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Earnings Differences by Major Field of Study: Evidence From Three Cohorts of Recent Canadian Graduates

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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. The principal findings include that earnings differences by discipline are statistically significant and in many cases large; that adding various control variables to the relevant regression models typically reduces the discipline effects but significant differences remain; and that 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 (individuals' regression-based predicted earnings levels versus their actual levels) 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.

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

In some studies (*e.g.*, Berger [1988], Côté and Sweetman [1997], Eide [1994], Finnie [1995], Grubb [1992], Hecker [1995]), earnings differences by major – as well as the effects of these differences on male-female earnings patterns, the rate-of-return to college, or shifts in earnings patterns over time – are the focus of the analysis. In other cases (*e.g.*, Betts, Ferrall and Finnie [1999], Daniel, Black and Smith [1999], Datcher Loury and Garman [1995], Daymont and Andrisani [1984], Grogger and Eide [1995], Grubb [1993a], Jones and Jackson [1990], and Rumberger and Thomas [1993]), discipline effects are considered along with other education-related (and other) factors which affect earnings, such as school quality/selection, performance (grades), curriculum (specific courses taken), and ability (test scores). In still other examples (*e.g.*, Dodge and Stager [1972], Ozay [1977], Vaillancourt [1995]), earnings patterns by discipline are used principally as inputs for calculating rates of return to education along this dimension

Taken together, this literature, mostly based on the NLS72 and High School and Beyond databases, typically finds statistically significant and quantitatively large differences in earnings levels by discipline, and although the precise effects depend on the particular field categories employed, the point in time following graduation at which individuals are observed, the control variables included in the models, and other varying factors, some clear patterns have emerged. Most notably, 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.

There is, therefore, strong empirical evidence that – at least in the American context – field of study is an important determinant of college graduates' earnings levels. 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 and 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 ledger is left completely unaddressed and there is no attempt to interpret individuals' earnings flows in terms of associated social benefits. The results are also relevant to other public policy issues, such as the (differential?) 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.

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

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 tells us something about the particular 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 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 graduation for each group of graduates (1984/87, 1988/91, 1992/95). These data have numerous strengths pertaining to this study. First, the longitudinal element (deriving from the two interviews undertaken for each cohort) allows the evolution of the differences in earnings by discipline to be tracked in a precise fashion in the early years following graduation, while the five-year interviews (at which point the average age of graduates is over thirty) provide a perspective of longer-run earnings patterns. Second, the availability of data for three different cohorts of graduates allows us to separate the more enduring patterns from those which have been more transient and begin to spot trends, while covering a period (the early 1980s through the mid-1990s) of important labour market changes, especially for younger workers. Third, the large sample sizes available and the representative nature of the NGS data mean that there are sufficient numbers of graduates to conduct the analysis at the desired level of detail and that the results should generalise to the full population of graduates. Finally, although the NGS data are lacking in certain background variables, there are sufficient controls available to estimate the standard sort of earnings models employed in this literature and to observe how the discipline effects change as different sets of controls are added to the specifications.

The paper is laid out in a straightforward manner: the next section discusses the econometric models and the data; this is followed by the presentation of the empirical findings; the concluding section summarises the results, discusses some of their implications, and suggests avenues for future work.

II. THE ECONOMETRIC MODELS AND THE DATA

II.1 The Models

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 which has been established in the literature is to estimate earnings models which 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, with earnings taken to be a function of variables representing individuals' human capital and other factors that affect earnings. The specific variables included in the models are described below.

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.

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 which interviews were carried out for each of the three cohorts of graduates. Such a disaggregated approach was adopted after conventional tests indicated that it was generally inappropriate to pool across years or by sex.

That is, the structure of earnings is sufficiently different for the two and five year points following graduation for a given cohort, across cohorts, and by sex to require the estimation of separate models for each period for male and female graduates separately. This also holds for the field effects themselves: pooling was rejected even after allowing all non-field parameters to vary freely across interview dates (and sex), thus indicating in a formal fashion that the field effects vary significantly from two to five years following graduation, across cohorts, and by sex – an interesting result to begin with, with potential relevance for other studies where such poolings are imposed.

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. It is a somewhat unconventional measure, but is relatively well-defined and analytically appropriate concept and thus suits the purposes of this study. All 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.

Standard practice is followed by using the natural log of earnings as the dependent variable, allowing the coefficient estimates to be interpreted in (approximately) percentage terms. Three models are specified. Model 1 includes no regressors except for the field of study indicators, and thus reveals the “raw” earnings differentials by discipline in a formal regression framework. Model 2, includes the 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 the effects, the discussion of these findings is relatively brief.

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 discipline 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 really 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 used in this analysis 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*
- *Other Fields/No Specialisation*¹

The other variables included in the models represent standard sorts of controls corresponding to the information available in the NGS databases. These include the following:

- *Holding a previously obtained higher degree*: a dummy variable indicating that the individual held a higher degree (Master's or Doctorate) before entering the Bachelor's programme.
- *Age and age squared*: note also the sample restriction to individuals under age 35 at graduation (as discussed below).

¹ 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 percent of the samples in each case).

- ***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 (the October in the following year and the January after that), 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:*** standard definition (30 hours), to control for individuals' labour supply decisions.
- ***Self-employment:*** standard dummy variable indicator (as opposed to a paid worker).
- ***Marital Status/Presence of Children:*** standard indicators which allow for the effects of children to vary by marital status: single (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.
- ***Occupation:*** 15 standard occupational groups.

II.2 The NGS Data and the Construction of the Working Samples

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.^{2,3}

² The NGS databases are based on a stratified sampling scheme (by province, level of education, and field of study), with all results reported below reflecting the appropriate sample weights. The sampling framework of the NGS databases is established through the use of institutions' administration files on graduates, with those records

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).⁴

In summary, the three NGS databases facilitate a focused, detailed, and dynamic analysis of the earnings patterns by field of study of Canadian Bachelor’s level graduates in the critical years following graduation from the early 1980s into the mid-1990s.

Selection of the Working Samples

The models were estimated for Bachelor’s level graduates who held jobs as of the interview dates who

also providing some of the basic educational information on the NGS files, such as programme and discipline 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.

³ The databases also include college and trade and vocational school graduates, and university graduates at the Master’s and Ph.D. levels, but these individuals are not included in the present analysis.

⁴ 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..

met the following sample restrictions.⁵ First, individuals who were thirty-five years 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 and to leave the others for a separate analysis.

Secondly, 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 only 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.⁶

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

⁵ 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). Such graduates are, however, included in the more descriptive analysis of post-graduation outcomes along a broader range of measures (including earnings) represented in Finnie [1999b].

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

information required for the models, or who had unreasonably low earnings.⁷

III. THE EMPIRICAL FINDINGS

The discussion of the empirical findings focuses on the following main themes:

- the identification of generally low, medium and high earnings fields of study;
- the evolution of the earnings patterns from two to five years following graduation;
- the cross-cohort patterns: stability, cyclical effects, secular trends;
- male versus female comparisons;
- the role of intermediary influences (labour market experience, personal characteristics, *etc.*) on the discipline effects;
- differences in the variance in the variability of earnings around the regression-based predicted values.

III.1 The Distribution of Graduates by Field of Study

Table 1 shows the distribution of graduates by discipline group. Interestingly, the distributions are generally quite stable across cohorts. For men, there was an increase in the percentage of pure and applied science and engineering/computer graduates from the first cohort to the second (from 36 percent to 40 percent), but this share then dropped back again in the third cohort (35 percent, although with some juggling amongst the specific disciplines, most notably a slight decline in Engineering and Computer Science). These shifts in the share of technical/scientific graduates were mirrored in the offsetting trends evidenced by the Other Social Science category (15, 12, and 15 percent for the three cohorts). None of the other fields varied more than one percentage point over time. As a result, the distribution of male graduates in the third cohort was generally quite similar to that of the first.

For women, the distributions were – not surprisingly – quite different. Female graduates have been much more likely than men to graduate with degrees in Education, Fine Arts and Humanities, and

⁷ Concerning the latter condition, full-time workers with less than \$5,000 in annual earnings (the equivalent of a wage of about \$3.20 per hour for 30 hours of work per week over 52 weeks) were deleted. These deletions together affected just 1 to 2 percent of the sample in each year.

Other Health (*i.e.*, a group representing graduates in the life sciences and health area apart from the doctors and related who are excluded from this analysis), and to a lesser degree in Commerce and the Other Social Sciences; they have been greatly under-represented in Economics, Engineering and Computer Science, and Mathematics and the Physical Sciences; while the shares of male and female graduates have been quite similar in the Agricultural and Biological Sciences.

As for cross-cohort patterns, the share of female graduates in the scientific/technical disciplines was more stable than the case of men, but at their much lower rates (22, 22, and 21 percent), with Engineering and Computer Science remaining the most glaring discrepancy in this regard (23, 24, and 20 percent for men, versus 3, 5, and 3 percent for women). More significant, perhaps, are the declines in the percentage of female graduates with degrees in Education and Fine Arts and Humanities, and the offsetting increases in Commerce and Other Social Sciences. Thus, while there was no general shift of female graduates towards engineering and the sciences (as many would like to see, for various reasons), there was in fact something of a shift away from the fields which have been most female-dominated in the past towards the slightly “harder” social sciences and business.

In summary, 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.⁸

The relative stability of the distribution of graduates, males in particular, is perhaps somewhat surprising, particularly when contrasted with the shifts which have been reported for the U.S., where the most marked changes have been increased numbers of graduates in the more technical disciplines, *especially* for women – with these shifts generally interpreted as having stemmed from the relatively higher earnings levels which have been enjoyed by graduates in these areas (*e.g.*, Eide [1994],

⁸ 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].

Rumberger and Thomas [1993], Grogger and Eide [1995].

The findings for Canada reported here thus beg a number of related questions – *albeit* the divergent trends cover somewhat different periods (from the 1980s to the 1990s versus the 1970s through 1980s period discussed in the U.S. literature). In particular, one might wonder if this stability primarily due to demand side or supply side factors with respect to the education system – that is, do the patterns reflect students' preferences or simply the spots available at universities? In particular, has the "production" of graduates in different fields been as flexible and responsive as it should have been as employment opportunities (and employers' needs) have been shifting over time? Should the general lack of any secular shifts in the distribution of graduates by field of study be cause for worry as the economy moves in directions which would seem to favour certain types of graduates over others?⁹ Is the fully public nature of the Canadian post-secondary system (there are no private universities or undergraduate colleges) an important factor in these dynamics (or lack thereof)?

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 – at the same time putting the observed distributions in a much more interesting light and perhaps suggesting directions for further work on the choice of field of study *per se*.¹⁰

III.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 results of the regression models which include only an intercept and the field variables – thus putting the same patterns in a more formal econometric framework. Figure 1 plots the field coefficients for this simple model, with the coefficients representing the earnings level of each field relative to the average level across all fields (*i.e.*, the coefficients sum to unity), as explained above.

⁹ See Lavoie and Finnie [1999] for the specific case of science and technology graduates.

¹⁰ See Turner and Bowen [1999] for a recent treatment of this issue in a gender context.

There are some clear and consistent patterns. Looking first at men, the highest earnings fields are (in order) Other Health, Engineering and Computer Science, Commerce, 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 .09 (1988) to a high of .21 (1984 and 1992). Thus, the general categorisation of the discipline groups into those with low, medium, and high earnings are broadly consistent over the early years in the labour market and across cohorts, but there is substantial interview-to-interview variation within these broad tendencies, as will be discussed in greater detail in the context of the other models presented below.

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 was found for men, the relative standings of these is somewhat different, with Engineering and Computer Science graduates generally performing even more strongly than was true for men, 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.

III.3 Adjusted Earnings Patterns

The Standard Models

Table 4 reports the discipline coefficients generated by the regression models which include the control variables representing labour market experience, personal characteristics, and so on, described above. 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) – as is the usual practice in this literature. Figure 2 graphs the coefficients.¹¹

The first principal finding is that 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 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 and Eide [1995]).

Second, the magnitudes of the effects remain quite large, typically varying from 30 to 40 log 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 $-.30$ and $.29$ 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 groups presumably reflect the effects of their typically finding employment in highly unionised public and semi-public sectors

¹¹ The full model results are reported in Finnie [1999a]. See Daymont and Andrisani [1984] for a discussion of the potential endogeneity of certain regressors in such models.

(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, an issue which is perhaps especially pertinent in the context of a general belief in the importance and value of degrees in science and technology disciplines in the new “knowledge based economy”. The clearest pattern here – most easily in Figure 2 – 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, then, we can at least say that there have been no general gains by the more technically and scientifically oriented graduates – contrary to what many might have expected.¹²

Other fields which relative earnings gains over time were Education (males and females both) and Fine

¹² 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.

Arts and Humanities in the case of females, but not males, while other general declines are observed for male Other Social Science graduates. For the other disciplines, the cross-discipline patterns showed no clear trends across the three cohorts.

Adding Occupation and Industry to the Models

Occupation and industry are fairly highly correlated with, and capture some of the effects of, discipline, and thus generate a generally less interesting set of findings on their own. They are, however, interesting for the light they cast on how the discipline effects play out in the labour market. Figure 3 thus plots 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 [1999a].¹³

Adding the 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, as their earnings are actually below average once such factors are taken into account.

¹³ 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.

III.4 The (Unexplained) Variation in Earnings by Discipline

Table 5 and Figure 4 show 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.¹⁴ To the degree the regression 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.¹⁵

The differences are interesting. Whereas we would expect some fields, as defined here, to have smaller errors simply because they represent more detailed categorisations and thus smaller and presumably more homogeneous (at least in terms of human capital) groups (e.g., Economics, Agricultural and Biological Sciences), other comparisons can be made across categories representing more evenly defined groups, while it is also interesting to note where the small-versus-large comparisons do not appear to follow a simple aggregation rule.

Over all disciplines, men's actual earnings deviate from the regression-predicted levels by an average of approximately 21 to 26 percent, and from 23 to 27 percent 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. Other Health disciplines, especially amongst women, also have relatively well-predicted

¹⁴ The results for the models with occupation and industry included are reported in Finnie [1999b].

¹⁵ 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.

earnings values, as do male Education graduates, again presumably reflecting the same sort of homogeneity as the Engineering and Computing group, 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 area. 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 which might have been expected from such a relatively uniform group of graduates.

IV. CONCLUSION

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 based on 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 of graduates across disciplines for either sex 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 earning 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 attributes 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” and students are often urged to enter these areas for the benefit of their own careers as well as the nation’s 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 measure of the difference between individuals’ actual earnings levels and those predicted by the regression models reported here is relatively constant across cohorts, with “average errors” ranging from approximately 21 to 27 percent, thus perhaps indicating that labour market outcomes have not necessarily become more variable or uncertain (in this sense) amongst Bachelor’s level university graduates 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.

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 extraneous shifts in demand or supply affect relative earnings patterns – with such effects expected to be greatest for those just entering the labour market and thus at its margins (*e.g.*, recent graduates). Second, compensating differentials would generate 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 requisite 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), associated professional associations (*e.g.*, the exams required to gain final certification in certain professions), 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 suggest 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 U.S. 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 surmisal further supported by the initial finding that the discipline effects are in fact 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. In short, what “works” for males also works for females, even though there are some moderate differences in this regard. Meanwhile, the very large differences in the distribution of graduates across disciplines by gender which are almost unchanged across the three cohorts of graduates represent an intriguing aspect of gender earnings patterns and labour market behaviour more generally.

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 – relative stability of the patterns by cohort, year relative to graduation, gender, *etc.* – hold up. It might also be particularly interesting to use the “average error” measure employed here to see how it behaves at a more detailed level and to see if there appear to be (equilibrium?) 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 – something which is not currently planned by Statistics Canada.

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 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.¹⁶

¹⁶ See Altonji [1993] for a model of the choice of the number of years of study with certain endogenous regressors, including discipline, and Garen [1984] as an earlier piece in the same spirit, and Côté and Sweetman [1997] for an attempt to model the differences in earnings by discipline with the choice of discipline treated as a choice outcome.

REFERENCES

- Altonji, Joseph G. [1993], "The Demand for and Return to Education When Outcomes Are Uncertain", *Journal of Labour Economics*, Vol. 11, No. 1, Pt. 1, pp. 48-83.
- Altonji, Joseph G. [1995], "The Effects of High School Curriculum on Educational and Labour Market Outcomes", *Journal of Human Resources*, Vol. XXX, No. 3, pp. 39-44.
- Berger, Mark C. [1988], "Cohort Size Effects on Earnings: Differences by College Major", *Economics of Education Review*, Vol. 7, No. 4, pp. 375-83.
- Betts, Julian, Chris Ferrall, and Ross Finnie [1999], "The Effects of School Quality on Bachelor's Graduates' Earnings", paper presented at the American Education Research Association Meetings, Montréal.
- Coté, Sylvain and Arthur Sweetman [1997], "Does it Matter What I Study? Post-Secondary Field of Study and Labour Market Outcomes in Canada", unpublished mimeo (University of Victoria).
- Daniel, Kermit, Dan Black and Jeffrey Smith [1999], "College Quality and the Wages of Young Men", paper presented at the American Education Research Association Meetings, Montréal.
- Datcher Loury, Linda and David Garman [1995], "College Selectivity and Earnings", *Journal of Labor Economics*, Vol. 13, No. 2, pp. 289-308.
- Daymont, Thomas A. and Paul J. Andrisani [1984], "Job Preferences, College Major, and the Gender Gap in Earnings", *Journal of Human Resources*, V. XIX, N. 3, pp. 408-28.
- Dodge, David and David A. A. Stager [1972], "Economic returns to Graduate Study in Science, Engineering and Business", *Canadian Journal of Economics*, V. V, No. 2 (May), pp. 182-98.
- Eide, Eric [1994], "College Major Choice and Changes in the Gender Wage Gap", *Contemporary Economic Policy*, Vol. XII, April, pp. 55- 64.
- Finnie, Ross [1999a], "What You Study Matters: An Econometric Analysis of Earnings Differences by Field of Study Amongst Recent Canadian Bachelor's Level University Graduates", paper prepared for the Applied Research Branch of Human Resources Development Canada (forthcoming departmental discussion paper).
- Finnie, Ross [1999b], "Fields of Plenty, Fields of Lean: A Cross-Cohort, Longitudinal Analysis of the Early Labour Market Outcomes of Canadian University Graduates by Discipline, paper prepared for the Applied Research Branch of Human Resources Development Canada and (forthcoming departmental discussion paper).

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- [1995], *Steppin' Out: An Analysis of Recent University Graduates Into the Labour Market*, paper prepared for Industry Canada, Working Paper Number No. 5, 129 pp.
- Finnie, Ross and Ted Wannell [1999], "The Gender Earnings Gap Amongst Canadian Bachelor's Level University Graduates: A Cross-Cohort, Longitudinal Analysis", in Richard Chaykowski and Lisa Powell (eds.), *Women and Work, Women and Work*, Kingston/Montreal: Queen's/McGill Press, forthcoming.
- Garen, John [1984], "The Returns to Schooling: A Selectivity Bias Approach with a Continuous Choice Variable", *Econometrica*, Vol. 52, No. 5 (September), pp. 1199-1218.
- Grogger, Jeff and Eric Eide [1995], "Changes in the College Skills and the Rise in the College Wage Premium", *Journal of Human Resources*, V. XXX, No. 2, pp. 280-310.
- Grubb, W. Norton [1993a], "The Varied Economic Returns to Postsecondary Education: New Evidence From the Class of 1972", *The Journal of Human Resource*, V. XXVIII, No. 2, pp. 365-81.
- Grubb, W. Norton [1993b], "Further Tests of Screening on Education", *Economics of Education Review*, V. 12, No. 2, pp. 125-36.
- Grubb, W. Norton [1992], "The Economic Returns to Baccalaureate Degrees: New Evidence From the Class of 1972", *The Review of Higher Education*, Vol. 15, No. 2, pp. 213-31.
- Hecker, Daniel E. [1995], "Earnings of College Graduates, 1993", *Monthly Labor Review*, December, pp. 3-16.
- Jones, Ethel B. and John D. Jackson [1990], "College Grades and Labor Market Rewards", *The Journal of Human Resources*, Vol. XXV, No. 2, pp. 253-66.
- Lavoie, Marie and Ross Finnie [1999], "Is it Worth Doing a Science or Technology Degree in Canada? Empirical Evidence and Policy Implications", *Canadian Public Policy*, Vol. XXV, No. 1, pp. 101-21.
- Mehmet, Ozay [1977], Economic Returns on Undergraduate Fields of Study in Canadian Universities: 1961 to 1972", *Industrial Relations/Relations Industrielles*, Vol. 32, No. 3, pp. 321-39.
- Murphy, Kevin M. and Finis Welch [1990], "Empirical Age-Earnings Profiles", *Journal of Labour Economics*, Vol. 8 (April), pp. 202-29.
- OECD [1996], *Employment Outlook*, Chapter 4: "Growing Into Work: Youth and the Labour Market Over the 1980s and 1990s", pp. 109-159, Organization for Economic Cooperation and Development, Paris.

- Rumberger, Russell, and Scott L. Thomas [1993], "The Economic Returns to College Major, Quality and Performance: A Multilevel Analysis of Graduates", *Economics of Education Review*, Vol. 12, No. 1, pp 1-19.
- Turner, Sarah E. and William G. Bowen [1999], "Choice of Major: the Changing (Unchanging) Gender Gap", *Industrial and Labor Relations Review*, Vol. 52, No. 2, pp. 289-313.
- Vaillancourt, François [1995], "The Private and Total Returns to Education in Canada, 1985", *Canadian Journal of Economics*, Vol. XXVIII, No. 3, pp. 532-53.

Table 1: The Distribution of Graduates by Field of Study¹

	1982 Cohort %	1986 Cohort %	1990 Cohort %
Males			
Other fields	3	5	4
Education	9	9	10
Fine Arts & 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
Females			
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

¹ 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.

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
Males									
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
Agricultural & 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
Females									
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
Agricultural & 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

Table 3: Model 1 - Field Variables Only ¹

	1982 Cohort				1986 Cohort				1990 Cohort			
	1984		1987		1988		1991		1992		1995	
	Coeff.	Std Err.	Coeff.	Std Err.	Coeff.	Std Err.	Coeff.	Std Err.	Coeff.	Std Err.	Coeff.	Std Err.
Males												
Other Fields	-0.12 **	0.05	-0.06	0.07	-0.01	0.04	0.06	0.04	-0.04	0.05	-0.03	0.04
Education	-0.03	0.02	-0.09 **	0.03	0.02	0.02	-0.06 **	0.02	0.05 *	0.03	-0.04	0.02
Arts & Hum.	-0.26 **	0.03	-0.22 **	0.03	-0.13 **	0.03	-0.21 **	0.02	-0.35 **	0.03	-0.22 **	0.02
Commerce	0.05 **	0.02	0.08 **	0.02	0.09 **	0.02	0.07 **	0.02	0.04	0.02	0.05 *	0.02
Economics	0.00	0.03	0.09 *	0.04	-0.07 *	0.03	-0.02	0.03	0.04	0.04	0.05	0.03
Other Soc. Sc.	-0.09 **	0.02	-0.06 *	0.03	-0.05	0.03	-0.08 **	0.03	-0.13 **	0.02	-0.12 **	0.02
Agr. & Bio. Sc.	-0.12 **	0.03	-0.11 **	0.04	-0.18 **	0.03	-0.11 **	0.04	-0.20 **	0.04	-0.15 **	0.04
Eng. & Comp. Sc.	0.21 **	0.02	0.14 **	0.02	0.09 **	0.02	0.11 **	0.02	0.21 **	0.02	0.15 **	0.02
Other Health	0.30 **	0.06	0.18 **	0.07	0.23 **	0.05	0.18 **	0.05	0.36 **	0.06	0.25 **	0.05
Math./Phy. Sc.	0.06 *	0.03	0.06	0.03	0.01	0.03	0.07 *	0.03	0.02	0.04	0.04	0.04
R ²	0.13		0.09		0.06		0.09		0.14		0.09	
Observations	2370		1904		2143		2005		2235		2193	
Females												
Other Fields	-0.14 *	0.06	-0.08	0.07	0.03	0.04	0.03	0.05	-0.13 **	0.05	-0.02	0.04
Education	-0.07 **	0.02	-0.10 **	0.02	-0.01	0.02	-0.05 *	0.02	0.04	0.02	-0.05 *	0.02
Arts & Hum.	-0.24 **	0.02	-0.20 **	0.03	-0.23 **	0.02	-0.16 **	0.02	-0.17 **	0.03	-0.15 **	0.02
Commerce	0.05	0.03	0.07 *	0.03	0.06 **	0.02	0.12 **	0.02	0.08 **	0.03	0.04	0.02
Economics	0.00	0.06	0.00	0.06	0.06	0.04	-0.06	0.05	-0.05	0.06	-0.03	0.06
Other Soc. Sc.	-0.17 **	0.02	-0.05 *	0.03	-0.11 **	0.02	-0.04	0.02	-0.10 **	0.02	-0.10 **	0.02
Agr. & Bio. Sc.	-0.08 *	0.04	-0.10 *	0.04	-0.18 **	0.04	-0.13 **	0.05	-0.11 **	0.04	-0.09 *	0.03
Eng. & Comp. Sc.	0.26 **	0.04	0.22 **	0.05	0.13 **	0.03	0.20 **	0.04	0.21 **	0.05	0.19 **	0.04
Other Health	0.24 **	0.03	0.07 *	0.03	0.18 **	0.02	0.09 **	0.03	0.26 **	0.03	0.13 **	0.03
Math./Phy. Sc.	0.15 **	0.05	0.18 **	0.06	0.07	0.05	0.07	0.06	-0.03	0.05	0.08	0.05
R ²	0.12		0.06		0.10		0.05		0.07		0.04	
Observations	2253		1884		2432		2182		2567		2545	

¹ One asterisk indicates significance at the .05 confidence level, two asterisks indicates significance at the .01 level.

Table 4: Model 2 - Adding Basic Control Variables^{1, 2}

	1982 Cohort				1986 Cohort				1990 Cohort			
	1984		1987		1988		1991		1992		1995	
	Coeff.	Std Err.	Coeff.	Std Err.	Coeff.	Std Err.	Coeff.	Std Err.	Coeff.	Std Err.	Coeff.	Std Err.
Males												
Other Fields	-0.08	0.04	-0.05	0.06	0.00	0.03	0.05	0.03	-0.02	0.04	-0.04	0.04
Education	0.01	0.02	-0.08 **	0.02	0.03	0.02	-0.05 *	0.02	0.04	0.02	-0.01	0.02
Arts & Hum.	-0.20 **	0.02	-0.15 **	0.03	-0.12 **	0.02	-0.14 **	0.02	-0.30 **	0.02	-0.16 **	0.02
Commerce	0.01	0.02	0.06 **	0.02	0.07 **	0.02	0.06 **	0.02	0.03	0.02	0.05 **	0.02
Economics	0.00	0.03	0.05	0.03	-0.08 **	0.03	-0.06 *	0.03	0.02	0.03	0.03	0.03
Other Soc. Sc.	-0.07 **	0.02	-0.04	0.02	-0.05	0.02	-0.08 **	0.02	-0.11 **	0.02	-0.13 **	0.02
Agr. & Bio. Sc.	-0.09 **	0.03	-0.08 *	0.03	-0.15 **	0.03	-0.10 **	0.03	-0.14 **	0.03	-0.14 **	0.03
Eng. & Comp. Sc.	0.15 **	0.02	0.10 **	0.02	0.08 **	0.02	0.09 **	0.02	0.17 **	0.02	0.14 **	0.02
Other Health	0.20 **	0.05	0.13 *	0.06	0.20 **	0.05	0.17 **	0.05	0.29 **	0.05	0.21 **	0.05
Math./Phy. Sc.	0.07 *	0.03	0.07 *	0.03	0.03	0.03	0.06 *	0.03	0.03	0.03	0.05	0.03
R ²	0.35		0.29		0.24		0.29		0.36		0.30	
Observations	2370		1904		2143		2005		2235		2193	
Females												
Other Fields	-0.05	0.05	-0.03	0.06	0.02	0.04	0.06	0.05	-0.09 *	0.04	0.01	0.04
Education	-0.01	0.02	-0.05 *	0.02	0.02	0.02	-0.01	0.02	0.04 *	0.02	-0.03	0.02
Arts & Hum.	-0.19 **	0.02	-0.17 **	0.02	-0.19 **	0.02	-0.14 **	0.02	-0.13 **	0.02	-0.09 **	0.02
Commerce	0.00	0.02	0.04	0.03	0.03	0.02	0.09 **	0.02	0.04	0.02	0.01	0.02
Economics	-0.02	0.05	-0.02	0.05	0.06	0.04	-0.12 **	0.04	-0.06	0.05	-0.10 *	0.05
Other Soc. Sc.	-0.16 **	0.02	-0.06 **	0.02	-0.12 **	0.02	-0.04 *	0.02	-0.07 **	0.02	-0.07 **	0.02
Agr. & Bio. Sc.	-0.03	0.03	-0.08 *	0.04	-0.15 **	0.03	-0.10 **	0.04	-0.13 **	0.03	-0.07 *	0.03
Eng. & Comp. Sc.	0.18 **	0.04	0.17 **	0.04	0.09 **	0.03	0.15 **	0.03	0.15 **	0.04	0.13 **	0.04
Other Health	0.17 **	0.02	0.08 **	0.03	0.17 **	0.02	0.13 **	0.02	0.24 **	0.03	0.16 **	0.02
Math./Phy. Sc.	0.12 **	0.04	0.12 **	0.05	0.06	0.04	0.05	0.05	-0.01	0.05	0.06	0.04
R ²	0.38		0.35		0.31		0.38		0.33		0.36	
Observations	2253		1884		2432		2182		2567		2545	

¹ 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.

² One asterisk indicates significance at the .05 confidence level, two asterisks indicates significance at the .01 level.

Figure 1: Model 1 Coefficient Estimates

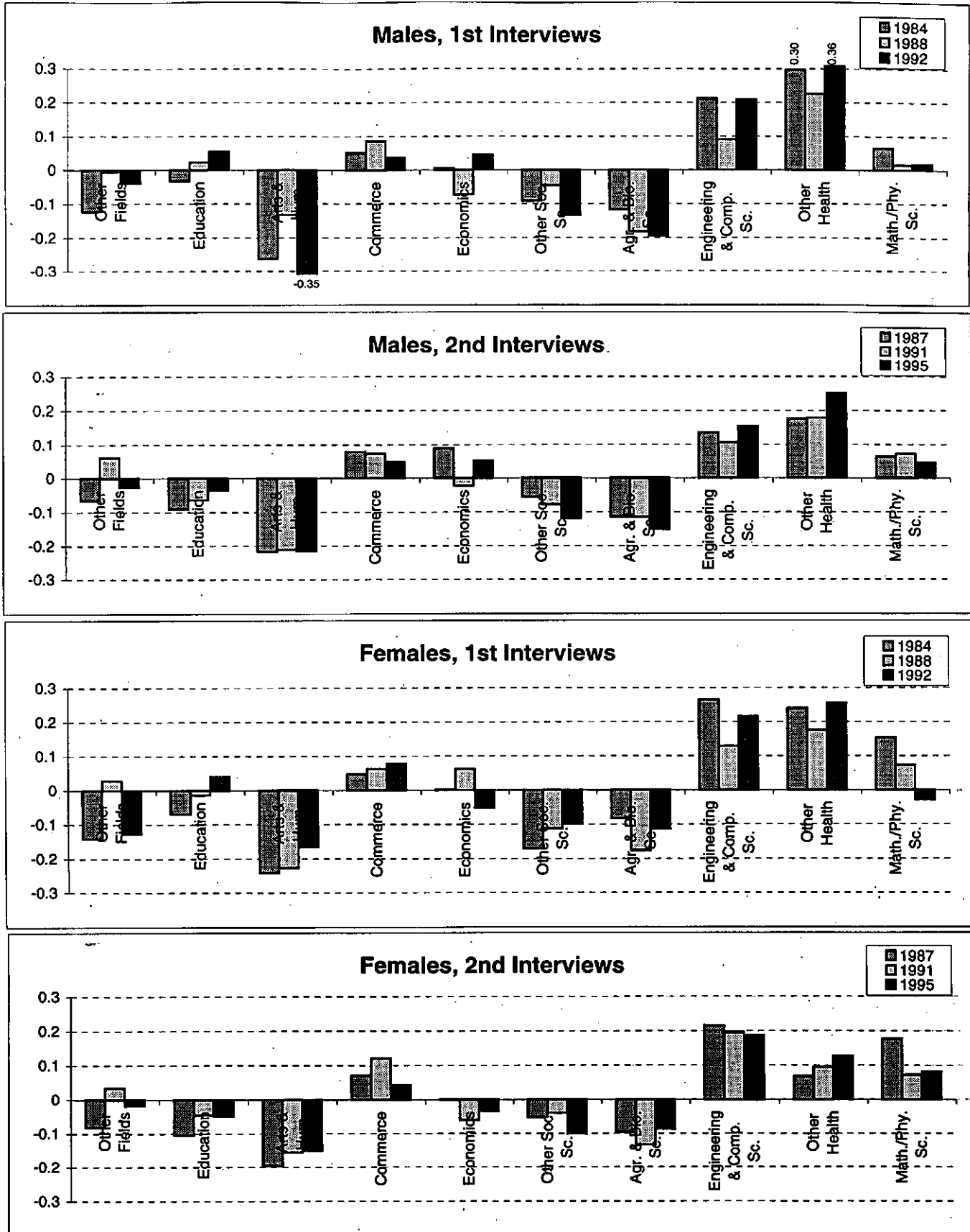


Figure 2: Model 2 Coefficient Estimates

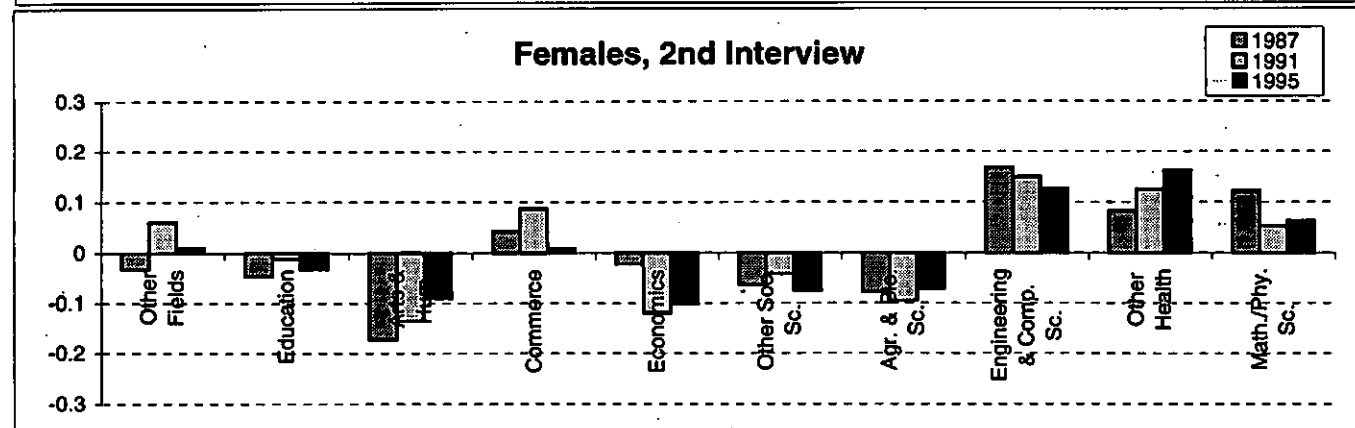
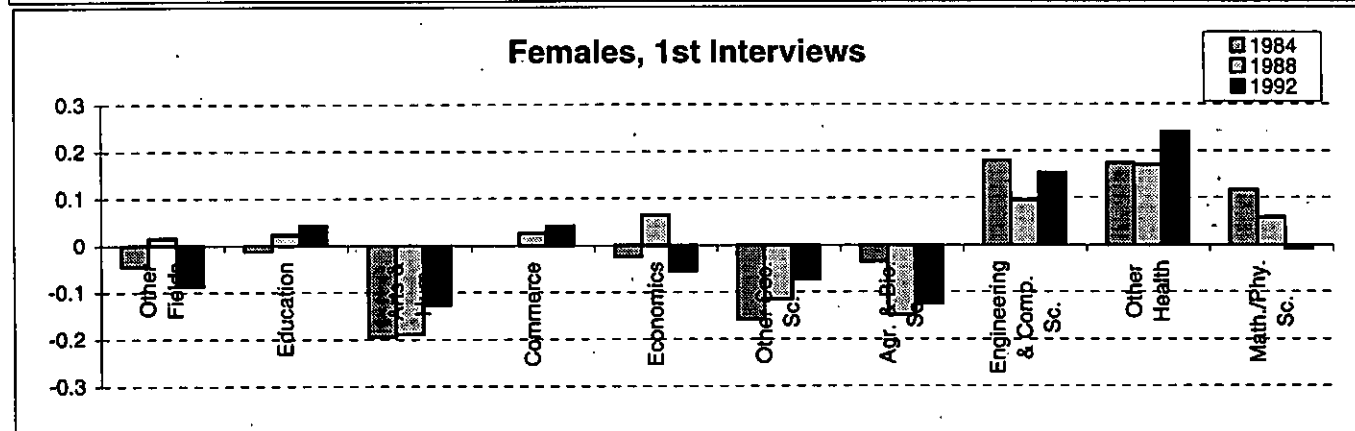
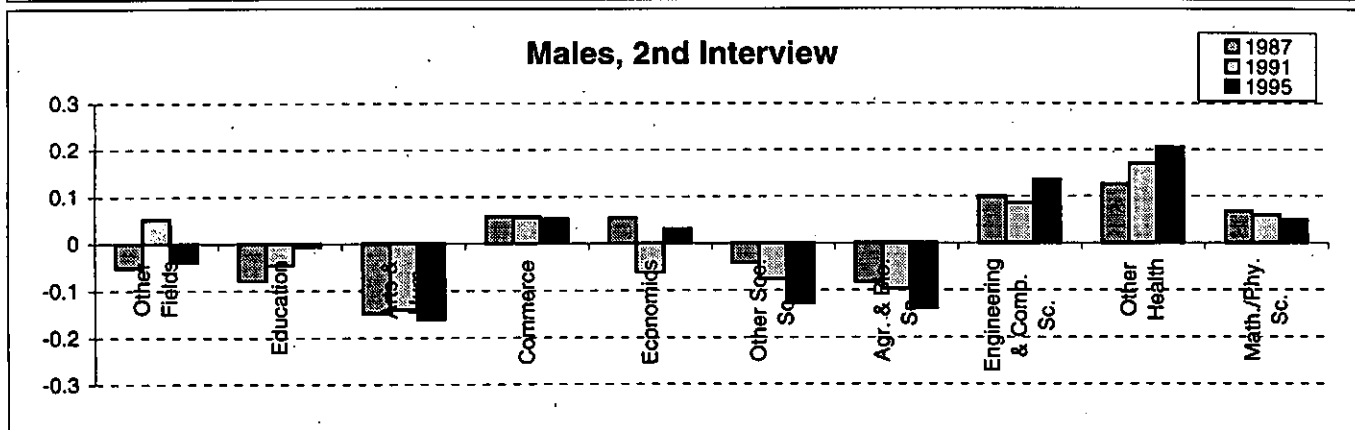
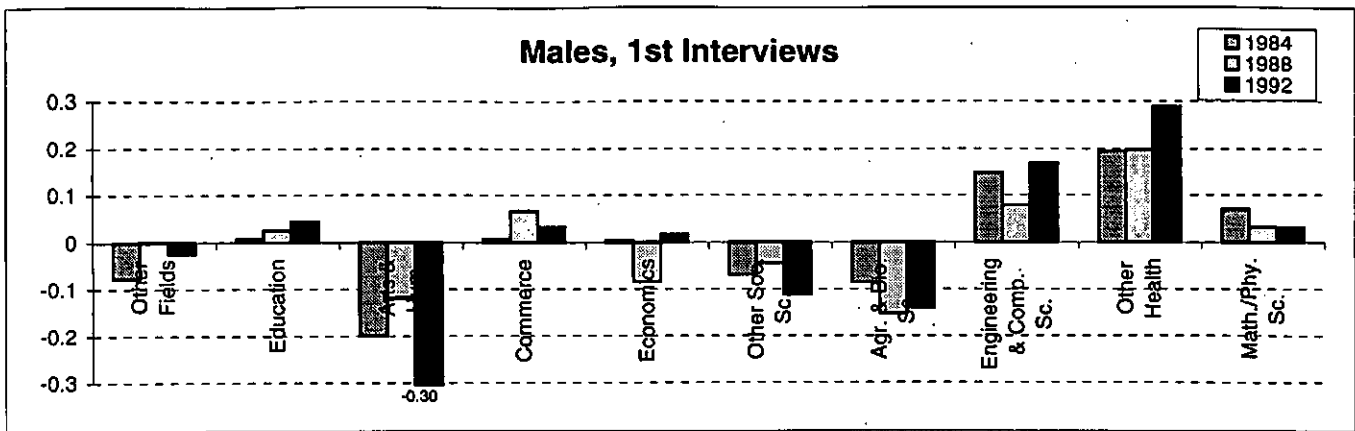


Figure 3: Mean Coefficients (All Three Cohorts) by Model

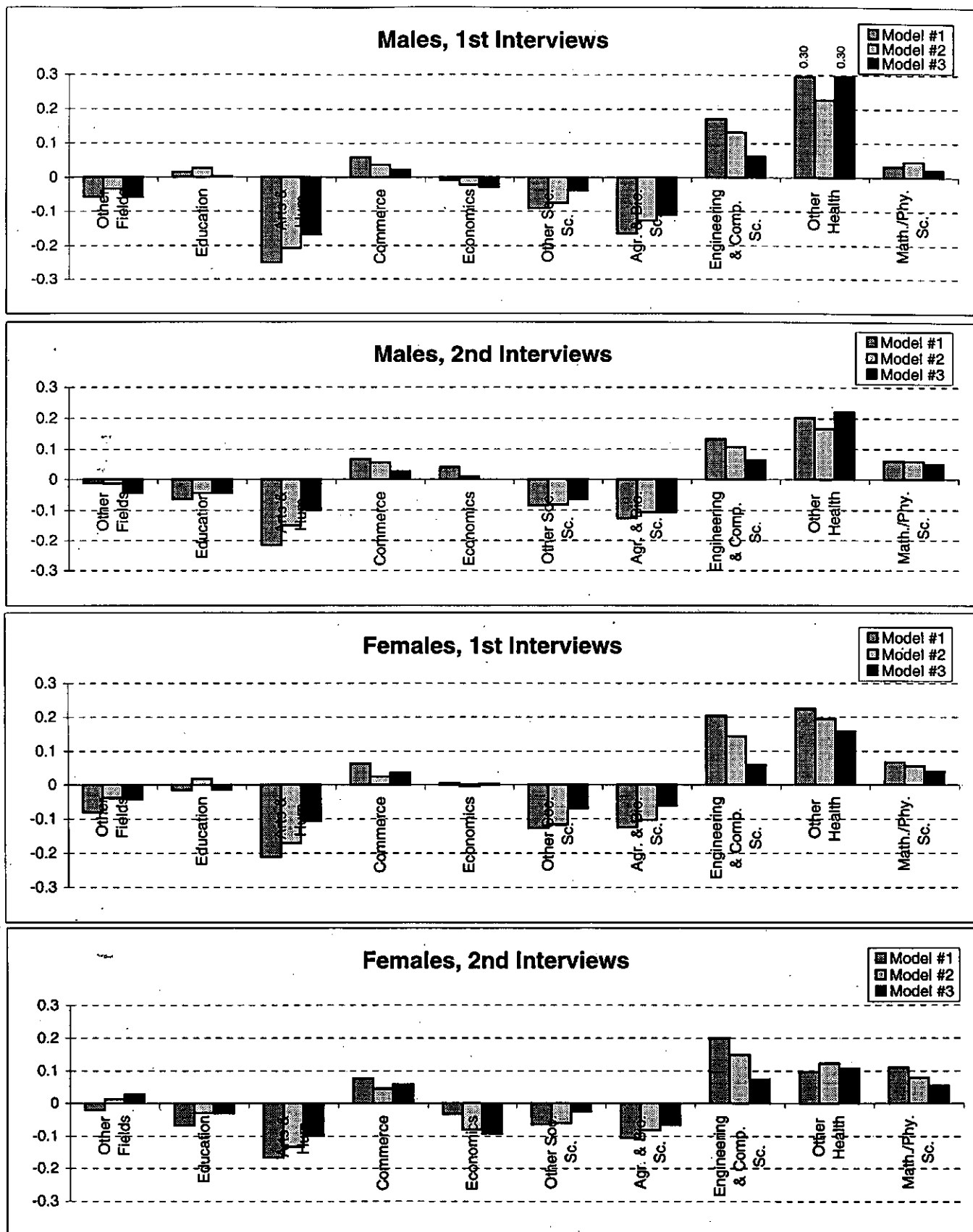


Figure 4: Mean Absolute Errors by Field of Study - Model #2

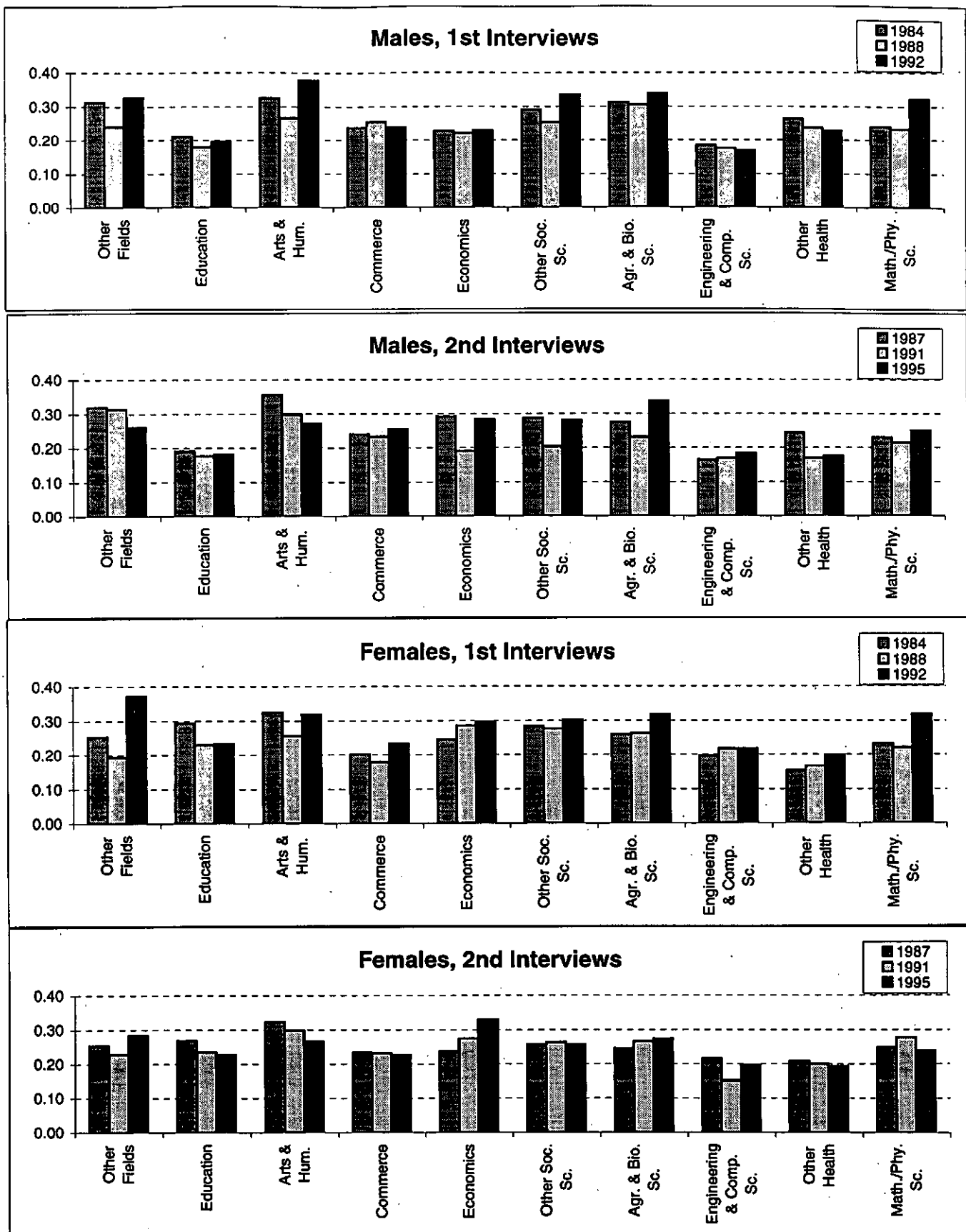


Table 5: Mean Absolute Errors by Field of Study - Model 2 ^{1,2}

	1982 Cohort		1986 Cohort		1990 Cohort	
	1984	1987	1988	1991	1992	1995
	\$	\$	\$	\$	\$	\$
Males						
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	0.19	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
Agricultural & 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
Females						
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
Agricultural & 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

¹ 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.

² The means with no letter subscript have standard errors below 0.01, and those with an asterisk have a standard errors between 0.01 and 0.02.