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Economics of Education Review 22 (2003) 179–192

Economics of  
Education Review

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# Earning differences by major field of study: evidence from three cohorts of recent Canadian graduates

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Received 28 September 2000; accepted 18 June 2001

## Abstract

This paper reports the results of an empirical analysis of earnings differences by major field of study for three cohorts of recent Canadian Bachelor's level university ('college') graduates. Earnings differences are statistically significant and in many cases large; adding various control variables to the relevant regression models typically reduces the discipline effects but leaves significant differences; the patterns are relatively consistent for male and female graduates, for the two points in time (two and five years) following graduation observed, and for the three cohorts of graduates, although there are some notable departures from these norms. A simple measure of the (conditional) variability of earnings indicates that the overall conditional variability in earnings has been relatively constant across cohorts, while some interesting patterns by discipline are observed. Various implications of the findings are discussed.

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*JEL classification:* J24; I21

*Keywords:* Educational economics; Human capital; Rate of return

## 1. Introduction

One of the classic topics in modern labour economics is the estimation of the returns to education. A large part of this literature focuses on the returns to the number of years and/or specific level of study (high school versus post-secondary, etc.). There is, however, also a steadily accumulating body of work, most of it American, on the related topic of earnings differences by field of study (or 'major') amongst college graduates. In basic human capital terms, the more traditional literature focuses more on the *amount* (or level) of human capital, while the lat-

ter is more concerned with the specific *type* of human capital.

There is strong empirical evidence that—at least in the American context—field of study is an important determinant of college graduates' earnings levels. Graduates from the more professionally oriented disciplines, such as engineering, and business, tend to have consistently higher than average earnings; those in the 'softer' disciplines, such as the arts and humanities, tend to have lower earnings, as—to a lesser degree—do those in the social sciences; while graduates with degrees in teaching and the hard sciences tend to be characterised by more variable patterns.

In this context, this paper reports the results of an empirical analysis of earnings differences by field of study amongst recent Canadian Bachelor's level university graduates ('college' graduates in American terms)—a country whose post-secondary system and labour mar-

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kets are in many ways similar to those of the US but which are also different in some important respects, thus making for some interesting cross-country comparisons.

Such findings are interesting and important for a number of reasons. First, these differences provide information on the value of the different types of human capital which the various disciplines represent, with recent graduates being especially interesting barometers in this regard due to their marginal position as new labour market entrants, and these differences coming at a critical period in individual's careers, especially in light of evidence indicating that the major portion of real lifetime earnings growth occurs during the early years of young people's post-schooling careers (Murphy & Welch, 1990).

Second, policy makers should find the evidence pertinent to thinking about differences in the value of post-secondary education (at least as far as earnings are concerned) and which fields should perhaps receive higher or lower priority in terms of expanding enrolments and future spending—although this paper does not represent any sort of proper benefit–cost analysis, in that the cost side of the ledger is left completely unaddressed and there is no attempt to interpret individuals' earnings flows in terms of associated social benefits. The results might also shed light in public policy issues, such as the shares of education costs which students might be expected to bear, the design of income contingent loan repayment systems, and so on.

Finally, graduates who have already been through the system might be interested in comparing their own experiences to those of others, while current and future students should benefit from being able to plan and make choices with a better understanding of the earnings patterns associated with different areas of study.

The paper also develops a simple measure of the (conditional) variability of earnings by field of study: the (absolute) difference between the individual's actual earnings level and the regression-based predicted (log) value. The resulting 'average errors' which are calculated could thus be thought of as capturing the unpredictable variation in earnings by field of study, which is interesting from a descriptive perspective, represents a factor which individuals would presumably take into account in making career decisions with respect to discipline, and tell us something about the structure of the labour markets faced by the graduates of different disciplines. A new element is thus added to the standard sort of analysis of earnings differences by discipline which could perhaps be built upon in the future.

The analysis employs the National Graduates Survey (NGS) series of databases, which comprise large, representative samples of those who successfully completed their programmes at Canadian colleges and universities in 1982, 1986, and 1990, with information gathered during interviews conducted two and five years after gradu-

ation for each group of graduates (1984/87, 1988/91, 1992/95). The NGS offers many advantages, such as a picture of the evolution of earnings by discipline in the critical early years following graduation, information from three cohorts spanning a period of important labour market changes for younger workers, large sample sizes that permit analysis at a desired level of detail, and the availability of sufficient control variables to estimate the standard earnings models employed in this literature.

## 2. The econometric models and the data

### 2.1. The models

#### 2.1.1. The basic earnings specifications and the discipline effects

The primary objective of this paper is to estimate the differences in labour market earnings by field of study for recent post-secondary graduates at the two specific points in time after leaving school corresponding to the interview dates of the NGS data employed. The standard approach is to estimate earnings models that include indicators of the graduate's discipline while controlling for various other influences. The models used here conform to these standard conventions as adapted to the post-graduation period covered and the information available in the NGS databases employed. The models are estimated separately for men and women for each of the six interview dates corresponding to the two and five year points in time following graduation for the three cohorts of NGS graduates.<sup>1</sup>

The earnings variable available on the NGS databases represents what the graduate would earn (before deductions) on an annual basis were the job held at the time of the interview to last the full year, regardless of the actual job status (i.e. the number of weeks worked). In adjusting for irregular work patterns in this manner, the measure represents the individual's rate of pay as measured on an annual basis rather than the amount necessarily earned. All (log) earnings values are expressed in constant 1995 dollars, rounded to the nearest thousand, and capped at the \$99,000 upper limit which characterises the 1984 data (the lowest bound in the six databases), or \$143,035 in constant 1995 dollars.

Three models are specified. Model 1 includes no regressors except for the field of study indicators, and thus reveals the 'raw' earnings differentials (approximately in percentage terms) by discipline in a formal regression framework. Model 2, includes the con-

<sup>1</sup> Such a disaggregated approach was adopted after conventional tests indicated that it was generally inappropriate to pool the field coefficients across cohorts, years following graduation, or by sex.

ventional variables representing labour market experience, previously held degrees, and personal characteristics listed below, thus yielding the earnings differences by field which hold after controlling for these factors. Model 3 adds dummy variables representing the individual's occupation and industry, but since these variables are fairly strongly correlated with field of study and undoubtedly pick up some of those effects, the discussion of these findings is relatively brief.

### 2.1.2. *The discipline groups and the other variables included in the models*

For the most part, the field of study categorisations reflect the standard major discipline groups used in the literature with some fine-tuning according to a preliminary analysis of earnings patterns to ensure that like disciplines were grouped together and those with distinctly different earnings profiles were kept separated. One specific differentiation worth noting is the splitting of the natural science and engineering groups: whereas these are often grouped together (especially the pure and applied sciences), their earnings patterns are actually quite different, as will be seen below; Economics graduates are separated from Other Social Sciences for similar reasons. On the other hand, Engineering and Computer Science graduates were safely grouped together. The field categorisations are, therefore: *Education* (Elementary/Secondary Teaching, Other Education), *Fine Arts and Humanities*, *Commerce* (Including Business Administration and related), *Economics*, *Other Social Sciences*, *Agricultural and Biological Sciences*, *Engineering* (Including Architecture and Computer Science), *Other Health and Life Sciences* (Nurses and Other Health Professionals), *Mathematics and Physical Sciences*, and *Other Fields/No Specialisation*.<sup>2</sup>

The other variables included in the models represent standard sorts of controls corresponding to the information available in the NGS databases. These include: *Holding a previously obtained higher degree* (Master's or Doctorate) before entering the Bachelor's programme, *Age and age squared*, *Post-graduation work experience* (proxied with the part-time and full-time employment status as of two specific dates between graduation and the first interview in the case of the first interview regressions and the addition of the first interview employment status in the second interview regressions. More conventional experience variables reflecting the total time working are not available in the NGS databases. Tenure with the current employer was excluded on the grounds that it could capture some of the effects

which properly belong to the discipline studied.), *Part-time work* (30 h or less) to control for individuals' labour supply decisions, *Self-employment*, *Marital Status/Presence of Children* (never married with/without children, married with/without children; widowed/separated/divorced with/without children), *Province/Language* (allows for province/region effects—Atlantic Canada, Québec, Ontario, Manitoba/Saskatchewan, Alberta, British Columbia and the Territories, plus minority language effects—anglophone in Québec, francophone outside of Quebec, other language), *Industry* (13 standard industrial sectors), and *Occupation* (15 standard occupational groups).

### 2.2. *The NGS data and the construction of the working samples*

#### 2.2.1. *The National Graduates Surveys*

The National Graduates Surveys (and Follow-Up) databases, developed by Statistics Canada in conjunction with Human Resources Development Canada, are representative of the underlying national population of university graduates, and are large (30,000–35,000 observations per survey), thus facilitating the meaningful analysis of the post-graduation experience at a detailed level—including by field of study.<sup>3</sup> Data are available for three separate cohorts of graduates—those who successfully completed their programmes in 1982, 1986, and 1990—thus permitting the comparison of earnings patterns by discipline for various different 'generations' of graduates, and over a period of time generally thought to have been characterised by important changes in labour market outcomes, especially for younger workers. The longitudinal aspect of the NGS databases, deriving from the two interviews carried out for each cohort, two and five years after graduation, allows the evolution of the field effects to be tracked over the early years in the labour market, while the later date provides a longer-term view of these differentials. Finally, the NGS databases include information on labour market attachment and personal characteristics, thus allowing these influences to be controlled for as the field effects are estimated (as discussed above).<sup>4</sup> In summary, the three NGS databases facilitate a focused, detailed, and dynamic analysis of the earnings patterns by field of study of Can-

<sup>2</sup> Represents either truly no specialisation or one too general to be fit into the other categories (e.g. 'general social sciences') and too small to be put on its own (just 2–4% of the samples in each case).

<sup>3</sup> The NGS databases are based on a stratified sampling scheme (by province, level of education, and field of study). All results reported below reflect the appropriate sample weights, and should therefore be representative of the relevant underlying populations of graduates in each year.

<sup>4</sup> Rumberger and Thomas (1993) show that the inclusion of family background variables has relatively little effect on their estimated discipline effects, thus indicating that the relative paucity of such information in the NGS databases is perhaps not a particularly important shortcoming.

adian Bachelor's level graduates in the critical years following graduation from the early 1980s into the mid-1990s.

### 2.2.2. Selection of the working samples

The models were estimated for Bachelor's level graduates who held jobs as of the interview dates who met the following sample restrictions.<sup>5</sup> First, individuals who were 35 yr or older or who had five or more years of full-time work experience at the time of graduation were excluded from the analysis. While such 'mature' students are interesting in their own right, it was decided to estimate 'pure' field effects untainted by previous experiences by focusing on 'fresh' graduates. Second, individuals who obtained an additional degree by a particular interview date were deleted from the analysis at that point. This was done on the grounds that such graduates no longer belonged to the original education group (e.g. a Bachelor's graduate might have become a Master's graduate and perhaps changed disciplines) and/or had in any event been mixing school and work in a way likely to affect the labour market outcomes upon which this analysis is focused. Including on-going students would also have thrown off the precise post-graduation time frame corresponding to the two interview dates (i.e., two and five years after graduation) which holds for the non-continuing group. Finally, it is impossible to identify the specific field of study in which any new degree was obtained as of the 1984 survey for the 1982 graduates. Third, part-time workers who cited school as the reason for their partial involvement in the labour market were also deleted on the grounds that such individuals were, by definition, still principally students and had therefore not yet entered the school-to-work transition phase of their careers in earnest. Other part-time workers were, on the other hand, generally included in the analysis, thus lending it a broad labour market base.<sup>6</sup> Finally, observations were deleted for the relatively small number of individuals who were neither regular wage nor self-employed workers (i.e., volunteers, family workers), were missing the information required for the models, or who had unreasonably low earnings (less than \$5000 in annual earnings for full-time workers).

<sup>5</sup> Conforming to the bulk of the established literature, law graduates, as well as medical doctors, dentists, optometrists, and other related medical professionals were deleted from this analysis, as these represent professional degrees which generally require individual to have already obtained a first diploma and are characterised by earnings levels a great deal higher than those of all other graduates (especially in the case of the medical fields).

<sup>6</sup> Results for full-time workers only are available from the authors, but the patterns are generally similar to those reported below (where part-time workers are included).

## 3. The empirical findings

### 3.1. The distribution of graduates by field of study

Table 1 shows the distribution of graduates by discipline group. To summarise, there was little change in the distribution of male graduates across cohorts, but slight shifts amongst female graduates from their traditional domains towards the social sciences and commerce—presumably reflecting a growing commitment to the labour market, steadier job attachment, and a generally stronger orientation towards their careers in general—consistent with what has been found in any other number of studies.<sup>7</sup> The major focus of this paper is, however, earnings patterns by discipline rather than the actual distribution of graduates by field of study, and it is to the earnings analysis we now turn.

### 3.2. Raw earnings patterns

Table 2 reports mean earnings by discipline as of each of the two interview dates, two and five years following graduation (see also the percentage change in mean earnings over time) for the three cohorts of male and female graduates, while Table 3 presents the coefficients of the regression models which include only an intercept and the field variables—thus putting the same patterns in a more formal econometric framework.

One innovation offered to the standard approach is to include dummy variables for each discipline group while imposing restrictions on the parameter estimates which force the field of study coefficients to be expressed relative to the (conditional) mean, rather than the more usual approach of using one discipline as the (omitted) baseline against which other field effects are measured. That conventional approach suffers from each of the coefficient estimates (i.e., the field effects) being expressed relative to the baseline (omitted) category, with various pair-wise comparisons required to gauge the effects of any specific discipline relative to the others. Furthermore, the estimated effects shift with the earnings of the baseline group, rendering cross-year and cross-sex comparisons particularly complex (e.g., a decrease (increase) in the relative earnings of the baseline group will cause all other coefficients to rise (fall)). The approach adopted here thus allows for a more straight-forward and robust 'relative to the average' interpretation of the estimated field effects.

There are some clear and consistent patterns. Looking first at men, the highest earnings fields are (in order) Other Health, Engineering and Computer Science, Com-

<sup>7</sup> The role of field of study in the overall gender earnings gap amongst Bachelor's level graduates, as well as other outcomes by gender, are analysed in Finnie and Wannell (1999).

Table 1  
The distribution of graduates by field of study<sup>a</sup>

	1982 cohort (%)	1986 cohort (%)	1990 cohort (%)
<i>Males</i>			
Other fields	3	5	4
Education	9	9	10
Fine art & humanities	12	12	13
Commerce	16	16	16
Economics	7	6	7
Other social sciences	15	12	15
Agric. & bio. sc.	6	6	7
Engineering & comp. sc.	23	24	20
Other health	1	2	2
Math. & other phys. sc.	6	8	6
	100	100	100
<i>Females</i>			
Other fields	2	4	3
Education	24	19	20
Fine arts & humanities	20	18	18
Commerce	10	12	12
Economics	2	3	2
Other social sciences	20	22	23
Agric. & bio. sc.	7	6	8
Engineering & comp. sc.	3	5	3
Other health	9	8	7
Math. & other phys. sc.	3	3	3
	100	100	100

<sup>a</sup> In this and all following tables, the samples exclude those who were older than 35 or who had more than five years of full-time experience by the date of graduation; those who were not regular paid or self-employed workers; those with unreasonably low earnings; and those missing any of the variables included in the analysis.

merce, and Mathematics/Physics. The low earnings fields are (from the bottom up) Arts and Humanities, Agricultural/Biological Sciences, and the (Other) Social Sciences. Education and Economics have more mixed records, but generally lie in the middle of the earning distribution.

The consistency of these patterns is interesting—although it should at the same time be recognised that the estimated effects do in fact vary to a significant degree across surveys. For example, the coefficient for Engineering and Computer Science graduates ranges from a low of 0.09 (1988) to a high of 0.21 (1984 and 1992).

The patterns for female graduates are relatively similar to those of male graduates, but show some moderate differences in the details. Thus, while the high earnings fields are the same four as for men, the relative standings of these is somewhat different, with Engineering and Computer Science graduates generally performing even more strongly, Mathematics/Physics graduates also typically doing a little better, and Other Health graduates not doing as well as in the male case. (In this context, recall, from Table 1, the very different distributions across these fields between men and women.) In short, these findings

indicate that cross-field earnings patterns are relatively similar for men and women, rather than varying with ‘femaleness’ of the discipline.

### 3.3. Adjusted earnings patterns

#### 3.3.1. The standard models

Table 4 presents the discipline coefficients generated by the regression models which include the control variables representing labour market experience, personal characteristics, and so on, described above.<sup>8</sup> The effects shown here are, therefore, net of any influences which operate through those other variables (e.g. certain fields lead to greater full-time employment opportunities).

The general ordering of the field effects is the same as for unadjusted earnings: once again, the high earnings fields are Other Health, Engineering and Computer Science, Mathematics/Physics, and Commerce; the low earnings fields are Arts and Humanities, Other Social

<sup>8</sup> The full model results are reported in Finnie (1998). See Daymont and Andrisani (1984) for a discussion of the potential endogeneity of certain regressors in such models.

Table 2  
Mean earnings (1995 constant dollars)

	1982 cohort			1986 cohort			1990 cohort		
	1984 (\$)	1987 (\$)	Change (%)	1988 (\$)	1991 (\$)	Change (%)	1992 (\$)	1995 (\$)	1995 (%)
All	31,100	39,100	26	31,200	38,400	23	31,600	37,700	19
<i>Males</i>									
All	34,000	43,800	29	33,700	42,100	25	32,800	41,100	25
Other fields	30,400	42,600	40	35,100	45,600	30	30,500	41,700	37
Education	31,100	36,600	18	33,400	38,100	14	31,800	36,800	16
Fine arts & humanities	25,900	38,600	49	28,300	35,100	24	23,400	32,400	38
Commerce	33,900	44,800	32	34,900	44,400	27	32,700	42,800	31
Economics	32,100	45,300	41	32,800	39,600	21	32,900	44,200	34
Other social sciences	30,400	41,300	36	29,800	36,200	21	28,100	36,800	31
Agric. & bio. sc.	29,400	41,400	41	27,500	39,800	45	26,800	34,800	30
Engineering & comp. sc.	38,900	47,000	21	36,200	44,800	24	37,500	46,000	23
Other health	45,100	62,600	39	47,400	56,700	20	45,300	51,300	13
Math. & other phys. sc.	35,000	46,100	32	33,900	44,700	32	33,200	44,500	34
<i>Females</i>									
All	28,300	34,300	21	28,800	34,700	20	30,500	34,800	14
Other fields	26,200	-	-	29,800	35,800	20	25,100	36,400	45
Education	27,600	31,900	16	28,700	32,700	14	30,900	33,700	9
Fine arts & humanities	23,900	31,000	30	24,200	29,400	21	26,400	31,400	19
Commerce	29,400	37,600	28	30,600	39,100	28	31,300	-	-
Economics	29,100	-	-	32,800	33,700	3	29,700	31,500	6
Other social sciences	24,900	31,900	28	26,300	33,200	26	26,600	31,700	19
Agric. & bio. sc.	26,500	33,000	25	25,000	32,200	29	26,300	32,900	25
Engineering & comp. sc.	36,700	43,600	19	33,600	41,500	24	36,800	42,400	15
Other health	35,700	38,800	9	35,000	38,000	9	37,400	40,000	7
Math. & other phys. sc.	33,500	42,800	28	32,000	39,700	24	30,100	39,200	30

Sciences, and the Agricultural and Biological Sciences, while Education and Economics are generally in the middle rank. The effects are smaller than those found in the simple field-only models—but this is to be expected in the presence of the added control variables, as found by others for the American situation (e.g. Rumberger and Thomas (1993), Grogger & Eide (1995)).

Second, the magnitudes of the effects remain quite large, typically varying from 30 to 40 log (or approximate percentage) points between the lowest and highest fields, and soaring as high as 59 points for male Fine Arts and Humanities versus Other Health graduates in 1992 (coefficients of  $-0.30$  and  $0.29$  respectively). There are, in short, large differences in earnings by field of study, even after controlling for certain standard labour market characteristics and personal attributes.

Third, the two-year versus five-year patterns—which exploit the longitudinal nature of the NGS data—are interesting, as they allow us to at least start to plot the evolution of field effects over individuals' careers and begin to point to the longer-term earnings profiles. In general, graduates with degrees in Education (both males and females) saw their relative earnings levels decline from two to five years following graduation, falling from close to average to decidedly below average over this interval—perhaps explaining why the results for this area of study has tended to vary across previous studies. Other Health graduates also saw declines, their relative earnings falling from amongst the very highest at the first interview points to more moderately advantageous levels three years later. The initially higher but then subsequently flatter earnings profiles observed for these two

Table 3  
Model 1—field variables only<sup>a</sup>

	1982 cohort		1986 cohort		1990 cohort	
	1984	1987	1988	1991	1992	1995
	Coeff.	Std err.	Coeff.	Std err.	Coeff.	Std err.
<i>Males</i>						
Other fields	-0.12**	0.05	-0.01	0.04	-0.04	0.04
Education	-0.13	0.02	0.02	0.02	0.05*	0.03
Arts & hum.	-0.26**	0.03	-0.13**	0.03	-0.35**	0.02
Commerce	0.05**	0.02	0.09**	0.02	0.04	0.02
Economics	0.00	0.03	-0.07*	0.03	0.04	0.03
Other soc. sc.	-0.09**	0.02	-0.05	0.03	-0.13**	0.02
Agric. & bio. sc.	-0.12**	0.03	-0.18**	0.03	-0.20**	0.04
Eng. & comp. sc.	0.21**	0.02	0.09**	0.02	0.21**	0.02
Other health	0.30**	0.06	0.23**	0.05	0.36**	0.06
Math./phys.sc.	0.06*	0.03	0.01	0.03	0.02	0.04
R <sup>2</sup>	0.13	0.09	0.06	0.09	0.14	0.09
Observations	2370	1904	2143	2005	2235	2193
<i>Females</i>						
Other fields	-0.14*	0.06	0.03	0.04	-0.13**	0.05
Education	-0.07**	0.02	-0.01	0.02	0.04	0.02
Arts & hum.	-0.24**	0.02	-0.23**	0.03	-0.17**	0.03
Commerce	0.05	0.03	0.06**	0.02	0.08**	0.03
Economics	0.00	0.06	0.06	0.04	-0.05	0.06
Other Soc. sc.	-0.17**	0.02	-0.11**	0.02	-0.10**	0.02
Agric. & bio. sc.	-0.08*	0.04	-0.18**	0.04	-0.11**	0.04
Eng. & comp. sc.	0.26**	0.04	0.13**	0.03	0.21**	0.05
Other health	0.24**	0.03	0.18**	0.02	0.26**	0.03
Math./phys. sc.	0.15**	0.05	0.07	0.05	-0.03	0.05
R <sup>2</sup>	0.12	0.06	0.10	0.05	0.07	0.04
Observations	2253	1884	2432	2182	2567	2545

<sup>a</sup> One asterisk indicates significance at the 0.05 confidence level, two asterisks indicates significance at the 0.01 level.

Table 4  
Model 2—adding basic control variables<sup>ab</sup>

	1982 cohort		1986 cohort		1990 cohort	
	1984	1987	1988	1991	1992	1995
	Coeff.	Std err.	Coeff.	Std err.	Coeff.	Std err.
<i>Males</i>						
Other fields	-0.08	0.04	0.00	0.03	0.05	0.04
Education	0.01	0.02	0.03	0.02	-0.05*	0.02
Arts & hum.	-0.20**	0.02	-0.12**	0.02	-0.14**	0.02
Commerce	0.01	0.02	0.07**	0.02	0.06**	0.02
Economics	0.00	0.03	-0.08**	0.03	-0.06**	0.03
Other soc. sc.	-0.07**	0.02	-0.05	0.02	-0.08**	0.02
Agric. & bio. sc.	-0.09**	0.03	-0.15**	0.03	-0.10**	0.03
Eng. & comp. sc.	0.15**	0.02	0.08**	0.02	0.09**	0.02
Other health	0.20**	0.05	0.13*	0.05	0.17**	0.05
Math./phys. sc.	0.07*	0.03	0.20**	0.03	0.06*	0.03
R <sup>2</sup>	0.35	0.29	0.24	0.29	0.36	0.30
Observations	2370	1904	2143	2005	2235	2193
<i>Females</i>						
Other fields	-0.05	0.05	0.02	0.04	0.06	0.04
Education	-0.01	0.02	0.02	0.02	-0.01	0.02
Arts & hum.	-0.19**	0.02	-0.19**	0.02	-0.14**	0.02
Commerce	0.00	0.02	0.03	0.02	0.09**	0.02
Economics	-0.02	0.05	0.06	0.04	-0.12**	0.05
Other soc. sc.	-0.16**	0.02	-0.12**	0.02	-0.04*	0.02
Agric. & bio. sc.	-0.03	0.03	-0.15**	0.03	-0.10**	0.03
Eng. & comp. sc.	0.18**	0.04	0.09**	0.03	0.15**	0.03
Other health	0.17**	0.02	0.17**	0.02	0.13**	0.02
Math./phys. sc.	0.12**	0.04	0.06	0.04	0.05	0.05
R <sup>2</sup>	0.38	0.35	0.31	0.38	0.33	0.36
Observations	2253	1884	2432	2182	2567	2545

<sup>a</sup> The models include controls for pre-programme educational level, age, post-graduation experience, self-employment status, marriage/children region, and language. See Table A1 for the detailed results for these variables.

<sup>b</sup> One asterisk indicates significance at the 0.05 confidence level, two asterisks indicates significance at the 0.01 level.



groups presumably reflect the effects of their typically finding employment in highly unionised public and semi-public sectors (although union status is not indicated in the NGS data).

Conversely, Fine Arts and Humanities graduates generally experienced relative gains over time, and although their earnings levels generally remained amongst the lowest at the five year points, they were typically not so far behind as they were just two years after graduation (males in the middle cohort are an exception in this regard). This tendency would seem to point to a more ‘dynamic’ labour market for what are typically more ‘generalist’ graduates, with individuals with Bachelor’s degrees in these areas in many cases finding interesting job opportunities, gaining promotions, and generally moving ahead in the workplace in the years following graduation. The other disciplines generally showed no clear or consistent patterns from two to five years following graduation.

The other dynamic nature of the analysis is the cross-cohort patterns. The clearest pattern here is that graduates in Other Health disciplines enjoyed higher relative earnings in the latest cohort than in the first (captured at approximately similar points in the business cycle and thus roughly controlling for general macro conditions). The other technical and scientific disciplines showed no such improvements, however, with the cross-cohort movements in many cases being in the opposite direction. More specifically, both male and female graduates in the Agricultural and Biological Sciences and in Mathematics and the Physical Sciences had lower relative earnings in the third cohort than in the first, except for female Agricultural and Biological graduates at the five year point, whose earnings were steady. Male Engineering and Computer Science graduates did a little better in the latest cohort (after a dip in the second), but this was another area of relative decline for female graduates. In summary, there have been no general gains by the more technically and scientifically oriented graduates—contrary to what many might have expected.<sup>9</sup>

Other fields with relative earnings gains over time were Education (both males and females) and Fine Arts and Humanities in the case of females, but not males, while other general declines are observed for male Other Social Science graduates. Elsewhere, the cross-discipline patterns show no clear trends across the three cohorts.

### 3.3.2. Adding occupation and industry to the models

Occupation and industry are fairly highly correlated with, and capture some of the effects of, discipline (i.e. they are endogenous outcomes), and thus generate a less interesting set of earnings effects on their own. They are, however, interesting for the light they cast on how the discipline effects play out in the labour market. Fig. 1 thus presents the coefficients estimated for each of the three models (just the field variables, the inclusion of the standard control variables, and the addition of the occupation and industry variables) averaged over all three cohorts, thereby showing the effects on the discipline coefficients of adding the two groups of control variables to the specification—which in fact accurately represent the findings for the three models for each of the cohorts individually, as reported in Finnie (1998).<sup>10</sup>

Adding the additional control variables is seen to generally, but not uniformly, reduce the (net) field effects in the case of both men and women. That is, the high earnings disciplines are not quite as high when the controls are added, the low earnings fields are not as low, and so on. The only really notable exception is the Other Health category in the case of men, where adding occupation and industry to the models actually increases its net advantage, suggesting that such graduates tend to find employment in what are generally (relatively) lower paying occupations and industries (for men). Economics is also of some interest in this respect, as in three of the four cases (excepting only female graduates two years after graduation) the coefficients become moderately less positive or more negative when the extra controls are added, indicating that while economics graduates have approximately average earnings overall, this is due to their having moderately ‘high earning’ labour market and personal attributes (including their industry and occupation), as their earnings are actually below average once such factors are taken into account.

### 3.4. The (unexplained) variation in earnings by discipline

Table 5 shows the mean absolute difference between predicted and actual earnings by field of study for the Model 2 specifications, thus representing in this log earnings model context the (approximate) average absolute error in percentage terms.<sup>11</sup> To the degree the regression

<sup>9</sup> Lavoie and Finnie (1999) investigate the outcomes of science and technology graduates across a wider range of outcomes using non-econometric techniques and discuss the implications of those findings with respect to public policy regarding science and technology.

<sup>10</sup> That is, the coefficients shown in Figure 3 represent the simple arithmetic means of the estimated coefficients of the simple fields-only earnings models across the three cohorts, the mean of the models with the basic set of controls included, and the means of the coefficients generated by the models which include occupation and industry.

<sup>11</sup> The results for the models with occupation and industry included are reported in Finnie (1998).

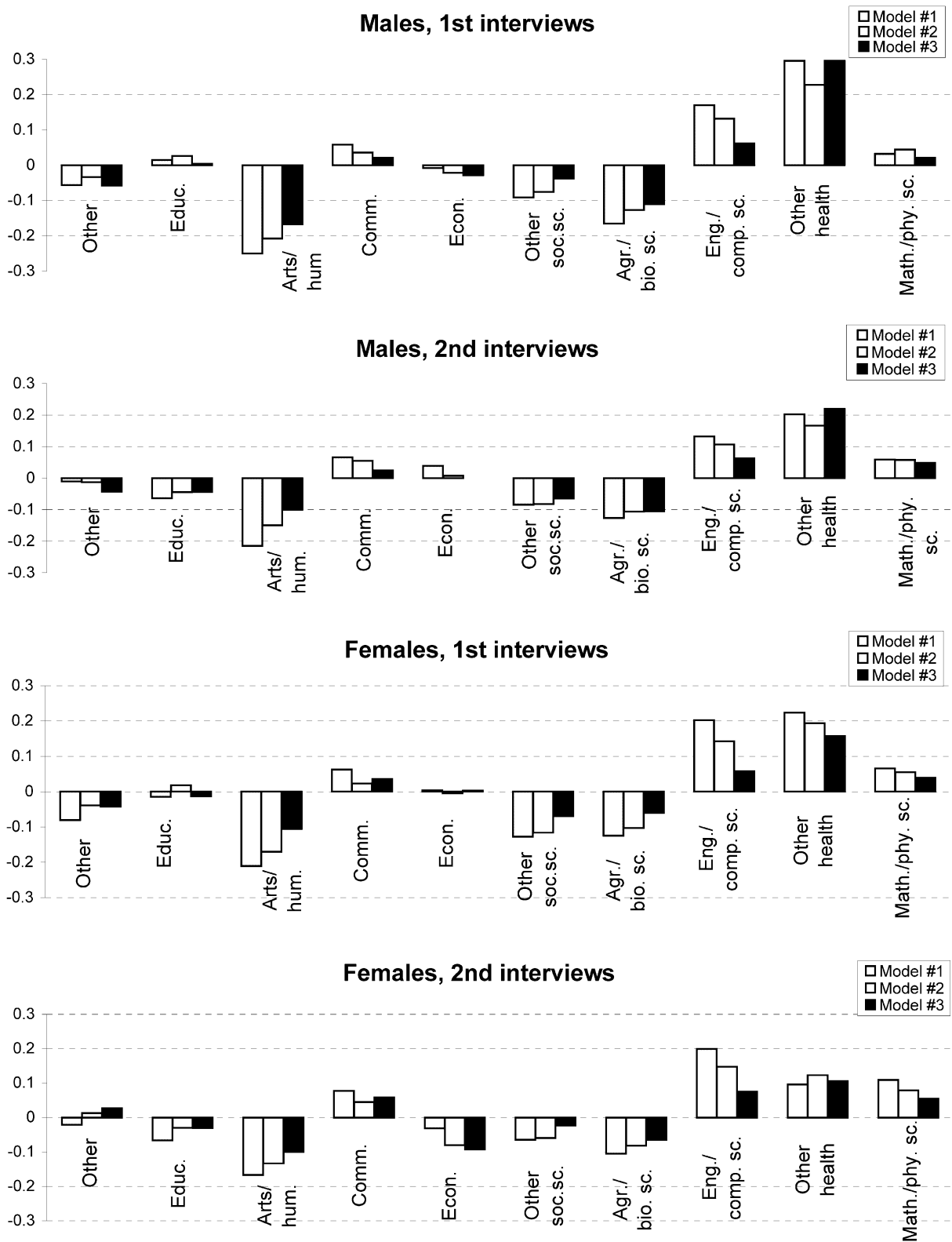


Fig. 1. Mean coefficients (all three cohorts) by model.

Table 5  
Mean absolute errors by field of study—model 2<sup>ab</sup>

	1982 cohort		1986 cohort		1990 cohort	
	1984 (\$)	1987 (\$)	1988 (\$)	1991 (\$)	1992 (\$)	1995 (\$)
<i>Males</i>						
All	0.24	0.24	0.22	0.21	0.26	0.24
Other fields	0.31*	0.32*	0.24	0.31*	0.33*	0.26
Education	0.21	0.16	0.18	0.18	0.20	0.18
Fine arts & humanities	0.33	0.36	0.27	0.30	0.38	0.27
Commerce	0.24	0.24	0.25	0.23	0.24	0.25
Economics	0.23	0.29	0.22	0.19	0.23	0.28
Other social sciences	0.29	0.29	0.25	0.20	0.34	0.28
Agric. & bio. sc.	0.31	0.27*	0.31	0.23	0.34	0.34
Engineering & comp. sc.	0.18	0.17	0.18	0.17	0.17	0.18
Other health	0.26*	0.24*	0.24*	0.17	0.23*	0.18
Math. & other phys. sc.	0.24	0.23	0.23	0.21	0.32	0.25
<i>Females</i>						
All	0.26	0.26	0.23	0.24	0.27	0.24
Other fields	0.25*	0.25*	0.19	0.23*	0.37*	0.28
Education	0.29	0.27	0.23	0.23	0.23	0.23
Fine arts & humanities	0.32	0.32	0.26	0.30	0.32	0.27
Commerce	0.20	0.23	0.18	0.23	0.23	0.23
Economics	0.24*	0.24	0.28*	0.27	0.30*	0.33*
Other social sciences	0.28	0.26	0.28	0.26	0.30	0.26
Agric. & Bio. sc.	0.26	0.24	0.26	0.27	0.32	0.27
Engineering & comp. sc.	0.20	0.21	0.22	0.15	0.22	0.20
Other health	0.15	0.21	0.17	0.20	0.20	0.19
Math. & other phys. sc.	0.23	0.25*	0.22	0.28*	0.32*	0.24

<sup>a</sup> Calculated as the mean absolute difference between actual log earnings and their predicted values (based on the regression estimates) for the individuals of each field.

<sup>b</sup> The means with no letter subscript have standard errors below 0.01, and those with an asterisk have standard errors between 0.01 and 0.02.

models reflect individuals' estimates of their future earnings, this measure will also represent the extent of uncertainty of future earnings for a typical graduate in a given discipline.<sup>12</sup>

Over all disciplines, men's actual earnings deviate from the regression-predicted levels by an average of approximately 21–26%, and from 23 to 27% in the case of women. Interestingly, there is no clear trend in the

extent of these errors from two to five years following graduation, nor in the cross-cohort patterns, except for the second cohort errors being slightly smaller than those of the first and last cohorts. There is much talk of labour markets having become more uncertain and outcomes more polarised, but these numbers would not seem to support this hypothesis in the case of these groups of Bachelor's level graduates.

By discipline, the most notable outcome is probably the relatively low percentage errors which characterise Engineering and Computer Science graduates, especially in the case of men, presumably representing relatively homogenous groups of workers who face similarly well-defined job opportunities and well-structured job mar-

<sup>12</sup> Other measures of variability could of course have been employed, but this 'average error' measure has a nice intuitive interpretation while generally serving the purposes of the analysis.

kets. Other Health disciplines, especially amongst women, also have relatively well-predicted earnings values, as do male Education graduates, again presumably reflecting the same sort of homogeneity as the Engineering and Computer Science, as well as the influences of the graduates of these disciplines typically finding jobs in highly unionised sectors characterised by standardised wage scales. At the other extreme, Fine Arts and Humanities graduates tend to have the greatest variation in earnings around the regression-based predicted values—hardly a surprising finding in light of the different types of graduates and commensurate variation in earnings opportunities (and perhaps preferences) characterising this broad discipline grouping. Of perhaps greater surprise is that the single field of Economics is characterised by prediction errors in the middle rank, rather than the smaller errors that might have been expected from such a relatively uniform group of graduates.

#### 4. Conclusion

##### 4.1. Summary of the findings

The goal of this paper was to report the results of an analysis of differences in earnings by discipline amongst Bachelor's level university graduates in Canada using the relatively under-utilised National Graduate Survey databases. The principal findings may be summarised as follows:

- There remain significant gender differences in the distribution of graduates by discipline, with perhaps surprisingly little change in the distributions for the three cohorts which finished their schooling in 1982, 1986, and 1990 covered in this analysis.
- There have been consistent, and in many cases large, differences in earnings by discipline amongst Canadian 'college' graduates: the highest earnings fields have been Other Health, Engineering and Computer Science, Commerce, and Mathematics/Physics; the low earnings fields have been Arts and Humanities, Agricultural/Biological Sciences, and Other Social Sciences; while Education and Economics have generally been in the middle of the earnings distribution.
- Adding two different sets of control variables to the models typically reduces the (net) field effects, but the same patterns typically persist to greater or lesser degrees across the various specifications. The effects of discipline on earnings thus appear to operate to some degree through the accumulation of greater labour market experience and other work-related characteristics (including occupation and industry) and are also perhaps associated with certain personal attri-

butes which affect earnings, but 'pure' discipline effects remain even after controlling for these influences.

- The patterns are relatively consistent for male and female graduates, at the two and five year interview points, and across the three cohorts of graduates, while the more notable departures from these norms have been noted (with tests indicating that the effects are in fact significantly different in a statistical sense along all these dimensions). Particularly worth mentioning is that there has been no general improvement in the earnings of science and technology graduates (Other Health workers excepted)—a perhaps somewhat surprising result in a context where these fields are typically cited as being critical to the 'knowledge based economy'; The general (moderate) *declines* in the relative earnings of pure and applied science graduates over this period are especially noteworthy in this regard; as are the continued low earnings of graduates in the applied sciences.
- Overall, the differences between individuals' actual earnings levels and those predicted by the regression models reported here are relatively constant across cohorts, with 'average errors' ranging from approximately 21 to 27%, thus perhaps indicating that labour market outcomes have not necessarily become more variable, more uncertain, or more polarised over the period covered by this analysis.
- Engineering and Computer Science and Other Health graduates have tended to have earnings levels which are more accurately predicted by the regression models, while the greatest (conditional) variation in earnings is amongst Fine Arts and Humanities graduates.

##### 4.2. Implications of the findings

There are various reasons for earnings to differ by field of study. First, there are the vagaries of the market, whereby short-run exogenous shifts in demand or supply affect relative earnings patterns, and such effects could be expected to be greatest for those just entering the labour market (i.e. recent graduates). Second, compensating differentials could generate more enduring earnings differences by discipline, with the underlying factors including the effort required at school and on the job, the degree of stress or level of responsibility, the uncertainty of outcomes, offsetting perquisites, and so on. Third, longer-term ('equilibrium') earnings differences will tend to arise in the face of any general scarcity of skills. For example, engineers and other more technically oriented workers might tend to be higher paid at least partly because there may be a limited number of individuals with the underlying technical abilities. Fourth, there could exist more artificial supply side constraints, perhaps reflecting the structure and behaviour of the post-secondary system itself (e.g. limited admission to certain

programmes), professional associations that have specific requirements for certification, and other institutional influences. Finally, there are undoubtedly other factors that affect earnings which are correlated with discipline – including various aspects of ‘ability’—which, to the degree they are not completely controlled for in the regression models, will be captured by the discipline indicators.

The relative stability of earnings patterns by discipline reported above suggests that these and any other forces have actually been relatively steady over time in Canada, at least as they apply to the three cohorts of recent Bachelor’s level graduates treated here. For example, for all the talk of the manner in which the economy has generally been shifting towards a science and technology orientation, of how ‘globalisation’ has affected national markets, of the emergence of the ‘knowledge-based economy’, of the ‘polarisation’ of employment opportunities and earnings, and so on, the earnings patterns reported above are remarkably stable—as is the distribution of graduates by discipline, with these two results presumably being related (on the assumption that individuals should tend to move towards disciplines with higher and/or increasing earnings). Interestingly, the shifts which *are* observed – the declines in the relative earnings of certain science graduates in particular—would seem to go in the opposite direction of what many might have predicted, while pointing to some divergence in the Canadian and US experiences in this regard.

The relative consistency of the earnings patterns from two to five years following graduation is also interesting, as it suggests that the above-mentioned forces are fairly constant (in proportional terms) over at least the early years in the labour market. At the same time, the shifts which are observed point to the existence of some significant differences in age-earnings profiles by discipline, with this finding further supported by the fact that the discipline effects are in general statistically different at the earlier and later points in time following graduation. These results also have implications for the interpretation of previous studies in which the differences in earnings by discipline are estimated across workers of different ages or at different points in time following graduation.

The general similarity of the earnings patterns across disciplines by gender is also noteworthy, even though there are some moderate differences in this regard. The very large differences in the distribution of graduates across disciplines by gender which are almost unchanged across the three cohorts of graduates remain an intriguing aspect of gender earnings patterns and labour market behaviour more generally.

#### 4.3. *Paths for future research*

One direction for future research might be to undertake an analysis similar to the one presented here at a

more detailed level for selected disciplines to see if the relatively aggregate level findings reported here hold up. It might also be particularly interesting to see how the ‘average error’ measure behaves at a more detailed level and to see if there appear to be tradeoffs across disciplines in terms of the average level and variance of earnings.

Another interesting avenue of research would be to look at earnings at a later point in time following graduation, but this would have to await another longer-term follow-up survey of one of the NGS cohorts already interviewed or other data.

Finally, it would be extremely interesting to model the choice of discipline and to control for such selection dynamics and the related omitted heterogeneity which likely affects both choice of discipline and earnings in the estimation of the earnings models in order to identify discipline parameters which are purged of such effects. This would, however, not only constitute a fairly complex task from a theoretical-econometric perspective, but would on a practical level probably lay beyond the capacity of the NGS data used here due to the relative paucity of the sorts of background variables which could be used to identify the various relevant structural relationships (e.g. high school grades and other measures of ability or aptitude, family background, and so on). In the meantime, the estimates reported here should be most humbly considered as ‘descriptive’—their value being that they at least provide a useful set of benchmark estimates of the earnings differences by field of study which have existed for Canadian graduates over the last decade and a half.<sup>13</sup>

#### Acknowledgements

Financial support received from the Applied Research Branch of Human Resources Development Canada and the Social Sciences and Humanities Research Council of Canada is gratefully acknowledged, as are the helpful comments received from Doug Giddings, Philip Jennings, John Myles, Garnett Picot, and Ted Wannell.

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<sup>13</sup> See Altonji (1993) for a model of the choice of the number of years of study with certain endogenous regressors, including discipline, Garen (1984) as an earlier piece in the same spirit, and Coté and Sweetman (1997) for an attempt to model the differences in earnings by discipline with the choice of discipline treated as an outcome.

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