.035)	(0.019)	(0.062)			
Cohort*Age (CT)	0.052	-0.041	0.196	0.041~	0.058*	0.094~
	(0.068)	(0.037)	(0.123)	(0.021)	(0.014)	(0.041)
Age (T)	3.185	6.670*	-1.830	3.477*	3.853*	1.049
	(1.973)	(1.234)	(4.007)	(0.964)	(0.758)	(2.302)
Age Squared (T^2)	-0.133~	-0.196*	-0.009	-0.139*	-0.152*	-0.057
	(0.061)	(0.046)	(0.144)	(0.053)	(0.044)	(0.133)
Age Cubed (T^3)	0.002	0.002~	0.002	0.002	0.002~	0.002
	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.003)
Unemployment Rate (UR)	-0.008	-0.008	-1.350	-0.008	-0.009	-1.755
	(0.005)	(0.005)	(1.017)	(0.005)	(0.005)	(0.906)
Number of Observations	198	262	261	198	262	261
R^2	0.749	0.838	0.316	0.749	0.833	0.314

* significant at the 1% level
~ significant at the 5% level

4.2 The evolution of relative earnings by field of study

This section examines differences in cohort effects across fields of study. Table 8 presents mean earnings for selected cohorts of men and women, grouped according to whether their degree was obtained in the Humanities, Sciences or Social Sciences, or Commerce and Engineering, and measured at 5, 10 and 15 years after graduation. Five years after graduation, men from the 1979-1981 graduating cohorts in Humanities, Social Sciences and Sciences earned an average of $36,018. Their counterparts who graduated about a decade later in 1990-92 earned $38,211, or 6.1% more. Commerce and Engineering graduates from the 1979-1981 cohort earned $51,820, while those from the 1990-92 cohort earned $54,325, an increase of 4.8%. Hence examining earnings five years after graduation for men from cohorts spaced a decade apart, we see that (1) earnings were higher in the applied fields of Commerce and Engineering, (2) earnings grew across cohorts for applied and academic graduates, and (3) earnings grew about equally for each group of graduates (the difference in the 6.1% and 4.8% growth rates was not statistically significant, and none of the other growth rates presented in table 8 were significantly different across fields). Examining across other cohorts at other levels of post graduate experience reveals similar results. The same was true for women.

Figures 3a to 3c expand these results to reflect all graduate cohorts in the data. These figures show mean earnings from selected fields of study evaluated relative to Economics graduates, at each of 5, 10 and 15 years after graduation:

$$\frac{\overline{E_{i,y,e}}}{\overline{E_{economics,y,e}}} - 1 \qquad (2)$$

where *i* indexes fields of study, *y* years of graduation and *e* the time that has passed since graduation. To improve the precision of the estimate, I group graduates across two consecutive graduation years. Also shown are 95% confidence intervals for relative earnings computed using bootstrap sampling of graduates and 1000 repetitions.

In all, figures 3a to 3c show no strong evidence of field specific cohort effects for men. The series are essentially flat in most cases, suggesting constant relative earnings across fields. In some cases, they are U-shaped as in Teacher Training and Engineering measured at 5 years after graduation, suggesting a relative decline across the 1970s and early 1980s, but an offsetting relative increase afterwards. Despite the large sample size, the 95% confidence interval for the estimates is quite large reflecting substantial variation across graduates in post graduate earnings which was discussed in Heisz (2003).

The picture for women is similar, not showing any strong cross field cohort shifts (figures 4a to 4c). While some fields show a relative rise in earnings at 10 and 15 years after graduation, the standard errors on these estimates are substantial, making it difficult to say if relative outcomes are rising for these fields.

Table 8: Annual Earnings, Selected Cohorts, Applied and Academic Graduates ($2002)*

	Men			Women		
	Graduate Cohort		%	Graduate Cohort		%
	1979-1981	1990-1992	change	1979-1981	1990-1992	change
5 years						
Humanities, Social Sciences and Sciences	36,018	38,211	6.1	29,796	33,316	11.8
Commerce and Engineering	51,820	54,325	4.8	40,967	45,262	10.5
	1974-1976	1984-1986	% change	1974-1976	1984-1986	% change
10 years						
Humanities, Social Sciences and Sciences	53,911	55,028	2.0	37,432	41,392	10.6
Commerce and Engineering	70,287	69,286	-1.4	44,900	50,293	12.0
15 years	1974-1976	1979-1981	% change	1974-1976	1979-1981	% change
Humanities, Social Sciences and Sciences	67,591	69,474	2.7	43,748	45,742	4.6
Commerce and Engineering	86,367	88,712	2.7	49,222	54,183	10.1

* Composition of graduates by field of study is held constant at starting values, which removes any influence of compositional change within rows. Earnings less than $2000 and more than $500,000 (in $2002 dollars) were removed to reduce the influence of outliers.

Figure 3a: Earnings relative to economics graduates, Men

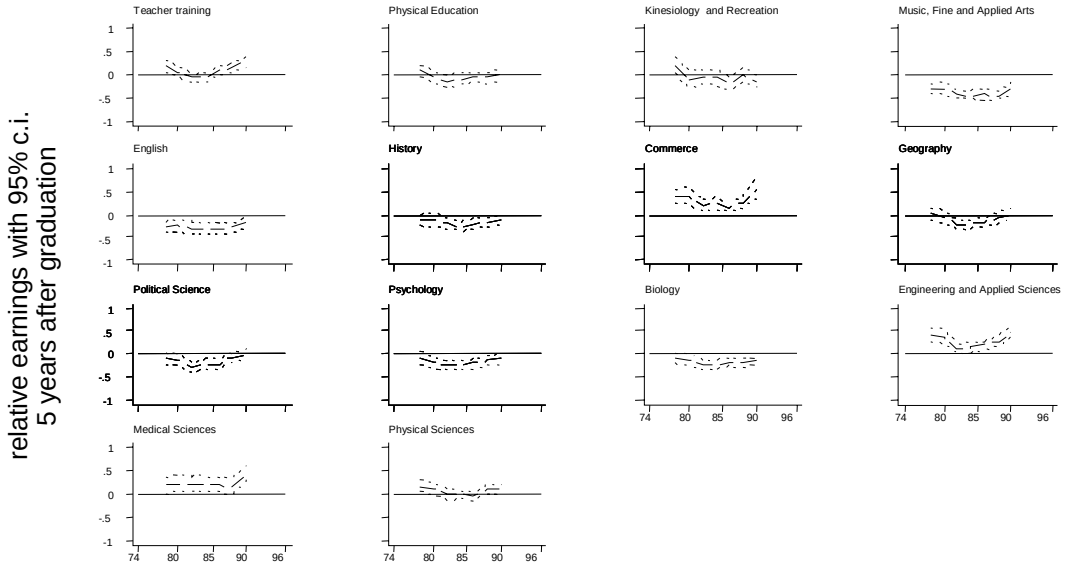


Figure 3b: Earnings relative to economics graduates, Men

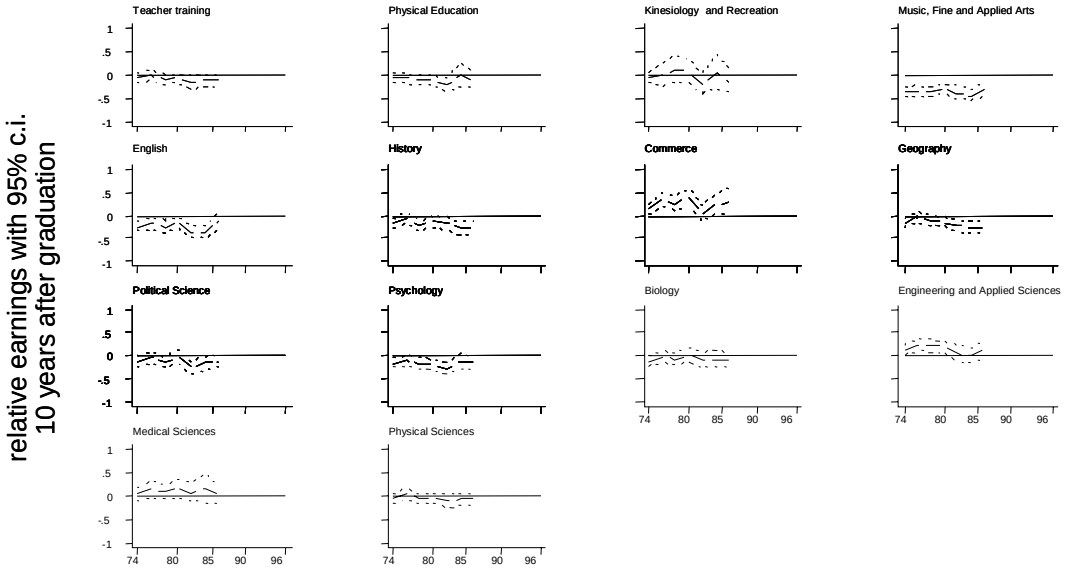
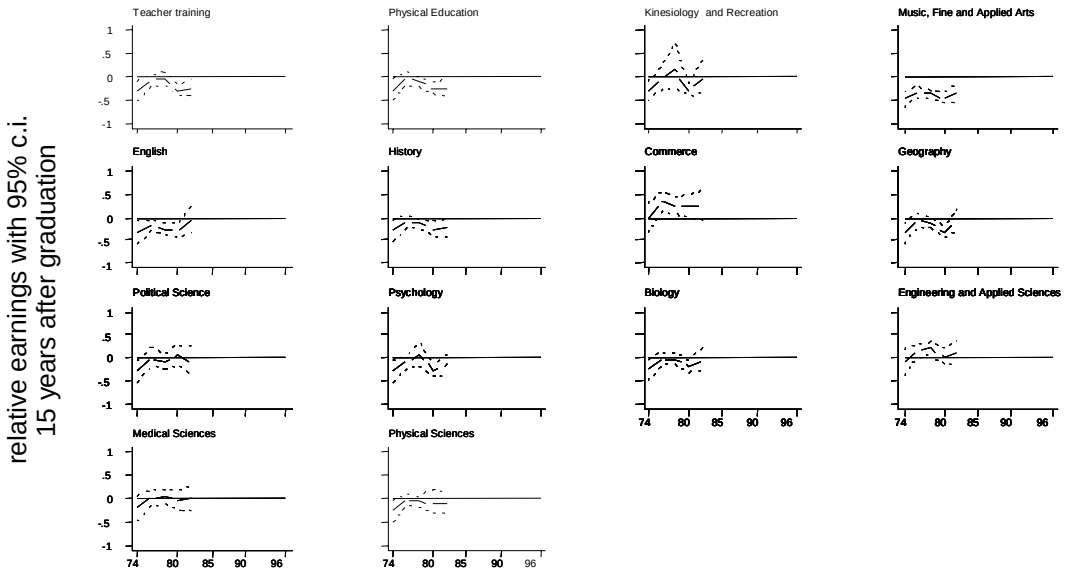


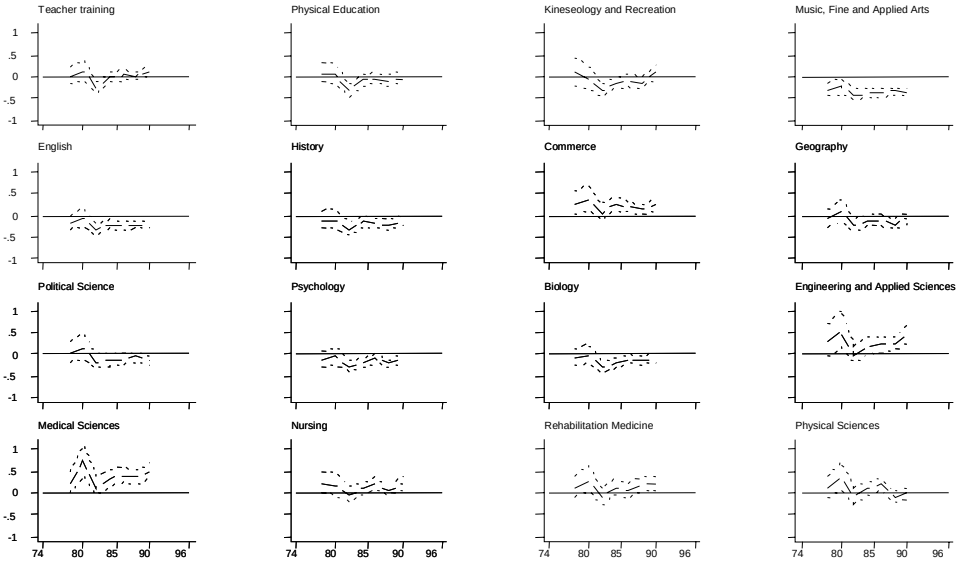
Figure 3c: Earnings relative to economics graduates, Men



relative earnings with 95% c.i.
15 years after graduation

year of graduation

Figure 4a: Earnings relative to economics graduates, Women



relative earnings with 95% c.i.
5 years after graduation

year of graduation

Figure 4b: Earnings relative to economics graduates, Women

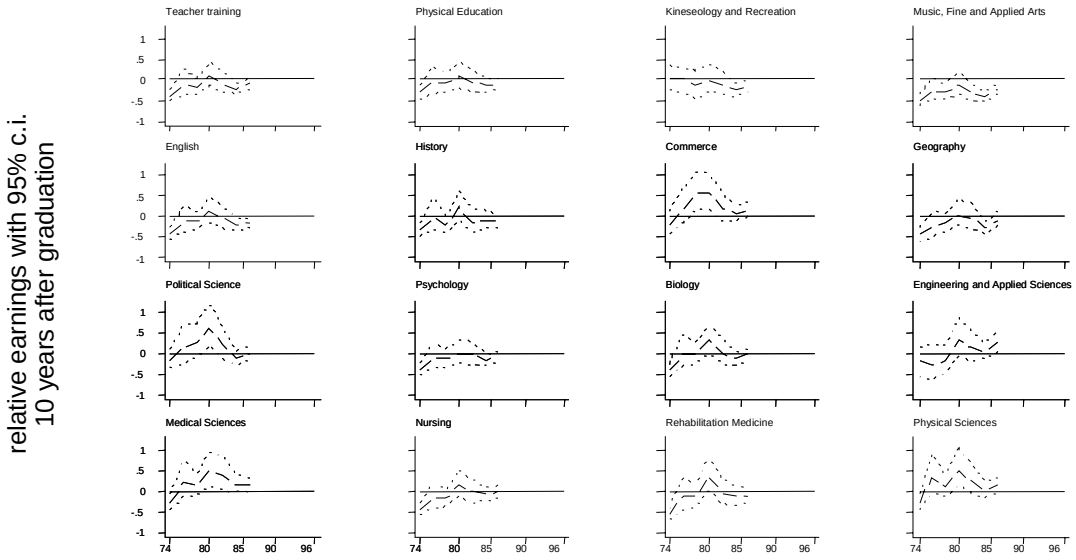
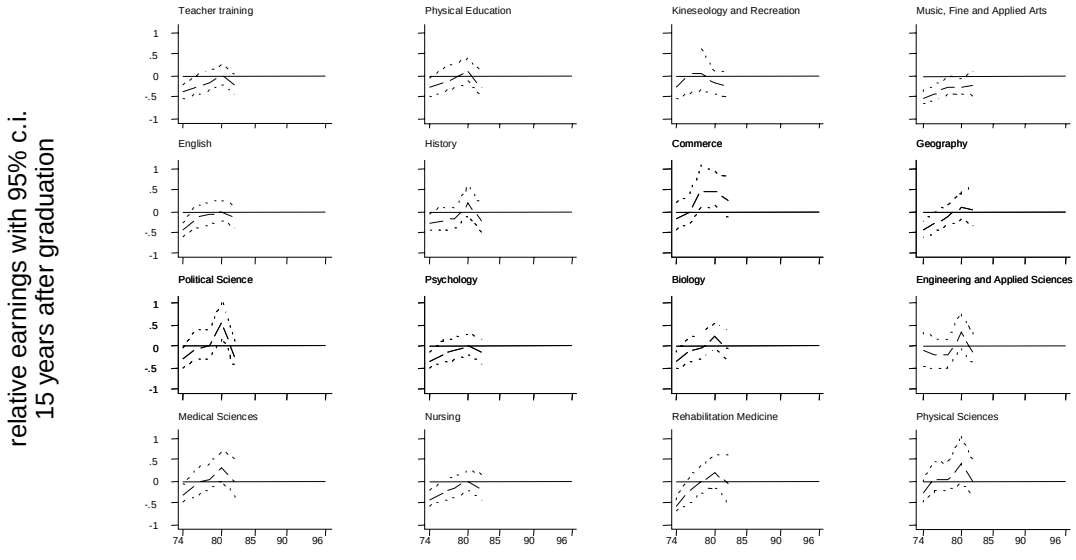


Figure 4c: Earnings relative to economics graduates, Women



4.3 Cohort effects by field of study

This section discusses relative trends by field of study using a simple statistical model. The main question asked here is: were the cohort patterns seen above for all B.C. university graduates experienced in a similar way for all fields of study? To answer this question we construct interacted versions of model 1:

$$\ln(y)=\beta_0 + \beta_1 C + \beta_2 C^2 + \beta_3 T + \beta_4 T^2 + \beta_5 T^3 + \beta_6 T^4 + \beta_7 CT + \beta_8 UR \quad (3)$$
$$+j \text{ field dummies} + j \text{ field dummies} \times (\beta C + \beta C^2 + \beta T + \beta T^2 + \beta T^3 + \beta T^4 + \beta CT + \beta UR)$$

In equation (3) field specific dummy variables are added, and all of the variables of the basic model are interacted with the field dummies to allow each field to have its own experience earnings profile. The empirical strategy is to determine through the estimation of restricted versions of (3) whether the cohort-field interactions are jointly significant. This would indicate that there were significant differences in cohort effects across fields of study.

Given the size of the dataset, it is not surprising that most interactions are significant under standard classical hypothesis tests. In the interest of developing a more parsimonious model this paper estimates restricted models using maximum likelihood (utilizing robust standard errors as above) and evaluates restrictions using the Akaike Information Criterion (AIC) and the Schwarz criterion (SC). These are given as:

$$\text{AIC} = -2 \times \text{log-likelihood} + 2 \times p \quad (4)$$
$$\text{SC} = -2 \times \text{log-likelihood} + \ln(n) \times p \quad (5)$$

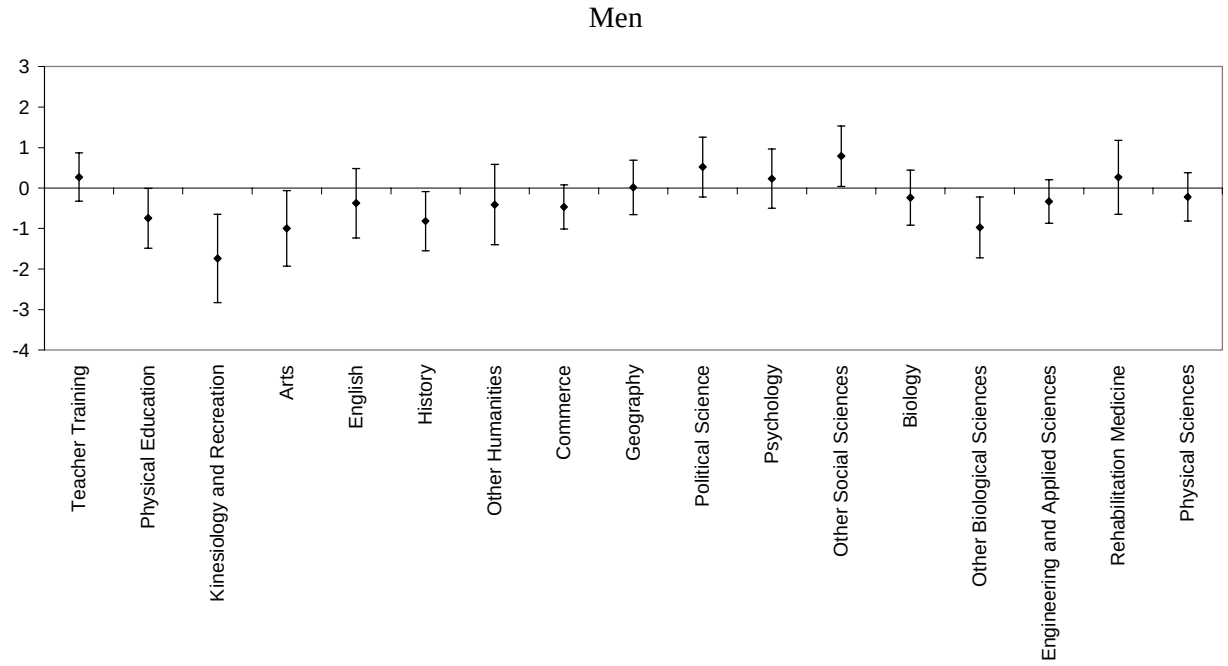
where p is the number of parameters in the model and n is the number of observations. Normally one could simply compare restricted and non-restricted models using the change in $-2 \times$ log-likelihood on adding or deleting variables in a model, or use a standard F-test after estimating using OLS. However, in such a large dataset, the probability of rejecting restrictions becomes very high, and the number of parameters in the model becomes very large, preventing one from making general statements about the data. The AIC and SC offer two ways to adjust the log likelihood test statistic to avoid over parameterizing the model. The AIC subtracts twice the number of parameters from the $-2 \times$ log-likelihood value while the SC criterion subtracts ln(N) times the number of parameters from the model. Lower values of AIC or SC indicate a better model, so the aim is to get the model that minimizes AIC or SC. The Schwarz Criteria in particular has been shown to be quite useful for restricting models in the case of large datasets (see Schwarz (1978), Akaike (1978), Leamer (1978), and Judge *et al* (1985) for a discussion of these tests). Alternately, one can test the restrictions in the maximum likelihood context by comparing the chi-squared value to a test statistic equal to $q\ln n$ where q equals the number of restrictions in the model (Deaton (1997)).

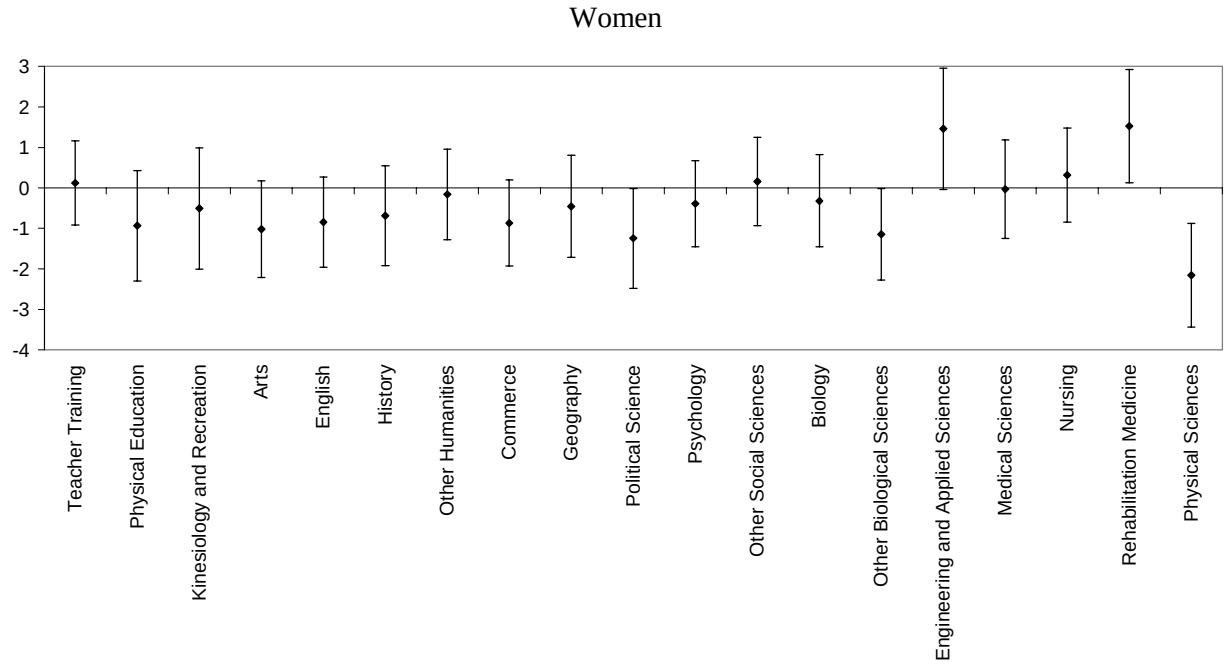
Before proceeding to formal model testing, it is useful to consider a restricted model with a straight forward interpretation. That is, cohort effects are estimated using a model assuming linear change in cohort effects and no experience effects:

$$\ln(y)=\beta_0 + \beta_1 C + \beta_3 T + \beta_4 T^2 + \beta_5 T^3 + \beta_6 T^4 + \beta_8 UR + j \text{ field dummies} + j \text{ field dummies} \times \beta C \quad (6)$$

Doing this allows a test of the overarching hypothesis that cohort effects are equal. Cohort-field interaction terms with 99% confidence intervals are shown in Figure 5. The reference group is Economics graduates. For men, shown in the top panel, cohort effects for most fields of study are not statistically different form the Economics group. Exceptions are Kinesiology and Recreation, Arts, History, and Other Biological Sciences graduates whose earnings declined relative to Economics across cohorts and the Other Social Sciences group which had rising relative earnings across cohorts. In all there were no tendencies for graduates from applied fields such as Commerce, Engineering, or Medical Sciences to enjoy rising relative earnings. For women in Engineering and Rehabilitation Medicine there were significant relative increases in earnings, but not for women in Commerce, Nursing, Teacher Training, Engineering or Medical Sciences. Thus for both men and women there does not appear to be any large differential cohort effects among fields of study, and in particular there are no patterns suggesting an increase in the relative earnings of graduates from applied programs.

Figure 5: Cohort Effects, by Field of Study, with 95% confidence intervals[a]





[a]: Predicted results are obtained from the estimation of equation 6. Detailed results are available from the author.

Statistics related to model selection are shown in Table 9. The pattern of results are the same for men and women, and we end up selecting the same model for both. The baseline model, model A, contains field dummies and interactions between the field dummies and the experience earnings profile (to allow experience earnings profiles to be different for each field of study) and no cohort effects. Adjusted chi-squared tests indicate that both field dummies and field-experience interaction effects are important additions to the model. Model B adds interactions between the field dummies and the business cycle. While standard classical tests would reject the restriction that these interactions equal zero, their addition raises the AIC and SC values and the adjusted chi-square test (where the test statistic is $q\ln n$) also indicates that this restriction can be made. Model C adds cohort effects, which reduce both the AIC and SC relative to model A. Model D interacts cohort effects with field of study dummy variables to test whether cohort effects differ among fields. This addition to the model raises the SC, but not the AIC, and the chi-sq values for the interaction terms are less than the critical value ($qlnn$=218.89 for men and 242.86 for women). Since the Schwarz criterion is argued to be better in large samples, and the adjusted chi-squared tests suggests that the restriction can be made, it is concluded that model (C) is the better model, and that cohort effects appear equal among fields of study for men and women.

Table 10 shows selected results for model C which controls for field of study. The reference group is graduates from Economics. The results have a similar character to those shown in Table 6 where field of study was not controlled for. However, the linear cohort term (C) is slightly larger indicating that some decline in earnings across cohorts was mitigated by graduates moving into higher earnings fields. This may be capturing the expansion of the shares of graduates in the Commerce and Engineering and Applied Sciences fields which were observed across the 1980 (but which returned to late 1970s levels in the early 1990s). Otherwise the conclusions are unaffected by adding in field of study.

5. Conclusions

Average earnings for British Columbia male bachelor's graduates were lower for more recent cohorts for the first few years after graduation, but this downward shift was eliminated by faster earnings growth of the later cohorts. For women, changes are better described as a pivoting up in the experience earnings profile across cohorts—recent women graduates started out at similar levels as earlier cohorts, but experienced more years of positive earnings growth. For men, these results differed from those obtained for Canada overall. For some reason, B.C. male university graduates have enjoyed increasing returns to experience, while other male Canadian university graduates have not.

There were no significant differential cohort effects across fields of study indicating that there has been no relative increase in earnings of holders of applied degrees. Altogether these results provide little support for arguments that the value of a university education has declined, or that the value of a liberal arts education has declined relative to applied graduates.

This evolution of earnings of B.C. university graduates occurred in an era of increasing supply of university graduates in the province, but with no large change in the relative supply of graduates from different fields of study. One can place this in the context of increasing technological change and the implied increase in demand for skills that this has created. It appears that

technological change has favoured B.C. university graduates in a balanced manor, that is, demand has risen in proportion to supply of university graduates. Additionally, the fact that the composition of supply by field of study did not shift remarkably over this period, combined with the fact that we did not observe differential cohort effects by field of study, is consistent with the argument that increased demand for skills associated with technological change has favoured the types of skills associated with academic programs as well as those associated with applied studies.

Table 9: Model Selection

	Model A	Model B	Model C	Model D
Field Dummies	Y	Y	Y	Y
Field Dummies*Experience-Earnings Profile	Y	Y	Y	Y
Field Dummies*Business Cycle		Y		
Cohort Effects				
Linear			Y	Y
Squared			Y	Y
Experience Interaction			Y	Y
Field Dummies*				
Linear				Y
Squared				Y
Experience Interaction				Y
Men				
N	390,881	390,881	390,881	390,881
Degrees of Freedom	90	107	93	144
-2*Log Likelihood	976,953	976,930	976,710	976,338
AIC	977,135	977,146	976,898	976,628
Schwarz	978,124	978,320	977,920	978,205
Chi-sq tests:				
Field Dummies=0	1,525			
Field Dummies*Experience=0	1,535			
Field Dummies*Cycle=0		32.02		
Linear Cohort Effects=0			138.15	
Squared Cohort Effects=0			130.22	
Experience Interaction=0			111.28	
Field Dummies*Linear Cohort Effects=0				72.68
Field Dummies*Squared Cohort Effects=0				73.04
Field Dummies*Experience Interaction=0				56.58
Women				
N	355,840	355,840	355,840	355,840
Degrees of Freedom	100	119	103	160
-2*Log Likelihood	998,678	998,658	997,632	997,119
AIC	998,880	998,898	997,840	997,441
Schwarz	999,967	1,000,192	998,961	999,177
Chi-sq tests:				
Field Dummies=0	2,311			
Field Dummies*Experience=0	2,339			
Field Dummies*Cycle=0		25.71		
Linear Cohort Effects=0			25.58	
Squared Cohort Effects=0			27.39	
Experience Interaction=0			138.69	
Field Dummies*Linear Cohort Effects=0				44.53
Field Dummies*Squared Cohort Effects=0				49.21
Field Dummies*Experience Interaction=0				49.77

Table 10: Expected changes in experience-earnings profiles for men and women, Controlling for Field of Study[1]

	men	women
Dependent Variable	ln(real annual earnings)	ln(real annual earnings)
Intercept[2]	10.088*	9.860*
	(0.046)	(0.069)
Cohort (C)	-4.128*	-2.164*
	(0.351)	(0.428)
Cohort Squared (C^2)	0.132*	0.071*
	(0.012)	(0.014)
Cohort*Years Since Graduation (CT)	0.206*	0.284*
	(0.019)	(0.024)
Other Controls:		
Quartic Experience Earnings Profile	Y	Y
Field Dummies	Y	Y
Field Dummies* (Quartic Experience Earnings Profile)	Y	Y
Unemployment Rate	Y	Y
Number of Observations	390,881	355,840

* significant at the 1% level
~ significant at the 5% level
[1]: Results are from estimations of model C shown in Table 9.
[2]: The reference group is Economics graduates

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