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Abstract

This paper models earnings of male and female Bachelor's graduates in Canada five years after graduation. Using a university fixed-effect approach, the research finds evidence of significant (fixed) variations in earnings among graduates from different universities. Within universities, changes over time in various characteristics are correlated with changes in graduates' earnings. Increases in undergraduate enrollment are associated with declines in subsequent earnings for graduates, suggesting crowding out. For men, but not women, increases in the professor–student ratio are associated with meaningful gains in students' subsequent earnings. Models that do not condition on a student's major show increased effects of changes in a university's characteristics, with estimated effects rising up to almost two-fold. For women in particular, changes in several university characteristics are strongly associated with changes in women's choice of major. Changes in university characteristics are not strongly related to the probability of employment five years after graduation.

Keywords: post-secondary education, graduates' earnings, graduates' employment, quality of post-secondary education, universities.

Executive summary

A major role of universities is to prepare their students for success in the labour market after they graduate. Surprisingly, we know very little about how universities' educational policies influence the success of their students. From a policy perspective, the role of field of study and university characteristics in determining labour market success of graduates is a compelling issue. Education feeds indirectly into both public and private budgets through productivity gains, earnings power and the tax base. How should scarce funds be spent to foster successful post-graduation outcomes?

In this paper, we use labour-market data from the 1982, 1986 and 1990 waves of the National Graduates Survey (NGS) to examine how graduates of Bachelor's programs in Canadian universities have fared in the labour market. Our specific goal is to test whether given types of educational spending in Canadian universities are helpful in increasing students' earnings five years after graduation. In addition we test for a link between the probability of employment five years after graduation and university characteristics.

Our data set includes measures of university traits at three separate periods (specific to each cohort of graduates) based on data gathered between 1978 and 1990. Such a model fully controls for all unobserved traits of each university that are fixed over time. Using university fixed effects, we identify the impact of certain university traits, such as professor-pupil ratio, on students' wages five years after graduation by (conditionally) correlating changes in these wages across cohorts with *changes* over time within each university in these traits.

We regress log annual earnings five years after graduation of men and women who graduated in 1982, 1986 or 1990 on a vector of personal and family traits. These include age and its square at the time of the survey, marital status, parental education, presence of children, province of residence, education completed prior to the Bachelor's degree, field of study, and the months of work experience prior to graduating from the Bachelor's program. The models condition on a vector of university characteristics, including measures of professor/student ratios, measures of the composition of the teaching staff, and median professor salaries.

To measure student success in the labour market, we model men's and women's annual earnings reported in the fifth year follow-up.

In order to measure university resources devoted to teaching, we merge the NGS data with data available from the federal government on the characteristics of each Canadian university: the ratio of full-time teaching personnel to undergraduate students, the proportion of teachers by rank (full, associate, assistant professors), median salaries of faculty by rank, and the proportion of graduate students in the total student population. The last of these variables, graduate share, serves as a proxy for the degree to which the university is oriented toward research.

We also examined the relation between average fees (including non-tuition fees) and subsequent earnings of graduates.

In addition, we obtained data on the proportion of the freshman with high school averages of 75% or higher, as well as the average high school grades of freshmen. The data, provided by Maclean's, are for 1994. Although these data are not matched to each cohort, and post-date the year of graduation of each student by 2 to 12 years, we used these variables in selected models to corroborate American evidence that the degree of selectivity in admissions at a university is positively associated with students' subsequent earnings.

Our regression sample consists of males and females who obtained a Bachelor's degree in 1982, 1986 or 1990, and who had valid data for age, province of residence, work experience prior to graduation, language spoken, and earnings. Earnings were top-coded at $150,000 per year.

As a starting point, we ran a random effects model that conditioned log wages on our two 1994 measures from Maclean's of the high school grades of incoming students. The coefficients on the two measures of high school achievement of freshman are positive whether they are entered together or alone, thus weakly corroborating evidence from the American literature that the selectivity of universities' undergraduate programs is positively linked to subsequent earnings.

Results for men (when one measure of university traits at a time is added to a basic model including personal demographic traits and past educational experiences) suggest that male graduates' earnings are positively linked to professor-to-student ratios. An increase of 0.01 in the professor-to-pupil ratio is predicted to raise students' earnings five years after graduation by about 0.25%. This represents a modest increase in university staffing, given that for the average student in our sample the professor-to-pupil ratio was 0.089, with a standard deviation of 0.084.

In contrast, a number of other university traits, such as median professor salary and the share of graduate students in the overall student population, are not significantly linked with undergraduates' earnings five years after graduation.

Higher fees, as measured by the total fees paid by arts undergraduates are positively associated with men's later earnings, providing indirect evidence that students benefit, to some extent, from fee hikes and consequent increases in expenditures on undergraduate education by universities during the time under study.

Another regressor of note is that the coefficients on the dummies indicating the field in which the graduate specialized are quite large. Apparently, a man's major influences his earnings in a significant way. Overall, there is a gap in predicted earnings between those in the most highly paid field "Other Health" and those in the lowest paying major, Fine Arts/Humanities, of about 60%.

For both men and women, an increase in enrollment of 1,000, or an increase of about 8% at a typical university, is associated with a 1% drop in earnings five years after graduation. But for women, in the final model that incorporates all of the university traits at once, enrollment remains the only significant university variable, in contrast to the results for men.

After dropping the controls for majors, for men, professor/student ratio, undergraduate enrollment, and fees remain significant, but the coefficients rise by a third to a half. The implication is that expansions in the professor/student ratio, increases in fees, and reductions in overall enrollment allow students a greater opportunity to enroll in majors that have high payoffs in the labour market.

When the controls for major are dropped for women, each university characteristic except for professor salary becomes statistically significant. In addition, the coefficients grow in absolute size by about half. Thus, changes in many of a university's characteristics may induce changes in a woman's major that, in turn, affect wages. Factors encouraging women to enroll in more highly paying majors include an increase in the professor/student ratio, a drop in overall enrollment, an increase in the share of graduate students in the overall student body, and an increase in fees.

To check for non-linearities, we reran the basic models after adding squared terms for each university characteristic. For men, we found a concave relation between log wages and tuition and fees, and a positive relation between log wages and tuition and fees up to about $5,900. Still, these results suggest that benefits from increases in tuition and fees arise primarily in the universities with the lowest tuition and the biggest gap between desired expenditures and actual budget.

For women, there is a positive concave relation between log wages and two university characteristics: tuition and fees and median professor salary. The quadratic relationship of log wages with tuition and fees is similar to that for men, with a peak at $5,800, but this relation is only weakly significant. More strongly significant is the quadratic in median professor salary, where a positive but diminishing link with log wages emerges, up to $58,800, beyond which the relationship becomes negative.

For men, none of the university characteristics is significantly related to the probability of employment. For women, with one important exception, none of the university characteristics is significant, and the signs of the coefficients match the results for men. As for men, the variable that is most highly significant is median professor salary, but unlike the model for men, it becomes marginally significant (t=1.91). A $1,000 increase in median professor salary is predicted to increase the probability of employment for female graduates by 0.36%.

This paper presents the first analysis of the link between university resources and earnings of Canadian undergraduates after they graduate. It also represents one of the first times that university fixed effects have been used to control for unobserved and fixed traits of the university. We find strong evidence that there are fixed and unobserved wage effects associated with attendance at different universities. After incorporating fixed effects we find that university traits, in particular the professor/student ratio, enrollment, and fees can explain some of the observed inter-university differences in earnings.

What do our findings imply for the earlier literature on American university quality, which has used purely cross-sectional variation to identify the impact of university spending? First, our consistent and strong rejection of the hypothesis that undergraduates' earnings are identical across campuses after controlling for the standard set of measures of university quality, for personal background, and for selectivity in admissions raises questions about the interpretation of earlier findings. Second, our fixed-effect approach offers more direct policy guidance. Our analysis cannot tell undergraduates which university is the best to attend, but we can predict the likely outcome if resources change over time.

The more important finding is how small such effects are. Variations in university spending may have a much smaller impact on graduates' earnings than do variations in unobserved traits across universities and the large observed variations in earnings across university majors.

1. Introduction

A major role of universities is to prepare their students for success in the labour market after they graduate. Surprisingly, we know very little about how universities' educational policies influence the success of their students. There exists a small number of American studies which model earnings of graduates as a function of the educational expenditures of the universities which they attended. See for example Morgan and Duncan (1979), James et al. (1989), Rumberger and Thomas (1993), Behrman, Rosenzweig and Taubman (1996), and Daniel, Black and Smith (1997). These papers tend to find that students who have attended more selective universities earn more upon graduation. The last two of these papers, much more so than the first three, also find some evidence in favour of the proposition that those who attend universities with higher educational expenditures per student earn more after graduating. Daniel, Black and Smith note that they find much more consistent effects of inputs than is typically found in the literature on inputs in the American K-12 education sector. Noting that the latter system offers little choice to parents while the American university system offers a wealth of choice, the authors interpret their finding as suggesting that competition between American universities leads to the productive use of educational funds.

From a policy perspective, the role of field of study and university characteristics in determining labour market success of graduates are compelling issues. On one hand, direct spending on education is one the largest items in government budgets and one of the largest investments made by individuals and their parents. On the other hand, education feeds indirectly into both public and private budgets through productivity gains, earnings power and the tax base. How should scarce funds be spent in order to foster successful post-graduation outcomes? Does the teacher–pupil ratio have an observable impact on earnings? Does the mix of faculty between assistant and more experienced associate and full professors matter? Do professors' salaries bear any detectable relationship to how students perform in the labour market? Do research-oriented universities tend to do a better or worse job of preparing undergraduates for the labour market?

In this paper, we examine these questions in a Canadian context. We use labour-market data from the 1982, 1986 and 1990 waves of the National Graduates Survey (NGS) to examine how male graduates of Bachelor's programs in Canadian universities have fared in the labour market after graduating. [1] These three panel surveys provide detailed information on the student's personal background, educational credentials, including the name of the university attended, degree earned and field of study, and earnings five years after graduating. The NGS databases allow us to link universities' attributes from other data sources to individual students, allowing us to analyze the effects of these attributes on earnings. The panel nature of the university characteristics, combined with repeated cross-sections of graduates, permits the use of university fixed effects. This approach can control for omitted university traits that are likely to bias the results of more conventional analyses. (Because under federal law Statistics Canada is forbidden to release information on a given person or entity or to release data in a way that would allow such a person or entity to be identified, we cannot identify information for specific universities.)

Our specific goal will be to test whether given types of educational spending in Canadian universities are helpful in increasing students' earnings five years after graduation. In addition we test for a link between the probability of employment five years after graduation and university characteristics.

1. See Finnie (2002) for an analysis of early labour-market outcomes of university graduates that uses the same survey.

2. *Methodology and comparison with the American literature*

Our data include large numbers of graduates from each university, spread across three cohorts of graduates who left university over an eight-year period. These traits of the data confer two methodological advantages.

First, we can test whether universities appear to differ significantly in quality, at least in terms of earnings received by graduates five years after graduation. This is accomplished by testing for the presence of university fixed effects. This test has not been possible in much of the earlier research due to the small number of individuals per university in many of the American data sets.[2] It is interesting to examine the distribution of earnings across graduates from different universities. We also explore relations between these average differences in earnings and average characteristics of the universities and their student bodies.

Clearly two separate factors are confounded in university effects: the direct quality of the institution as it relates to earnings power after students graduate and the sorting of students by quality (e.g., ability, prior preparation and motivation) across universities. For instance, suppose that the finding by James et al. (1989) that elite northeastern universities in the United States produce graduates who earn more reflects a "Harvard effect". That is, suppose that certain universities, by virtue of their history, have garnered such a reputation that they attract unusually talented students. Such an effect would create a positive correlation between university spending and students' later earnings that was not fully causal.[3]

Second, although we cannot fully rectify the above problem, the panel aspect of our data does provide some leverage to identify the marginal effect of university characteristics on later earnings. That is, we can control for all that is unobserved about each university that is fixed over each period. To the extent that one university has a better stock of teachers than another, and that highly able versus less able high school students sort differently into universities, and to the extent that these and other unobserved or imperfectly observed characteristics of universities and their students are fixed over the eight-year period we examine, we can remove these factors from the analysis. Thus, we allow the earnings function for graduates of each university to have an intercept for each university:

$$(1) \quad \ln(w_{ist}) = \sum_{j=1}^{S} \alpha_j + X_{ist}\beta + UNIV_{st}\Gamma + \varepsilon_{ist}$$

2. For instance, James et al. (1989) cannot conduct a similar overall test of variations in university quality, because in their data set there are almost as many universities as individuals. In such a case, one cannot discern whether variations in earnings across universities reflect unobserved variations in university quality or simply interpersonal variations in earnings capacity. In contrast, the study by Rumberger and Thomas (1993) does contain enough observations per university to assess the extent of variation in earnings across universities. These latter authors do not formally test the null of identical university intercepts but report that university attended could explain 8% to 28% of mean earnings.

3. Indeed, much of the recent American literature on the wage effects of attending university has focused largely on the question of selectivity bias. See for instance Fox (1993), Datcher Loury and Garman (1995), Behrman, Rosenzweig and Taubman (1996), Brewer, Eide and Ehrenberg (1999), and Monks (2000). Black and Smith (2004) use a propensity score approach to control for selection of students into each university. One paper, that makes an especially compelling case that much of the correlation between wages and holding a degree from elite American universities is simply selectivity bias, is provided by Berg Dale and Krueger (2002) who, roughly speaking, show that students who are accepted at an elite American university but who attend a less prestigious university earn almost the same as admittees to the elite university who do enroll.

where i indexes graduates, s indexes the schools (universities) which number S in total, and t indicates the time period. The X and UNIV vectors include personal and university traits respectively, while the α_j terms are a set of fixed effects for the set of S universities. In data sets such as those used by James et al. (1989), in which there is only one observation across time on university traits, the Γ vector is not identified because it is perfectly collinear with the set of university dummy variables. Since such a data set is particularly prone to omitted variable bias related to the presence of university fixed effects, authors such as James et al. have been particularly careful to include proxies for unobserved university quality, using variables that indicate the selectivity of the given university. Of course, such variables are unlikely to capture fully the unobserved variations among universities.

Our data set includes measures of university traits at three separate periods (specific to each cohort of graduates) based on data gathered between 1978 and 1990. This panel aspect of the data allows model (1) to be estimated with university fixed effects while leaving Γ identified. Such a model fully controls for all unobserved traits of each university that are fixed over time. (It cannot, however, control for any interactions between these unobserved factors and characteristics of individual students.) Naturally, this model does not control fully for unobserved aspects of each university that vary over time, but we believe that these are likely to represent a much smaller problem than unobserved but fixed differences.

Note that under this approach with university fixed effects, we identify the impact of university traits such as the professor–pupil ratio on students' wages five years after graduation by (conditionally) correlating changes in these wages across cohorts with *changes* over time within each university in these traits.

It is important to understand that our fixed-effect approach is useful because it controls for any unobserved but constant traits of graduates of each university. For instance, if the dummy variables for each province are insufficient to control adequately for especially strong (or weak) labour markets in the area surrounding the university, then the fixed effects will control for these differences across universities to the extent to which they are constant over time. We can then use variations in the level of funding, student–teacher ratios and so on over time at each university to identify their impact on earnings in a robust way. For instance, if lower student–professor ratios increase earnings of students after graduation because they improve the quality of education, and if these ratios have declined at university X between 1982 and 1990, then more recent graduates should earn more than the 1982 graduates from that university.

Our university fixed effects are unlikely to control completely for selection of students into each university. However, to the extent that the most able students in a province always attended universities A and B over the eight-year period under study, the fixed effects sweep *average* ability of the university's student body out of the wage equations. The American literature as described in an earlier footnote has not taken this approach but has instead added individual proxies for ability such as test scores and in some cases modeled selectivity directly using additional controls for student characteristics, Heckman selectivity corrections or propensity score matching. We can control for many personal characteristics but rely on the university fixed effects that have not been a possibility with the American data sets. To the extent that *changes* in the nature of a university's selectivity do not occur over the eight-year period we study, we can then use changes in resources at each university and changes in graduates' earnings to identify something approaching a causal effect of resources on student outcomes.

Our data set has weaknesses in addition to the strengths listed above. First, our measure of university selectivity is not as precise as those contained in American data sets because it is available for 1994 only, while all students in our sample graduated in 1982, 1986 or 1990. However, we feel that this is a minor drawback, since we fully control for the average achievement of incoming freshmen using the fixed-effect approach. In addition, it is worth mentioning that the structure of the Canadian university system is in some ways quite different from its American counterpart. Although we cannot prove this, our impression is that variations in quality and student selectivity are greater in the United States. One reason for this is the predominance in the United States of private universities and colleges that benefit from large endowments. In contrast, all Canadian universities are public institutions. A second, and in our view more important limitation, is that our models typically include 43 universities, compared to several hundred in the typical study based on U.S. data. In effect, this is the flip side of the argument we made above that the large number of observations per university allows us to estimate the importance of university fixed effects precisely. Canadian universities also tend to vary less in observed spending than do universities and colleges in the United States, in part because the United States features a large system of private universities. This lack of variation in university resources across individuals is counterbalanced by the extremely large sample size relative to that used in most of the earlier studies. In addition, our use of fixed effects removes the between-university component of variations in resources, so that inter-university variation is not required for us to identify the effect of universities' traits.

Another weakness relative to the American literature is that we have no test scores of students before they enter university, and so cannot directly control for selectivity in university admissions. Against this drawback, we raise two points. First, the university fixed effects are likely to remove most of the correlation between unobserved ability and motivation and the average resources used at each university. Second, Canadian universities are widely perceived as varying less dramatically in quality than American universities. For instance, the Canadian system does not include private universities with large endowments that are so central in creating the spread in university resources across American universities.

We regress log annual earnings five years after graduation of men and women who graduated in 1982, 1986 or 1990 on a vector of personal and family traits. These include age and its square at the time of the survey, marital status, parental education, presence of children, province of residence, education completed prior to the Bachelor's degree, field of study, and the months of work experience prior to graduating from the Bachelor's program. The models also condition on a vector of university characteristics. These include measures of professor–student ratios, measures of the composition of the teaching staff, and median professor salaries. We also examine the impact of the research orientation of the university, as measured through the share of graduate students in the overall student population. We also allow for (dis)economies of scale, or more properly adjustment costs, by including full-time-equivalent undergraduate enrollment in one model.

We estimate reduced forms of each of these models, in the sense that the given outcome five years after graduation is modeled as a function of the educational background and work experience of the student at the time of graduation. We do not condition on subsequent work experience or education since these are likely to be endogenous functions of the person's undergraduate experience.

3. Data and the choice of measures of university resources

Our primary data source is the 1982, 1986 and 1990 waves of the National Graduates Survey (NGS), which follow large representative samples of Canadian postsecondary students who graduated in the stated years. The data provide a rich set of personal and family background variables that are likely to affect earnings. Together, the three panels contain a far larger sample of Bachelor's graduates than is available in the American data sets commonly used to model the determinants of university quality, with roughly 8,000 men and 8,000 women.[4]

To measure student success in the labour market, we separately model men's and women's annual earnings reported in the fifth year follow-up, well after graduation.[5] This variable will reflect the impact of university traits on both hourly earnings and hours worked per year.

In order to measure university resources devoted to teaching, we merge the NGS data with data available from the federal government on the characteristics of each Canadian university. Specifically, we use the ratio of full-time teaching personnel to undergraduate students, the proportion of teachers by rank (full, associate, assistant professors), median salaries of faculty by rank, and the proportion of graduate students in the total student population. The last of these variables, graduate share, serves as a proxy for the degree to which the university is oriented toward research. As James et al. (1989) point out, students may benefit from being taught by faculty whose research is at the leading edge of knowledge. But on the other hand, undergraduates at research universities may suffer if they are taught largely by inexperienced graduate students. So there is no simple prediction for the sign of the coefficient on the proportion of the student population who are graduate students. The ratios of undergraduate enrollment to teaching personnel provide an admittedly rough proxy to class size, while the mix of professors by rank potentially can indicate whether there is a payoff to attending universities with a greater share of full professors. Such professors tend to have more teaching and research experience than more junior professors, but they are not necessarily more engaged as classroom teachers. The professor salary variable provides one specific measure of educational expenditures, which we hypothesize could be positively related to the overall quality of education provided if there is heterogeneity across universities in the quality of professors. We also examined the relation, if any, between average fees (including non-tuition fees) and subsequent earnings of graduates. To the extent that fee hikes feed through into higher educational expenditures, we hypothesize a possible positive relation.[6]

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4. In one of the best known American studies, by James et al. (1989), the sample derived from the National Longitudinal Study of the High School Class of 1972 (NLS72) contains only 1,241 people. The more recent National Longitudinal Survey of Youth (NLSY) sample employed by Daniel, Black and Smith (1997) uses a considerably larger sample, of about 3,000 workers, but again this is fairly small compared to the over 16,000 workers in our sample. Rumberger and Thomas (1993) use a sample from a single cohort of approximately 8,000 American undergraduates. But their paper focuses more on the role of college major in determining earnings than on the impact of specific types of university resources.

5. At the time of the interview part way through the year, respondents are asked to estimate their annual earnings assuming that the job lasts all year.

6. We used undergraduate tuition for arts majors for this analysis because this represented a major available at almost all of the universities under study. At most universities, variations in fees between arts and other majors were quite small compared to the difference in fees *between* universities. We thus believe that we have captured the most important variations in university fees across campuses through our measure. Appendix Table A1 shows the sample size, mean and other descriptive statistics for arts tuition and tuition in other majors.

We obtained data for these from three Statistics Canada publications (various years): “Salaries and Salary Scales of Full-Time Teaching Staff at Canadian Universities”, “Tuition and Living Accommodation Costs at Canadian Universities”, and “Universities: Enrolments and Degrees”. In each case, we obtained data for 1978, 1980 and so on through 1990, interpolated linearly for a limited number of missing observations, and then took three-year averages for each of the cohorts. For instance, for the cohort that graduated in 1990, university traits were averaged over 1986, 1988 and 1990, which approximates the time when graduates from 1990 entered, were in the middle of, and finished their undergraduate studies respectively.

We calculated professor–pupil ratios as the number of professors at a university divided by the full-time equivalent number of undergraduates. We calculate the latter as the number of full-time undergraduates plus one-third the number of part-time undergraduates, in line with American practice. Statistics Canada provides consistent time series on the total number of lecturing faculty, and the numbers of full, associate and assistant professors. The total exceeds the sum of these three subcomponents because the overall measure of teaching faculty will include non-tenure-track faculty such as lecturers.

In addition, given evidence from the American literature that students who graduate from more selective universities earn more, we also obtained data on the proportion of the freshman entering class with high school averages of 75% or higher, as well as the average high school grades of entering freshmen. The data, generously provided by Maclean’s, the leading Canadian weekly newsmagazine, are for 1994.[7] These data are thus not matched to each cohort, and post-date the year of graduation of each student by 2 to 12 years. Nevertheless, we used these variables in selected models to corroborate American evidence that the degree of selectivity in admissions at a university is positively associated with students’ subsequent earnings.

Our regression sample consists of males and females who had obtained a Bachelor’s degree in 1982, 1986 or 1990, and who had valid data for age, province of residence, work experience prior to graduation, language spoken and earnings. We deleted a small number of people who reported that they were working part time due to further attendance at university in the survey five years after graduating from their Bachelor’s programs. We also deleted a small number of students whose undergraduate majors were medicine and law, for fear of distorting the estimated average earnings of students who earned undergraduate degrees in favor of universities with large medical and law programs. We argue that both law and medicine are best thought of as postgraduate work. Earnings were top-coded at $150,000 per year. This and all other financial variables in the analysis were expressed in terms of 1995 prices. We used the annual all-items price index Matrix 9957 from CANSIM for this purpose.

Tables A1 and A2 in the appendix show mean, standard deviation and extrema of the key variables in the analysis for men and women, respectively. In some cases, the variable descriptions are stated more fully in these tables than in the following tables with regression results. The top part of the tables shows the university traits that are used in the analysis. Proxies for university expenditures,

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7. Prior to 1994, Maclean’s published rankings of universities based on, e.g., grades of incoming freshmen. Instead of using these rankings, we opt to use the proportion of freshmen with averages of 75% or greater from 1994, in the belief that this provides a more meaningful measure of universities’ degree of selectivity. If no data were available from 1994 (15 universities did not respond that year), we then searched 1995 and then 1996 publications for the data. Failing this, we used the 1993 publication, which publishes rankings within 3 categories of universities, and interpolated from the nearest surrounding pair of universities in the rankings for which we did have data in 1994. We were able to interpolate data for two universities this way: Laval and Sherbrooke.

such as the professor–student ratio and median professor salaries, show reasonably large standard deviations. However, the 1994 measure of the average high school grades of incoming freshmen ranges from a high of 87 to a low of only 72.

Table A3 shows the overall, within-university, and between-university standard deviations of the key university characteristics that we focus on below. Roughly speaking, the standard deviations within universities are one-quarter to one-half as big as the overall standard deviation. The biggest reductions are for median professor salary and enrollment. But even in these cases we are left with reasonable variations such as a standard deviation in enrollment within universities of almost 1,300 students, compared to a mean of about 12,000 students for both the male and female wage samples.

4. Results

As a starting point that bears some resemblance to the U.S. literature, we did not include university fixed effects but instead ran a random effect model that conditioned log wages on our two 1994 measures from Maclean's magazine of the high school grades of incoming students. The coefficients on the two measures of high school achievement of freshman were positive whether they were entered together or alone, and when entered alone the t-statistic on the given measure of selectivity was about 1. We suspect that the lack of availability of consistent measures of university selectivity that could be matched to earlier years introduces some measurement error into the estimated effect of university selectivity. In sum, these results weakly corroborate the evidence from the American literature that the selectivity of universities' undergraduate programs is positively linked to subsequent earnings of graduates.

Because the Maclean's rankings are not available for the 1980's they do not vary over time in our data. Therefore, we cannot include these variables in the models with university fixed effects that we will focus on below. This raises a natural question: are fixed effects, which control for any factors that are fixed over time related to each university, really necessary? Tables 1 and 2, which show the main specifications for men and women respectively, provide ample evidence that this is the case. The bottom of the tables shows the p-values for a test of ordinary least squares versus fixed effects: in each case this p-value is less than 0.0005, so that we strongly reject the null that all university effects are identical.[8]

The top rows of Table 1 show the results for men when one measure of university traits at a time is added to a basic model including personal demographic traits and past educational experiences, including postsecondary experience prior to the Bachelor's degree and the student's major in the Bachelor's program. Other regressors not shown include the set of university fixed effects, dummies for whether the person's mother or father had any postsecondary education, dummies for missing parental education, dummies for those whose language spoken at home and region were (English/Quebec), (French/outside Quebec), (other language/Quebec), and (other language/outside Quebec), dummies for residence in the year of the wage observation in all provinces but Ontario, a dummy for residence in the Northwest Territories or the Yukon, dummies for being a single parent,

8. Moreover, models that do not include university dummy variables are likely to be biased. For instance, we estimated models with university random effects and in every case Hausman tests strongly rejected the null that the random effect models were consistent. In many cases, the coefficients on key university characteristics change meaningfully when we sweep unobserved characteristics of each university out of the error term through the addition of fixed-effects.

a married parent, or a person who is married with no children, and dummies for the cohorts who graduated in 1986 or 1990.[9]

To this extensive list of personal traits, we add one university trait at a time to reduce the risk of collinearity between the various university quality proxies.

Table 1 suggests that male graduates' earnings are positively linked to professor-to-student ratios. An increase of 0.01 in the professor-to-pupil ratio is predicted to raise students' earnings five years after graduation by about 0.25%. This represents a modest increase in university staffing, given that for the average student in our sample the professor-to-pupil ratio was 0.089, with a standard deviation of 0.084 (see Table A1). In contrast, a number of other university traits, such as median professor salary and the share of graduate students in the overall student population, are not significantly linked with undergraduates' earnings five years after graduation. Rumberger and Thomas (1993) come to similar conclusions with regard to the share of graduate students in the student population, suggesting that research universities do not produce graduates from their undergraduate programs who are significantly better or worse prepared for the labour market. However, in our case, the result is best interpreted as follows: a *change* in the share of graduate students in a given campus population has no effect on wages of undergraduates. A rise in undergraduate enrollment is predicted to lower men's earnings, suggesting that, on average, schools at which enrollment grew during the 1980's did a less effective job teaching than they had in the past, perhaps due to crowding effects, or that teaching did not improve sufficiently to make up for a possible reduction in entrance requirements. The former pattern may represent diseconomies of scale. However, because we identify this effect from changes in enrollment over three cohorts separated by only eight years, the negative effect of enrollment could arise from short-run adjustment costs. See Finnie (2005) for a discussion of the implications of expanding university capacity.

Higher fees, at least as measured by the total fees paid by arts undergraduates (tuition plus other fees) are positively associated with men's later earnings, providing indirect evidence that students benefited, to some extent, from fee hikes and consequent increases in expenditures on undergraduate education by universities during the time under study. Daniel, Black and Smith (1997) find similar evidence using American data that earnings are increasing in the fees charged by the university, although the effect weakens as the authors add more background controls. These authors also find evidence that higher faculty-to-student ratios are associated with higher earnings, and that this result is robust to the addition of additional background controls.[10]

The final column of the table shows a model that adds all of the university characteristics at once. Coefficients change and the only university trait that is significant is graduate share, which now enters negatively. This regression shows the hallmarks of multicollinearity. Thus, we need to be cautious about over-interpreting the models with a single university characteristic. We also note that the R^2 in this final model is substantially bigger than that for any of the earlier models, suggesting

9. The motivation for the set of language—region interactions are to control for people whose language spoken at home is not the majority language e.g., French in Quebec and English elsewhere.

10. When the models in Table 1 were repeated using random effects, the coefficients and t-statistics on the university characteristics differed from those in Table 1. Most notably, in model 1, the coefficient (t-statistic) on the professor–student ratio was 0.094 (0.28). In the other models, the coefficients (t-statistics) were 0.000978 (1.08) for (median professor salary)/1000, 0.00126 (1.46) for (undergraduate enrollment)/1000, -0.0417 (-0.44) for (graduate student share)/1000, and 0.0500 (2.49) for (undergraduate fees in arts programs)/1000. Because the Hausman tests reject these models, we focus on the fixed-effect models in the text.

that any one university characteristic does not come close to capturing all of the university earnings effect.

Some of the other regressors in Table 1 are of note. For instance, the coefficients on the dummies indicating the field in which the Bachelor's graduate specialized are quite large. Apparently, a man's major influences his earnings in a significant way. For instance in the first column, compared to the omitted major, engineering, graduates of fine arts/humanities programs are predicted to earn 34.6% less while the top-paid group, Other Health, majors out-earned engineers by 8.0%.[11] Overall, there is a gap in predicted earnings between those in the most highly paid field "Other Health" and those in the lowest paying major, Fine Arts/Humanities of about 60%. Interestingly, James et al. (1989), using 1986 wage observations in their American sample, estimate a similarly sized wage gap (0.47 log points) across fields of study, compared to 0.50 log points in our data. Rumberger and Thomas (1993) find a 0.40 log point wage gap across majors in their sample of American male graduates. In spite of the striking similarity among these estimates of variations in the returns to university major, there may, in reality, be more variation in earnings between fields of study in the United States than in Canada: these two American studies both used seven fairly highly aggregated categories of majors, compared to 13 in our data. Indeed, Grogger and Eide (1995) claim that one-quarter of men's increased returns to a university degree in the United States in the 1980's arose from shifts by undergraduates to more highly remunerative majors.

Some of the measured wage gaps across majors probably reflect real differences in the "value added" by majors that are more and less relevant to the job market. But the wage gaps probably also reflect self-selection of students into majors.

A person's months of working experience prior to graduating is a positive and significant predictor of earnings. Postsecondary education attained prior to the Bachelor's program, although not widespread, is also a significant positive predictor of earnings.

Table 2 provides corresponding results for women. The signs on the coefficients of the university characteristics are the same as for men, but the only coefficient that is statistically significant is enrollment. For both men and women, an increase in enrollment of 1,000, or an increase of about 8% at a typical university, is associated with a drop in earnings five years after graduation to the order of 1%. As always, in regression analysis some other variable may be driving this correlation, but one possible interpretation is that increases in enrollment at a given university over a half decade lead to crowding and a slightly lower quality of education. We also note that in the final model that incorporates all of the university traits at once, results are little changed from the sequence of simpler models. For instance, enrollment remains the only significant university variable. This consistency stands in contrast to the results for men.

Models without controls for majors

It is possible that changes in university characteristics influence earnings in part by altering students' choices of major. Just one possibility here is that increases in fees might be used to expand programs that were oversubscribed by undergraduates. Table 3 replicates the models in Tables 1 and 2 after dropping the controls for major. In the top panel, for men, we see that the three university traits that were significant, professor–student ratio, undergraduate enrollment and fees, remain significant, but the coefficients rise by a third to a half. The implication is that expansions in

11. This gap is calculated by taking the exponential of the coefficient and subtracting 1, and converting to a percentage.

the professor–student ratio, increases in fees (and, we infer, subsequent increases in educational spending) and reductions in overall enrollment each allow students a greater opportunity to enroll in majors that have high payoffs in the labor market.

The changes that result from dropping the controls for major are even more dramatic for women. As shown in the bottom panel of Table 3, each university characteristic except for professor salary becomes statistically significant. In addition, the coefficients typically grow in absolute size by about half. The implication is that changes in many of a university's characteristics may induce changes in a woman's major that in turn affect wages. Factors that appear to encourage women to enroll in more highly paying majors include an increase in the professor–student ratio, a drop in overall enrollment, an increase in the share of graduate students in the overall student body, and an increase in fees.[12]

Robustness

The models in Tables 1 and 2 are linear in university characteristics. To check for non-linearities we reran the basic models after adding squared terms for each university characteristic. The results appear in Table 4. As shown in the upper panel, for men we found evidence of a concave relation between log wages and tuition and fees. There is a positive relation between log wages and tuition and fees up to about $5,900 in 1995 prices. This encompasses tuition and fees for most of our observations, for which average tuition was $1,850. Still, these results suggest that the benefits from increases in tuition and fees, if they exist, arise primarily in the universities with the lowest tuition and, perhaps, the biggest gap between desired expenditures and actual budget.

For women, as shown in the bottom panel of Table 4, a positive concave relation emerges between log wages and two university characteristics: tuition and fees and median professor salary. The quadratic relationship of log wages with tuition and fees is very similar to that found for men, with the peak occurring at $5,800, well above the mean observed in the sample (see Table A2). However, this relation is only weakly significant. More strongly significant is the quadratic in median professor salary, where a positive but diminishing link with log wages emerges, up to $58,800, beyond which the relationship becomes negative. As shown in Table A-2, the mean of this variable for women was $69,500. We infer that if there is ever a positive relation between women's log wages and the median professor salary at their alma mater, it must occur only for gains in professor salary toward the bottom end of the distribution.

In results that are not shown due to space constraints, we examined other variants to the basic models in Tables 1 and 2. First, we studied the impact of the professor–student ratio in further detail, by replacing the overall professor–student ratio with the professor–student ratio based on numbers of full professors, associate professors and assistant professors separately. In all cases, for men a strong positive link emerges. The fifth specification adds to the total professor–student ratio the shares of professors made up of full, associate and assistant professors (with the share of lecturers and other non-tenure-track teachers as the omitted group). In no case does strong evidence emerge of variations in teacher effectiveness across these ranks and the omitted lecturer rank.

12. Earlier we noted that Daniel, Black and Smith (1997) conjectured that the relatively greater degree of competition in the postsecondary sector compared to the K-12 sector could explain why in the United States we have stronger evidence that spending "matters" more for universities than for public schools. Our results support that conjecture, as we find evidence that in Canada university resources are related to wages. Bedard (2003) studies the link between school inputs and wages in Canada and concludes that the pupil–teacher ratio and public school teachers' salaries affect different students in different ways, so that the average effect is near zero.

Finally, we ran a model that included the total professor–student ratio and median professor salary. The results changed little.

When we used these alternative measures of the professor–student ratio for women, none of them became significant, although in the model that added the shares of professors of each rank weak evidence arose that an increase in the share of assistant professors was associated with declines in subsequent earnings for women.

In other results that we do not show due to space constraints, we studied the impact of professors' salary on students' later wages in more detail, by considering the independent effects of median salary in the three tenure-track ranks.

In specifications for men in which we first combined the median salaries for these three ranks, and then in a second specification added overall median salary, we found some weak evidence that salary at the assistant professor rank might be positively associated with students' later earnings. The evidence suggests that an increase of $5,000 in median assistant professor salary increases male students' later earnings by about 5%. Again, recall that under the fixed-effect specification the proper interpretation is that "at universities at which median salary of assistant professors increased during the time period, undergraduates' earnings five years after graduation increased." This is intuitive as increased salaries for higher ranks in the short term may lead only to higher professorial rents while leaving the makeup of the pool of more senior professors little changed. In contrast, increased starting salaries at a university might lead to tangible improvements in the quality of assistant professors hired each year.[13]

We found hints of the same pattern in models of women's earnings but the relation was not significant (t=1.1).

The probability of employment

In another robustness test, we added non-workers back into the sample by setting their annual earnings to $100 and taking logs. This increased the numbers of men and women in the sample by 9% and 13% respectively. It is not clear in which direction this addition should move estimates of our log wage models. If certain university characteristics, such as low professor salaries, are correlated with discouragement of students who subsequently have weak attachment to the labor force, then coefficients on university traits such as these should become larger and more significant. If, on the other hand, changes in our set of university characteristics do not affect workers on the margin of working versus not working, then the addition of these former students to the sample should lower coefficients and levels of significance.

For men, we found the latter pattern: when we added non-workers to the sample none of the university characteristics remained significant. However, even though enrollment became insignificant (t=1.49), its coefficient doubled from -0.015 to -0.033. This provides very weak evidence that although imprecisely measured, increases in undergraduate enrollment could have a negative effect on students' subsequent employment probabilities.

For women, inclusion of non-workers led to one new significant result: median professor salary became positive and weakly significant (t=1.69) with a coefficient of 0.018. On the other hand,

13. We thank a referee for this point.

enrollment becomes insignificant (t=1.50) even though, just as for men, the coefficient becomes more negative, changing from -0.014 to -0.033.

These results are sufficiently interesting to merit a closer look at the probability that students are employed. Table 5 presents the results of linear probability models of the probability that a student is working five years after graduating. (We also ran probit models that produced highly similar results. We show the linear probability models because of the ease of interpretation of the coefficients.) These models used the same regressors as in the wage models in Table 1, including dummies for each university.

The results tend to confirm the inferences from the wage models that added non-workers back into the sample. The top panel of Table 5 shows results for men. None of the university characteristics is significantly related to the probability of employment, although the variable that comes closest is professor median salary (t=1.53). The coefficient suggests that a $1,000 increase in median professor salary is associated with a 0.26% increase in the probability of employment.

The bottom panel of Table 5 shows results for women. The overall tenor of the results is similar to those for men. With one important exception, none of the university characteristics is significant, and the signs of the coefficients match the results for men. As for men, the variable that is most highly significant is median professor salary, but unlike the model for men, it becomes marginally significant (t=1.91). A $1,000 increase in median professor salary is predicted to increase the probability of employment for female graduates by 0.36%.

Although other, possibly macroeconomic, variables may be driving this relationship in ways that are not captured by our time and province dummies, we guardedly conclude that at a given university increases in professor salary may be associated with better employment outcomes for graduates five years after graduation.

A closer look at the university fixed effects [14]

In this sub-section, we look at the variation in the coefficients on university fixed effects. Before we do this, we need to emphasize that there are problems related to omitted variable bias and measurement error that limit what we can say. We discuss these two problems in turn.

First, problems of interpretation afflict all attempts to model individual wages as a function of individual characteristics, because the researcher does not know whether unobserved characteristics such as ability and motivation are correlated with personal characteristics that we do observe. As already mentioned, unobserved individuals' characteristics surely account for part of the large variations in wages related to university major. Similarly, when we examine differences in (conditional) mean earnings of graduates across different universities, as measured by the university fixed effects, part of these differences probably reflect variations in unobserved student characteristics. These differences reflect how students self-select and are selected into different universities. Put differently, if we randomly assigned two identical people to two different universities, we would not expect the resulting gap in their earnings to equal the gap predicted by the model with university fixed effects, because the university fixed effects are only partly causal.

14. We thank a referee for suggesting many of the exercises summarized in this sub-section.

Second, because the university fixed effects are estimated to fit the sample data and are subject to sampling error, treating them as known parameters will tend to overstate the true variation in earnings related to the university attended.[15]

Nonetheless it remains interesting to see just how big the variation in mean earnings across universities might be. Figure 1 shows the predicted earnings for a person with average observable characteristics as calculated from our sample for each of the university fixed effects, ordered from the "lowest paying" to the "highest paying" university. In order to increase precision of the results we estimated a log wage model that pooled men and women while adding a dummy variable for women. Results are broadly similar for separate analyses of men and women, but as expected are slightly more variable. In this figure, the difference in predicted earnings among universities results from substituting one fixed-effect coefficient and then another into the equation. The solid dots show predicted earnings while the vertical line show 95% confidence intervals based on the standard errors on the university fixed effects.[16]

The first thing that will strike most readers is the fairly large variation in predicted mean earnings, from a low of $30,800 to a high of $38,700, with a mean of $35,400. This translates into a variation in earnings of about 25.6%, which is considerably below the 60% variation across college majors noted earlier. Of course, some of the predicted wage variation related to both university attended and college major will reflect sampling variation.

We can also learn something from the distribution of predicted earnings. There appears to be a fairly gradual and even increase in predicted earnings across universities, with perhaps a longer tail at the bottom end. These impressions are confirmed by mildly negative kurtosis and skewness (with values of -0.55 and -0.26 respectively). In other words, there are more universities far below average than far above average, and there are more universities at both extremes than one would expect if these were derived from a normal distribution. Certainly, Canadian universities are spread quite widely in terms of earnings of their graduates. But visual inspection suggests that the national system is not characterized by a handful of universities that completely dominate all the rest.

It is worthwhile to examine the correlation between the fixed effects and averages of university characteristics, while bearing in mind that there are myriad causal pathways between the university attended and graduates' earnings. For our regressors, we took a simple average of the university characteristics calculated for each of the three cohorts. In addition, we are able to correlate these fixed effects with the two measures of the high school achievement of incoming freshmen that we briefly discussed at the start of the Results section. We also sought more direct measures of the quality and quantity of research emanating from each university. Therefore, for a small sample of nine universities we were able to calculate the number of publications at one point in time.

15. There is a way of correcting for this. For instance, we can estimate the variance of the true underlying university fixed-effects by subtracting from the observed variance in the university fixed-effects, the sum of the squares of the standard errors divided by the number of fixed-effects minus one. However, as often happens with this approach, the resulting variance estimate was negative. This results from using the standard errors on the coefficients to estimate their true variance. Still, this exercise suggests that the true variation in underlying outcomes is smaller than what Figure 1 suggests.

16. We predicted log wages using the mean of all regressors apart from the fixed-effects, adding the fixed-effect coefficient for the given university, and then taking the exponential of this to convert into annual earnings in 1995 prices. The confidence intervals were calculated in a similar way.

We calculated correlations between the fixed-effect coefficients and also p-values for the null of no association between the coefficients and the given characteristic. Table 6 shows the results, with the first number in each cell showing the correlation and the second number showing the p-value. In almost all cases, no significant correlation arises. We show results based on log wage regressions for the pooled sample and men and women separately.

In most cases, we find the expected sign for the correlations. There are a few exceptions, such as negative correlations with the professor–student ratio and total arts tuition and fees. But these correlations are exceedingly weak in the sense that we strongly retain the null of zero correlation. The Maclean's rankings are a mixed bag, in some cases showing a positive correlation with earnings but in a few cases a negative correlation.[17]

Perhaps one of the most useful insights from this analysis is that the correlation between average enrollment at each university and average post-graduation earnings, as reflected in the fixed-effect coefficients, is positive. Recall that we typically found in Tables 1 and 2 that the coefficient on enrollment was *negative*. Why do the results differ? Our identification strategy in Tables 1 and 2 was to measure the correlation between *changes* in enrollment and subsequent earnings of graduates at individual universities. The negative coefficient may well be at least partly causal, and could reflect a crowding out effect caused by sudden surges in enrollment.

But this identification strategy tells us little about the optimal size of a Canadian university. There are many reasons why the University of Toronto and Trent University chose dramatically different sizes for their undergraduate student body. The positive correlation between average enrollment and average earnings suggests, very weakly, that in Canada, students who graduate from bigger universities earn slightly more. But we should not rely on this positive correlation to predict that doubling the size of every university in Canada will make all graduates better off. There are simply too many unobserved factors that have led to variations among universities in averages over time in characteristics such as enrollment.

In contrast, the negative coefficient on enrollment in our earlier fixed-effect models may well represent the consequences for students of short-term enrollment increases, because fixed aspects of each university and its student body have been swept out of the equation. For example, the negative coefficient on enrollment may well capture negative consequences for students of short-term increases in enrollment. This hypothesis is corroborated by a related finding that increases in enrollment at a given university lead to shifts in choice of major away from the most remunerative majors. This resembles instances of overcrowding that most university professors routinely see on their campuses.

17. The Maclean's rankings takes a measure of the undergraduate experience at Canadian universities, comparing schools in three peer groupings. The primarily undergraduate universities are those largely focused on undergraduate education, with relatively few graduate programs. For the reputational ranking, Maclean's surveyed high-school guidance counsellors, university officials, heads of organizations, Chief Executive Officers and recruiters at corporations across the country. Below this, in Table 6, we show correlations with publishing rank. Chant and Gibson (2002) report for a variety of disciplines such as computer science and engineering the top three Canadian universities by number of papers published between 1994 and 1998. We counted the number of instances a university was listed in the top three. Then, the university which was listed most often was ranked number 1 and so on. Clearly this is a rather imperfect measure of research quality because departments that rank just outside the top three are not counted at all. Still, this variable is of interest because it is the only one we have that measures research output.

5. Conclusion

This paper presents the first analysis of the link between university resources and earnings of Canadian undergraduates after they graduate. To the best of our knowledge, this paper also represents one of the first times that university fixed effects have been used to control for unobserved and fixed traits of the university. We find strong evidence that there are fixed and unobserved wage effects associated with attendance at different universities, and that failure to account for these fixed effects materially affects the results. After incorporating fixed effects we find that university traits, in particular the professor–student ratio, enrollment, and fees can explain some of the observed inter-university differences in earnings.

In models that do not control for major, the coefficients on university characteristics typically grow by roughly half, and in the case of women, many of the university characteristics become statistically significant. We infer that for both men and women an increase in the professor–student ratio, a decrease in undergraduate enrollment and an increase in fees are associated with higher earnings five years after graduation, and that much of these estimated effects work through changes in majors.

There are, of course, many explanations for these correlations. For instance, the negative estimated effect of an increase in enrollment at a university could reflect either overcrowding effects or a drop in admissions standards, among many other things. However, because much of this effect of higher enrollment is associated with changes in students' choice of majors, the congestion hypothesis seems somewhat plausible. As another example, the positive coefficient on fees might suggest that universities use increased fee revenues to expand preferentially the majors that lead to the most highly paid careers. Alternatively, the positive coefficient on fees could merely reflect collinearity with unobserved variables.

There are other ways in which changes in university resources could influence outcomes for students. We studied one of these mechanisms by modeling the probability of employment five years after graduation and found fairly weak evidence of a relation. A second way in which university resources could "matter" is by affecting the probability that university students graduate. Because the National Graduates Survey (NGS) sampling frame begins with a sample of graduates, we were unable to study this. Thus, it is possible that we could be understating the overall effects of university characteristics on outcomes.

Another striking finding from this analysis is the extent to which a person's major and choice of university influence his or her later earnings. Earnings five years after graduation varied about 60% between the majors with the highest and lowest rate of pay ("Other Health" and "Fine Arts/Humanities" respectively). Similarly, the coefficients on the university fixed effects suggest that the average earnings of graduates, *ceteris paribus*, vary about 26% from the least to the most remunerative universities. It is important to recognize that these estimates of 60% and 26% variation in wages related to major and university are likely to be overstated due to sampling error. In addition, selection of students into majors and universities almost surely contributes to both of these large spreads in earnings.

Nonetheless, in contrast, variations over time in individual universities' resources and other traits can explain a relatively small proportion of the overall variation in wages. For example, for both men and women, an increase in undergraduate enrollment of 1,000, or an increase of about 8% at a typical university, is associated with a drop in earnings five years after graduation on the order of 1%, or 2% once we allow changes in undergraduate enrollment to work through changes in major as well. These predicted changes are meaningful but modest compared to the range of earnings related to university and major selected.

What do our findings imply for the earlier literature on American university quality, which has used purely cross-sectional variation to identify the impact of university spending? The approach traditionally used in this latter literature is to control for observed university traits and for selectivity bias in university admissions. Although our ordinary least squares models take a similar approach, our measure for the selectivity of each university's admission process is rather crude relative to what is available in the American data sets. It could well be that the superior measures of university selectivity used by earlier authors control adequately for unobserved traits of each university. Nevertheless, our consistent and strong rejection of the hypothesis that undergraduates' earnings were identical across campuses after controlling for the standard set of measures of university quality, for personal background, and for selectivity in admissions raises serious questions about the interpretation of earlier findings. With this in mind, we have attempted to highlight the points of agreement and disagreement between our findings and those of earlier work with American data.

Second, we believe that our fixed-effect approach is useful in a second regard. It offers more direct policy guidance than the cross-sectional regressions that typify the earlier literature. In effect, we are asking: What happens to earnings of graduates if the resources invested in the university *change* while the student is enrolled? Our analysis cannot claim to tell undergraduates which university is the best to attend, because we difference out the average earnings of graduates from each university and the average values of each university trait. But we can offer predictions as to the likely outcome if resources change over time. At least in the case of the professor–student ratio, additional expenditures appear to matter. Conversely, increases in the size of the undergraduate student population at a given university are associated with drops in earnings.

In spite of our evidence in favour of the hypothesis that changes in universities' resources tangibly affect undergraduates' earnings, the more important finding in the paper is how small such effects are. Variations in university spending—at least over a decade—may have a much smaller impact on graduates' earnings than do variations in unobserved traits across universities and the large observed variations in earnings across university majors. In short, for university students it's what you study, and where you study, that matters more than the size of classes at your university, or the rank of the professor who is teaching you.

Is it possible to reconcile the small marginal effects of contemporaneous changes in university resources with large differences across universities after controlling to some extent for quality of incoming students? One way is to hypothesize that university quality is related to a climate of good teaching that is specific to the university. This climate depends on stock that can be built up or depleted by resources committed to teaching quality, but only slowly. To subject such a hypothesis to formal tests, researchers might benefit from longer-term observations of universities, particularly contrasting new or dramatically altered universities to more established ones. Frenette (forthcoming 2007) studies the creation of new universities in Canada, and the effect on rates of postsecondary enrollment. His survey of the spread of universities across Canada suggests that longer-term studies could prove a fruitful avenue for future research.

Table 1 Estimates of basic log wage models for men using university fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)
Professor–student ratio	0.2421	…	…	…	…	-0.7359
	(2.04)**	…	…	…	…	(0.93)
Median professor salary, per 1000	…	-0.0017	…	…	…	-0.0024
	…	(0.64)	…	…	…	(0.88)
Full-time equivalent enrolment, per 1000	…	…	-0.0149	…	…	-0.0126
	…	…	(2.62)***	…	…	(1.33)
Graduate student share	…	…	…	-0.0136	…	-0.5380
	…	…	…	(0.10)	…	(2.60)***
Total arts tuition and fees, per 1000	…	…	…	…	0.0151	0.0642
	…	…	…	…	(2.26)**	(1.42)
Age	-0.0013	-0.0009	-0.0012	-0.0008	-0.0014	-0.0014
	(0.29)	(0.19)	(0.26)	(0.18)	(0.30)	(0.30)
Age squared	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.21)	(0.07)	(0.19)	(0.07)	(0.23)	(0.24)
Experience prior to degree	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
	(8.85)***	(8.84)***	(8.83)***	(8.82)***	(8.85)***	(8.84)***
Newfoundland	-0.1202	-0.1185	-0.1223	-0.1195	-0.1201	-0.1184
	(3.38)***	(3.33)***	(3.44)***	(3.36)***	(3.38)***	(3.33)***
Prince Edward Island	-0.2592	-0.2593	-0.2598	-0.2592	-0.2593	-0.2552
	(5.23)***	(5.24)***	(5.25)***	(5.23)***	(5.24)***	(5.15)***
Nova Scotia	-0.2427	-0.2428	-0.2429	-0.2426	-0.2426	-0.2406
	(8.06)***	(8.06)***	(8.07)***	(8.05)***	(8.06)***	(7.99)***
New Brunswick	-0.1984	-0.1983	-0.1998	-0.1983	-0.1983	-0.1996
	(6.01)***	(6.01)***	(6.05)***	(6.01)***	(6.01)***	(6.05)***
Quebec	-0.1177	-0.1184	-0.1180	-0.1179	-0.1174	-0.1169
	(2.97)***	(2.98)***	(2.97)***	(2.97)***	(2.96)***	(2.95)***
Manitoba	-0.1811	-0.1811	-0.1814	-0.1807	-0.1813	-0.1824
	(5.72)***	(5.72)***	(5.73)***	(5.70)***	(5.72)***	(5.76)***
Saskatchewan	-0.1390	-0.1387	-0.1395	-0.1385	-0.1393	-0.1407
	(4.30)***	(4.29)***	(4.31)***	(4.28)***	(4.31)***	(4.35)***
Alberta	-0.0091	-0.0089	-0.0094	-0.0087	-0.0094	-0.0101
	(0.38)	(0.37)	(0.39)	(0.36)	(0.39)	(0.42)
British Columbia	0.0001	0.0009	-0.0004	0.0009	-0.0001	-0.0002
	(0.00)	(0.04)	(0.02)	(0.03)	(0.01)	(0.01)
Yukon and Northwest Territories	0.3184	0.3178	0.3190	0.3180	0.3180	0.3189
	(3.94)***	(3.93)***	(3.95)***	(3.93)***	(3.93)***	(3.95)***
No specialty	-0.1756	-0.1765	-0.1766	-0.1762	-0.1763	-0.1787
	(7.51)***	(7.55)***	(7.56)***	(7.54)***	(7.55)***	(7.61)***
Elementary and Secondary education	-0.2369	-0.2367	-0.2362	-0.2364	-0.2369	-0.2354
	(11.25)***	(11.24)***	(11.22)***	(11.22)***	(11.25)***	(11.18)***

Table 1 Estimates of basic log wage models for men using university fixed effects (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
Other field of education	-0.2412	-0.2433	-0.2418	-0.2431	-0.2413	-0.2430
	(9.75)***	(9.84)***	(9.78)***	(9.83)***	(9.76)***	(9.82)***
Fine arts and humanities	-0.4253	-0.4258	-0.4250	-0.4260	-0.4251	-0.4245
	(21.34)***	(21.36)***	(21.33)***	(21.37)***	(21.33)***	(21.31)***
Commerce	-0.0713	-0.0716	-0.0712	-0.0716	-0.0713	-0.0711
	(4.10)***	(4.11)***	(4.09)***	(4.11)***	(4.10)***	(4.09)***
Economics	-0.0786	-0.0794	-0.0786	-0.0793	-0.0783	-0.0771
	(2.95)***	(2.98)***	(2.95)***	(2.97)***	(2.94)***	(2.89)***
Other social science	-0.2730	-0.2733	-0.2737	-0.2734	-0.2731	-0.2737
	(14.66)***	(14.67)***	(14.70)***	(14.67)***	(14.66)***	(14.70)***
Agriculture and biological sciences	-0.2105	-0.2113	-0.2109	-0.2113	-0.2104	-0.2117
	(10.01)***	(10.05)***	(10.03)***	(10.05)***	(10.01)***	(10.08)***
Veterinary science	-0.1216	-0.1219	-0.1220	-0.1218	-0.1217	-0.1333
	(2.54)**	(2.55)**	(2.55)**	(2.54)**	(2.55)**	(2.78)***
Other health (not medical)	0.0772	0.0788	0.0739	0.0783	0.0768	0.0744
	(2.18)**	(2.23)**	(2.09)**	(2.21)**	(2.17)**	(2.10)**
Computer sciences	-0.0133	-0.0110	-0.0137	-0.0114	-0.0135	-0.0131
	(0.59)	(0.49)	(0.61)	(0.51)	(0.60)	(0.58)
Mathematical and physical sciences	-0.1610	-0.1614	-0.1611	-0.1616	-0.1609	-0.1607
	(7.65)***	(7.67)***	(7.66)***	(7.68)***	(7.65)***	(7.64)***
Single parent	0.0994	0.0996	0.0990	0.0998	0.0994	0.0987
	(2.42)**	(2.42)**	(2.41)**	(2.43)**	(2.42)**	(2.40)**
Married parent	0.1401	0.1400	0.1405	0.1399	0.1402	0.1408
	(11.35)***	(11.33)***	(11.38)***	(11.33)***	(11.35)***	(11.40)***
Married no children	0.1028	0.1023	0.1029	0.1023	0.1029	0.1027
	(9.14)***	(9.09)***	(9.15)***	(9.10)***	(9.14)***	(9.13)***
Language spoken and location						
English in Quebec	-0.0313	-0.0318	-0.0304	-0.0318	-0.0316	-0.0326
	(0.68)	(0.69)	(0.66)	(0.69)	(0.69)	(0.71)
French outside Quebec	-0.0295	-0.0287	-0.0298	-0.0287	-0.0296	-0.0281
	(0.97)	(0.94)	(0.98)	(0.94)	(0.97)	(0.92)
Other in Quebec	-0.0760	-0.0774	-0.0754	-0.0777	-0.0759	-0.0757
	(1.31)	(1.34)	(1.30)	(1.34)	(1.31)	(1.31)
Other outside Quebec	-0.0475	-0.0474	-0.0474	-0.0476	-0.0474	-0.0468
	(2.70)***	(2.69)***	(2.69)***	(2.71)***	(2.69)***	(2.66)***
Some college or CEGEP	-0.0055	-0.0009	-0.0061	-0.0004	-0.0062	-0.0065
	(0.26)	(0.04)	(0.29)	(0.02)	(0.29)	(0.31)
Prior bachelor's	0.0648	0.0644	0.0638	0.0642	0.0648	0.0639
	(3.84)***	(3.82)***	(3.79)***	(3.81)***	(3.85)***	(3.79)***
Prior master's	0.1416	0.1399	0.1391	0.1389	0.1415	0.1392
	(2.71)***	(2.68)***	(2.67)***	(2.66)***	(2.71)***	(2.67)***
Prior doctorate	0.5614	0.5597	0.5565	0.5602	0.5616	0.5519
	(1.38)	(1.38)	(1.37)	(1.38)	(1.38)	(1.36)

Table 1 Estimates of basic log wage models for men using university fixed effects (concluded)

	(1)	(2)	(3)	(4)	(5)	(6)
Other postsecondary	0.0280	0.0153	0.0309	0.0143	0.0298	0.0349
	(0.95)	(0.53)	(1.06)	(0.49)	(1.01)	(1.19)
Father: more than high school	-0.0067	-0.0070	-0.0066	-0.0069	-0.0066	-0.0063
	(0.61)	(0.63)	(0.60)	(0.63)	(0.61)	(0.57)
Father: education missing	0.0182	0.0183	0.0179	0.0184	0.0183	0.0182
	(0.59)	(0.59)	(0.58)	(0.59)	(0.59)	(0.59)
Mother: more than high school	-0.0146	-0.0143	-0.0145	-0.0144	-0.0146	-0.0143
	(1.30)	(1.27)	(1.29)	(1.28)	(1.30)	(1.28)
Mother: education missing	-0.0173	-0.0171	-0.0170	-0.0169	-0.0173	-0.0187
	(0.52)	(0.51)	(0.51)	(0.50)	(0.52)	(0.56)
Graduated 1986	-0.0629	-0.0622	-0.0421	-0.0636	-0.0674	-0.0545
	(5.30)***	(5.13)***	(2.91)***	(5.30)***	(5.63)***	(2.22)**
Graduated 1990	-0.0956	-0.0954	-0.0622	-0.0992	-0.1029	-0.0903
	(6.90)***	(6.37)***	(3.15)***	(7.22)***	(7.44)***	(2.37)**
Constant	10.7200	10.8532	10.9065	10.7367	10.7195	11.0782
	(111.38)***	(51.98)***	(93.95)***	(110.84)***	(111.42)***	(43.56)***
Observations	7,631	7,631	7,631	7,631	7,631	7,631
Number of universities	43	43	43	43	43	43
R-squared	0.1540	0.1536	0.1543	0.1536	0.1541	0.1553
Test of ordinary least squares versus fixed effects (p-value)	0.002	0.007	0.004	0.005	0.001	0.002

… not applicable

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Note: The numbers in parentheses are absolute t-statistics. The bottom of the table lists p-values for tests of ordinary least squares (OLS) versus models with university fixed effects, and for OLS versus random university effects. Experience refers to months of work experience acquired prior to graduation. Age refers to age at time of wage observation. Province refers to province of residence at time of wage observation. Other regressors not shown include a set of university fixed effects, dummies for whether the person's mother or father had any postsecondary education, dummies for missing parental education, dummies for those whose language spoken at home and region were (English/Quebec), (French/outside Quebec), (other language/Quebec), and (other language/outside Quebec), dummies for residence in the year of the wage observation in all provinces but Ontario, a dummy for residence in the Northwest Territories or the Yukon, dummies for single parents, married parents, and married with no children, and dummies for the cohorts who graduated in 1986 or 1990. The R-squared is net of the explanatory power of the university fixed effects. The regressions contain a series of dummy variables. Omitted categories are: for field of study, engineering; for marital/parental status, single /widowed/separated/divorced without children; for province of residence, Ontario; for language spoken/location, majority language (French in Quebec, English elsewhere); for prior postsecondary education, no postsecondary education; and for mother's and father's education, no postsecondary education.

Source: Statistics Canada, the 1982, 1986 and 1990 National Graduates Surveys.

Table 2 Estimates of basic log wage models for women using university fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)
Professor–student ratio	0.1666	…	…	…	…	-0.6715
	(1.28)	…	…	…	…	(0.72)
Median professor salary, per 1000	…	-0.0025	…	…	…	-0.0023
	…	(0.78)	…	…	…	(0.71)
Full-time equivalent enrolment, per 1000	…	…	-0.0135	…	…	-0.0194
	…	…	(2.12)**	…	…	(1.78)*
Graduate student share	…	…	…	0.2240	…	0.1803
	…	…	…	(1.50)	…	(0.78)
Total arts tuition and fees, per 1000	…	…	…	…	0.0103	0.0230
	…	…	…	…	(1.41)	(0.43)
Age	0.0207	0.0207	0.0208	0.0207	0.0207	0.0207
	(4.02)***	(4.02)***	(4.03)***	(4.02)***	(4.02)***	(4.02)***
Age squared	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
	(3.63)***	(3.62)***	(3.64)***	(3.64)***	(3.63)***	(3.64)***
Experience prior to degree	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013
	(8.75)***	(8.77)***	(8.72)***	(8.76)***	(8.75)***	(8.71)***
Newfoundland	-0.0962	-0.0954	-0.0960	-0.0969	-0.0963	-0.0958
	(2.21)**	(2.19)**	(2.21)**	(2.23)**	(2.21)**	(2.20)**
Prince Edward Island	-0.2953	-0.2960	-0.2947	-0.2964	-0.2953	-0.2960
	(5.07)***	(5.08)***	(5.06)***	(5.09)***	(5.07)***	(5.08)***
Nova Scotia	-0.2039	-0.2037	-0.2030	-0.2033	-0.2039	-0.2021
	(5.64)***	(5.63)***	(5.61)***	(5.62)***	(5.64)***	(5.59)***
New Brunswick	-0.1275	-0.1266	-0.1270	-0.1283	-0.1277	-0.1273
	(3.16)***	(3.14)***	(3.15)***	(3.18)***	(3.17)***	(3.15)***
Quebec	-0.0979	-0.0968	-0.0981	-0.0980	-0.0979	-0.0980
	(2.02)**	(2.00)**	(2.03)**	(2.03)**	(2.02)**	(2.03)**
Manitoba	-0.1102	-0.1104	-0.1096	-0.1107	-0.1101	-0.1094
	(2.80)***	(2.81)***	(2.79)***	(2.82)***	(2.80)***	(2.78)***
Saskatchewan	-0.1099	-0.1097	-0.1100	-0.1097	-0.1098	-0.1095
	(2.77)***	(2.77)***	(2.78)***	(2.77)***	(2.77)***	(2.76)***
Alberta	0.0142	0.0141	0.0146	0.0140	0.0142	0.0145
	(0.47)	(0.46)	(0.48)	(0.46)	(0.47)	(0.47)
British Columbia	-0.0023	-0.0018	-0.0025	-0.0027	-0.0023	-0.0025
	(0.07)	(0.06)	(0.08)	(0.08)	(0.07)	(0.08)
Yukon and Northwest Territories	0.2733	0.2717	0.2747	0.2738	0.2731	0.2738
	(3.27)***	(3.25)***	(3.29)***	(3.28)***	(3.27)***	(3.28)***
No specialty	-0.2378	-0.2390	-0.2373	-0.2395	-0.2383	-0.2404
	(5.15)***	(5.17)***	(5.14)***	(5.18)***	(5.16)***	(5.19)***

Table 2 Estimates of basic log wage models for women using university fixed effects (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
Elementary/Secondary education	-0.1969	-0.1969	-0.1953	-0.1968	-0.1969	-0.1946
	(4.64)***	(4.64)***	(4.60)***	(4.64)***	(4.64)***	(4.58)***
Other field of education	-0.2372	-0.2390	-0.2358	-0.2369	-0.2372	-0.2360
	(5.30)***	(5.35)***	(5.28)***	(5.30)***	(5.31)***	(5.28)***
Fine arts and humanities	-0.3889	-0.3892	-0.3879	-0.3884	-0.3889	-0.3868
	(9.14)***	(9.14)***	(9.11)***	(9.12)***	(9.14)***	(9.08)***
Commerce	-0.0777	-0.0778	-0.0766	-0.0774	-0.0776	-0.0756
	(1.77)*	(1.77)*	(1.74)*	(1.76)*	(1.77)*	(1.72)*
Economics	-0.1463	-0.1474	-0.1465	-0.1458	-0.1464	-0.1473
	(2.39)**	(2.41)**	(2.40)**	(2.38)**	(2.39)**	(2.41)**
Other social science	-0.2856	-0.2858	-0.2849	-0.2853	-0.2856	-0.2845
	(6.81)***	(6.82)***	(6.80)***	(6.80)***	(6.81)***	(6.78)***
Agriculture and biological sciences	-0.2466	-0.2473	-0.2452	-0.2464	-0.2464	-0.2444
	(5.57)***	(5.59)***	(5.54)***	(5.57)***	(5.57)***	(5.52)***
Veterinary science	-0.1836	-0.1836	-0.1830	-0.1801	-0.1837	-0.1799
	(2.55)**	(2.55)**	(2.54)**	(2.50)**	(2.55)**	(2.50)**
Other health (not medical)	-0.0592	-0.0586	-0.0587	-0.0589	-0.0594	-0.0581
	(1.37)	(1.35)	(1.36)	(1.36)	(1.37)	(1.34)
Computer sciences	0.0094	0.0127	0.0080	0.0101	0.0090	0.0094
	(0.17)	(0.23)	(0.15)	(0.18)	(0.16)	(0.17)
Mathematical and physical sciences	-0.1671	-0.1676	-0.1658	-0.1668	-0.1672	-0.1653
	(3.35)***	(3.36)***	(3.32)***	(3.34)***	(3.35)***	(3.31)***
Single parent	-0.0221	-0.0223	-0.0224	-0.0221	-0.0220	-0.0226
	(0.70)	(0.71)	(0.71)	(0.70)	(0.70)	(0.72)
Married parent	-0.1560	-0.1563	-0.1558	-0.1559	-0.1559	-0.1555
	(10.60)***	(10.63)***	(10.59)***	(10.60)***	(10.60)***	(10.57)***
Married no children	0.0103	0.0099	0.0103	0.0104	0.0103	0.0102
	(0.80)	(0.78)	(0.81)	(0.81)	(0.81)	(0.80)
Language spoken and location						
English in Quebec	-0.1169	-0.1179	-0.1164	-0.1172	-0.1170	-0.1173
	(2.12)**	(2.14)**	(2.12)**	(2.13)**	(2.13)**	(2.13)**
French outside Quebec	0.1234	0.1237	0.1226	0.1235	0.1233	0.1225
	(3.90)***	(3.91)***	(3.87)***	(3.90)***	(3.89)***	(3.87)***
Other in Quebec	-0.2118	-0.2181	-0.2096	-0.2124	-0.2111	-0.2115
	(2.75)***	(2.84)***	(2.72)***	(2.76)***	(2.74)***	(2.75)***
Other outside Quebec	0.0010	0.0007	0.0010	0.0009	0.0010	0.0010
	(0.05)	(0.03)	(0.05)	(0.04)	(0.05)	(0.05)
Some college or CEGEP	0.0345	0.0373	0.0328	0.0351	0.0342	0.0336
	(1.53)	(1.66)*	(1.46)	(1.56)	(1.52)	(1.49)
Prior bachelor's	0.0844	0.0842	0.0843	0.0842	0.0843	0.0838
	(4.84)***	(4.83)***	(4.84)***	(4.83)***	(4.84)***	(4.81)***

Table 2 Estimates of basic log wage models for women using university fixed effects (concluded)

	(1)	(2)	(3)	(4)	(5)	(6)
Prior master's	0.1952	0.1952	0.1960	0.1958	0.1952	0.1967
	(3.43)***	(3.43)***	(3.44)***	(3.44)***	(3.43)***	(3.45)***
Prior doctorate	0.0976	0.0953	0.0982	0.0956	0.0977	0.0948
	(0.34)	(0.34)	(0.35)	(0.34)	(0.34)	(0.33)
Other postsecondary	0.0159	0.0086	0.0216	0.0144	0.0169	0.0211
	(0.55)	(0.30)	(0.75)	(0.51)	(0.58)	(0.73)
Father: more than high school	0.0104	0.0099	0.0105	0.0104	0.0104	0.0104
	(0.81)	(0.78)	(0.82)	(0.82)	(0.81)	(0.82)
Father: education missing	-0.0082	-0.0084	-0.0083	-0.0082	-0.0082	-0.0086
	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.28)
Mother: more than high school	-0.0069	-0.0070	-0.0069	-0.0070	-0.0068	-0.0069
	(0.55)	(0.56)	(0.55)	(0.56)	(0.54)	(0.55)
Mother: education missing	-0.0495	-0.0494	-0.0502	-0.0495	-0.0495	-0.0504
	(1.39)	(1.38)	(1.41)	(1.39)	(1.39)	(1.41)
Graduated 1986	-0.0870	-0.0863	-0.0685	-0.0905	-0.0901	-0.0694
	(6.27)***	(6.18)***	(4.15)***	(6.47)***	(6.45)***	(2.47)**
Graduated 1990	-0.0594	-0.0572	-0.0291	-0.0613	-0.0644	-0.0254
	(3.70)***	(3.34)***	(1.30)	(3.85)***	(4.02)***	(0.58)
Constant	10.2101	10.3955	10.3709	10.2002	10.2093	10.5969
	(93.71)***	(43.06)***	(81.08)***	(93.06)***	(93.76)***	(36.57)***
Observations	8,394	8,394	8,394	8,394	8,394	8,394
Number of universities	43	43	43	43	43	43
R-squared	0.1046	0.1044	0.1049	0.1046	0.1046	0.1051
Test of ordinary least squares versus fixed effects (p-value)	0.000	0.000	0.000	0.000	0.000	0.000

… not applicable
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.
Notes: The numbers in parentheses are absolute t-statistics. See notes to Table 1.
Source: Statistics Canada, the 1982, 1986 and 1990 National Graduates Surveys.

Table 3 Wage estimates that do not condition on university major for men and women

Men	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Professor–student ratio	0.3543	…	…	…	…	-0.7966
	(2.86)***	…	…	…	…	(0.97)
Median professor salary, per 1000	…	-0.0010	…	…	…	-0.0017
	…	(0.36)	…	…	…	(0.62)
Full-time equivalent enrolment, per 1000	…	…	-0.0205	…	…	-0.0156
	…	…	(3.45)***	…	…	(1.57)
Graduate student share	…	…	…	0.0857	…	-0.5230
	…	…	…	(0.61)	…	(2.42)**
Total arts tuition and fees, per 1000	…	…	…	…	0.0216	0.0708
	…	…	…	…	(3.09)***	(1.50)
Observations	7,631	7,631	7,631	7,631	7,631	7,631
R-squared	0.0739	0.0729	0.0743	0.0729	0.0741	0.0753
Women						
Professor–student ratio	0.3138	…	…	…	…	-0.5786
	(2.38)**	…	…	…	…	(0.61)
Median professor salary, per 1000	…	-0.0033	…	…	…	-0.0031
	…	(1.04)	…	…	…	(0.94)
Full-time equivalent enrolment, per 1000	…	…	-0.0196	…	…	-0.0205
	…	…	(3.03)***	…	…	(1.84)*
Graduate student share	…	…	…	0.3707	…	0.2149
	…	…	…	(2.44)**	…	(0.91)
Total arts tuition and fees, per 1000	…	…	…	…	0.0186	0.0238
	…	…	…	…	(2.51)**	(0.44)
Observations	8,394	8,394	8,394	8,394	8,394	8,394
R-squared	0.0645	0.0640	0.0649	0.0646	0.0646	0.0652

… not applicable
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Notes: The two panels of the table show separate models for men and women. See Table 1 for a full list of regressors not shown in this table. These models are identical to those in Table 1 except that they do not include the controls from Table 1 for university major. See other notes to Table 1.

Source: Statistics Canada, the 1982, 1986 and 1990 National Graduates Surveys.

Table 4 Estimates of log wage models that include quadratic terms for university characteristics, for men and women

Men	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Professor–student ratio	1.6689	…	…	...	…
	(0.83)	…	…	…	…
(Professor–student ratio) squared	-1.9715	…	…	…	…
	(0.71)	…	…	…	…
Median professor salary, per 1000	…	0.0327	…	…	…
	…	(1.27)	…	…	…
(Median professor salary, per 1000) squared	…	-0.0003	…	…	…
	…	(1.34)	…	…	…
Full-time equivalent enrolment, per 1000	…	…	-0.0006	…	…
	…	…	(0.03)	…	…
(Full-time equivalent enrolment, per 1000) squared	…	…	-0.0004	…	…
	…	…	(0.87)	…	…
Graduate student share	…	…	…	0.6604	…
	…	…	…	(0.42)	…
(Graduate student share) squared	…	…	…	-1.2796	…
	…	…	…	(0.43)	…
Total arts tuition and fees, per 1000	…	…	…	…	0.1649
	…	…	…	…	(2.23)**
(Total arts tuition and fees, per 1000) squared	…	…	…	…	-0.0139
	…	…	…	…	(2.04)**
Observations	7,631	7,631	7,631	7,631	7,631
R-squared	0.1541	0.1538	0.1544	0.1536	0.1546
Women					
Professor–student ratio	2.6913	…	…	...	…
	(1.19)	…	…	…	…
(Professor–student ratio) squared	-3.4857	…	…	…	…
	(1.12)	…	…	…	…
Median professor salary, per 1000	…	0.0588	…	…	…
	…	(2.09)**	…	…	…
(Median professor salary, per 1000) squared	…	-0.0005	…	…	…
	…	(2.19)**	…	…	…
Full-time equivalent enrolment, per 1000	…	…	-0.0283	…	…
	…	…	(1.41)	…	…
(Full-time equivalent enrolment, per 1000) squared	…	…	0.0004	…	…
	…	…	(0.78)	…	…
Graduate student share	…	…	…	1.5386	…
	…	…	…	(0.86)	…
(Graduate student share) squared	…	…	…	-2.4965	…
	…	…	…	(0.74)	…
Total arts tuition and fees, per 1000	…	…	…	…	0.1578
	…	…	…	…	(1.82)*
(Total arts tuition and fees, per 1000) squared	…	…	…	…	-0.0137
	…	…	…	…	(1.71)*
Observations	8,394	8,394	8,394	8,394	8,394
R-squared	0.1047	0.1050	0.1049	0.1047	0.1049

… not applicable
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.
Notes: This table lists separate models for men and women. Regressors are identical to those listed for Tables 1 and 2, except that a squared term for each university characteristic is now entered.
Source: Statistics Canada, the 1982, 1986 and 1990 National Graduates Surveys.

Table 5 Linear probability models of probability of employment five years after graduation for men and women

Men	(1)	(2)	(3)	(4)	(5)	(6)
Professor–student ratio	0.0197	…	…	…	…	-0.2922
	(0.26)	…	…	…	…	(0.58)
Median professor salary, per 1000	…	0.0026	…	…	…	0.0024
	…	(1.53)	…	…	…	(1.38)
Full-time equivalent enrolment, per 1000	…	…	-0.0032	…	…	-0.0048
	…	…	(0.88)	…	…	(0.78)
Graduate student share	…	…	…	-0.0518	…	-0.1378
	…	…	…	(0.59)	…	(1.03)
Total arts tuition and fees, per 1000	…	…	…	…	0.0015	0.0185
	…	…	…	…	(0.34)	(0.64)
Observations	8,311	8,311	8,311	8,311	8,311	8,311
R-squared	0.0529	0.0532	0.0530	0.0530	0.0529	0.0535
Women						
Professor–student ratio	0.0184	…	…	…	…	-0.4360
	(0.24)	…	…	…	…	(0.79)
Median professor salary, per 1000	…	0.0036	…	…	…	0.0036
	…	(1.91)*	…	…	…	(1.90)*
Full-time equivalent enrolment, per 1000	…	…	-0.0037	…	…	-0.0067
	…	…	(0.97)	…	…	(1.04)
Graduate student share	…	…	…	-0.0109	…	-0.0351
	…	…	…	(0.12)	…	(0.25)
Total arts tuition and fees, per 1000	…	…	…	…	0.0013	0.0210
	…	…	…	…	(0.31)	(0.67)
Observations	9,453	9,453	9,453	9,453	9,453	9,453
R-squared	0.0595	0.0599	0.0596	0.0595	0.0595	0.0601

… not applicable

* Significant at the 10% level.

Notes: The two panels of the table show separate models for men and women. See Table 1 for a full list of regressors not shown in this table. These models are identical to those in Table 1 except that the dependent variable is a dummy equal to 1 if the person was working five years after graduation. The numbers in parentheses are absolute t-statistics. See other notes to Table 1. R-squared in these models is inclusive of the university fixed effects.

Source: Statistics Canada, the 1982, 1986 and 1990 National Graduates Surveys.

Table 6 Correlations and p-values between university fixed effects and various characteristics of universities

	Regression samples		
Actual regressors	**Pooled**	**Men**	**Women**
Professor–student ratio	-0.08, 0.6	-0.13, 0.4	-0.01, 0.95
Median professor salary, per 1000	0.19, 0.21	0.07, 0.66	0.20, 0.19
Full-time equivalent enrollment, per 1000	0.34, 0.02	0.19, 0.22	0.3, 0.05
Graduate student share	0.29, 0.06	0.14, 0.35	0.33, 0.03
Total arts tuition and fees, per 1000	-0.08, 0.6	-0.13, 0.4	-0.02, 0.9
Measures of freshmen high school grades			
Average high school grades	0.11, 0.51	0.13, 0.43	0.07, 0.69
Proportion of freshmen class with high school grades of 75% or higher	0.14, 0.38	0.14, 0.37	0.11, 0.49
Maclean's rankings			
Comprehensive universities	-0.56, 0.12	-0.71, 0.03	-0.46, 0.21
Medical	0.61, 0.05	0.33, 0.32	0.61, 0.05
Undergraduate universities	0.17, 0.57	0.41, 0.14	-0.02, 0.96
Reputational ranking	0.11, 0.61	0.07, 0.73	0.1, 0.64
Publication quality			
Publishing rank	0.23, 0.55	0.37, 0.32	0.11, 0.77

Notes: Each cell shows the correlation between the university fixed effects estimated from a sample indicated at the top of each column, followed by a comma and then the p-value for a test of no association between the given university characteristic and the university fixed effects.

Source: Statistics Canada, the 1982, 1986 and 1990 National Graduates Surveys.

Table A1 Means, standard deviations, minima and maxima of variables for male regression sample

Variable	Obs[1]	Mean	Std. dev.[2]	Minimum	Maximum
Characteristics of universities					
Professor–student ratio	7,631	0.09	0.09	0.04	0.63
Full professor–student ratio	7,631	0.03	0.02	0.00	0.16
Associate professor–student ratio	7,631	0.04	0.04	0.01	0.29
Assistant professor–student ratio	7,631	0.02	0.03	0.01	0.18
Full professor share	7,631	0.34	0.09	0.09	0.54
Associate professor share	7,631	0.37	0.07	0.23	0.57
Assistant professor share	7,631	0.21	0.06	0.12	0.47
Median professor salary, per 1000	7,631	70.31	7.03	47.44	82.32
Median full professor salary, per 1000	7,631	85.71	6.85	71.41	96.90
Median associate professor salary, per 1000	7,631	67.92	4.73	54.51	77.14
Median assistant professor salary, per 1000	7,631	52.41	3.31	43.47	61.52
Full-time undergraduates, per 1000	7,631	10.87	5.70	0.71	28.69
Part-time undergraduates, per 1000	7,631	4.56	3.15	0.04	19.00
Undergraduate enrollment (full-time equivalent), per 1000	7,631	12.39	6.28	0.72	32.72
Graduate student share	7,631	0.12	0.08	0.00	0.44
Total arts tuition and fees, per 1000	7,631	1.85	1.42	0.76	10.22
Average high school grades of freshmen (1994)	7,187	79.94	3.12	72.00	87.00
Percentage of freshmen with high school averages of at least 75%	7,187	74.99	17.01	32.20	99.60
Characteristics of graduates					
ln (earnings)	7,631	10.54	0.44	6.96	11.92
Age (current)	7,631	30.37	5.42	17.75	101.83
Work experience prior to graduation (months)	7,631	25.22	43.23	0	480.00
Resides in Newfoundland	7,631	0.06	0.24	0	1
Prince Edward Island	7,631	0.02	0.13	0	1
Nova Scotia	7,631	0.05	0.23	0	1
New Brunswick	7,631	0.05	0.21	0	1
Quebec	7,631	0.12	0.32	0	1
Ontario	7,631	0.27	0.44	0	1
Manitoba	7,631	0.08	0.27	0	1
Saskatchewan	7,631	0.07	0.25	0	1
Alberta	7,631	0.17	0.38	0	1
British Columbia	7,631	0.11	0.31	0	1
Yukon and Northwest Territories	7,631	0.003	0.06	0	1
Field studied for bachelor's					
No specialty	7,631	0.06	0.24	0	1
Elementary and secondary education	7,631	0.09	0.29	0	1
Other fields of education	7,631	0.05	0.21	0	1

Table A1 Means, standard deviations, minima and maxima of variables for male regression sample (concluded)

Variable	Obs[1]	Mean	Std. dev.[2]	Minimum	Maximum
Fine arts and humanities	7,631	0.09	0.28	0	1
Commerce	7,631	0.14	0.35	0	1
Economics	7,631	0.04	0.19	0	1
Other social science	7,631	0.11	0.31	0	1
Agricultural and biological sciences	7,631	0.08	0.27	0	1
Veterinary science	7,631	0.01	0.10	0	1
Engineering	7,631	0.18	0.38	0	1
Other health (not medical)	7,631	0.02	0.14	0	1
Computer sciences	7,631	0.06	0.24	0	1
Math/physical sciences	7,631	0.07	0.26	0	1
Demographic and background traits					
Single parent	7,631	0.01	0.12	0	1
Married parent	7,631	0.27	0.45	0	1
Married no children	7,631	0.29	0.45	0	1
Language spoken and location					
English in Quebec	7,631	0.02	0.14	0	1
French outside Quebec	7,631	0.04	0.19	0	1
Other in Quebec	7,631	0.01	0.09	0	1
Other outside Quebec	7,631	0.08	0.28	0	1
Highest level of education before starting bachelor's program					
Some college or CEGEP	7,631	0.08	0.28	0	1
Bachelor's	7,631	0.12	0.32	0	1
Master's	7,631	0.01	0.09	0	1
Doctorate	7,631	0.0001	0.01	0	1
Other postsecondary	7,631	0.05	0.21	0	1
Parents' education					
Father: More than high school	7,631	0.38	0.49	0	1
Father: Education missing	7,631	0.04	0.19	0	1
Mother: More than high school	7,631	0.34	0.47	0	1
Mother: Education missing	7,631	0.03	0.18	0	1
Worker's year of graduation					
Graduated 1986	7,631	0.44	0.50	0	1
Graduated 1990	7,631	0.27	0.44	0	1

1. Observations.
2. Standard deviation.
Source: Statistics Canada, the 1982, 1986 and 1990 National Graduates Surveys.

Table A2 Means, standard deviations, minima and maxima of variables for female regression sample

Variable	Obs[1]	Mean	Std. dev.[2]	Minimum	Maximum
Characteristics of universities					
Professor–student ratio	8,394	0.09	0.09	0.04	0.63
Full professor–student ratio	8,394	0.03	0.02	0.00	0.16
Associate professor–student ratio	8,394	0.04	0.04	0.01	0.29
Assistant professor–student ratio	8,394	0.02	0.03	0.01	0.18
Full professor share	8,394	0.33	0.10	0.09	0.54
Associate professor share	8,394	0.37	0.07	0.23	0.57
Assistant professor share	8,394	0.22	0.06	0.12	0.47
Median professor salary, per 1000	8,394	69.49	7.46	47.44	82.32
Median full professor salary, per 1000	8,394	85.06	6.83	71.41	96.90
Median associate professor salary, per 1000	8,394	67.43	4.82	54.51	77.14
Median assistant professor salary, per 1000	8,394	52.16	3.41	43.47	61.52
Full-time undergraduates, per 1000	8,394	10.58	5.91	0.71	28.69
Part-time undergraduates, per 1000	8,394	4.57	3.32	0.04	19.00
Undergraduate enrollment (full-time equivalent), per 1000	8,394	12.11	6.54	0.72	32.72
Graduate student share	8,394	0.12	0.08	0.00	0.44
Total arts tuition and fees, per 1000	8,394	1.88	1.48	0.76	10.22
Average high school grades of freshmen (1994)	7,872	79.95	3.08	72.00	87.00
Percentage of freshmen with high school averages of at least 75%	7,872	74.62	16.85	32.20	99.60
Characteristics of graduates					
ln (earnings)	8,394	10.35	0.52	6.55	11.92
Age (current)	8,394	31.68	7.35	17.75	101.83
Work experience prior to graduation (months)	8,394	33.01	55.64	0	994.00
Resides in Newfoundland	8,394	0.07	0.26	0	1
Prince Edward Island	8,394	0.02	0.14	0	1
Nova Scotia	8,394	0.06	0.24	0	1
New Brunswick	8,394	0.05	0.22	0	1
Quebec	8,394	0.12	0.33	0	1
Ontario	8,394	0.25	0.43	0	1
Manitoba	8,394	0.08	0.27	0	1
Saskatchewan	8,394	0.08	0.27	0	1
Alberta	8,394	0.16	0.36	0	1
British Columbia	8,394	0.11	0.31	0	1
Yukon and Northwest Territories	8,394	0.004	0.07	0	1
Field studied for bachelor's					
No specialty	8,394	0.06	0.24	0	1
Elementary and secondary education	8,394	0.19	0.39	0	1
Other fields of education	8,394	0.07	0.26	0	1

Table A2 Means, standard deviations, minima and maxima of variables for female regression sample (concluded)

Variable	Obs[1]	Mean	Std. dev.[2]	Minimum	Maximum
Fine arts and humanities	8,394	0.13	0.33	0	1
Commerce	8,394	0.09	0.29	0	1
Economics	8,394	0.01	0.11	0	1
Other social science	8,394	0.18	0.38	0	1
Agricultural and biological sciences	8,394	0.08	0.27	0	1
Veterinary science	8,394	0.01	0.09	0	1
Engineering	8,394	0.02	0.14	0	1
Other health (not medical)	8,394	0.11	0.31	0	1
Computer sciences	8,394	0.02	0.14	0	1
Mathematical and physical sciences	8,394	0.03	0.17	0	1
Demographic and background traits					
Single parent	8,394	0.03	0.18	0	1
Married parent	8,394	0.26	0.44	0	1
Married no children	8,394	0.34	0.47	0	1
Language spoken and location					
English in Quebec	8,394	0.02	0.14	0	1
French outside Quebec	8,394	0.05	0.22	0	1
Other in Quebec	8,394	0.01	0.08	0	1
Other outside Quebec	8,394	0.07	0.26	0	1
Highest level of education before starting bachelor's program					
Some college or CEGEP	8,394	0.09	0.28	0	1
Bachelor's	8,394	0.14	0.35	0	1
Master's	8,394	0.01	0.10	0	1
Doctorate	8,394	0.0004	0.02	0	1
Other postsecondary	8,394	0.06	0.24	0	1
Parents' education					
Father: More than high school	8,394	0.35	0.48	0	1
Father: Education missing	8,394	0.05	0.22	0	1
Mother: More than high school	8,394	0.36	0.48	0	1
Mother: Education missing	8,394	0.04	0.19	0	1
Worker's year of graduation					
Graduated 1986	8,394	0.45	0.50	0	1
Graduated 1990	8,394	0.28	0.45	0	1

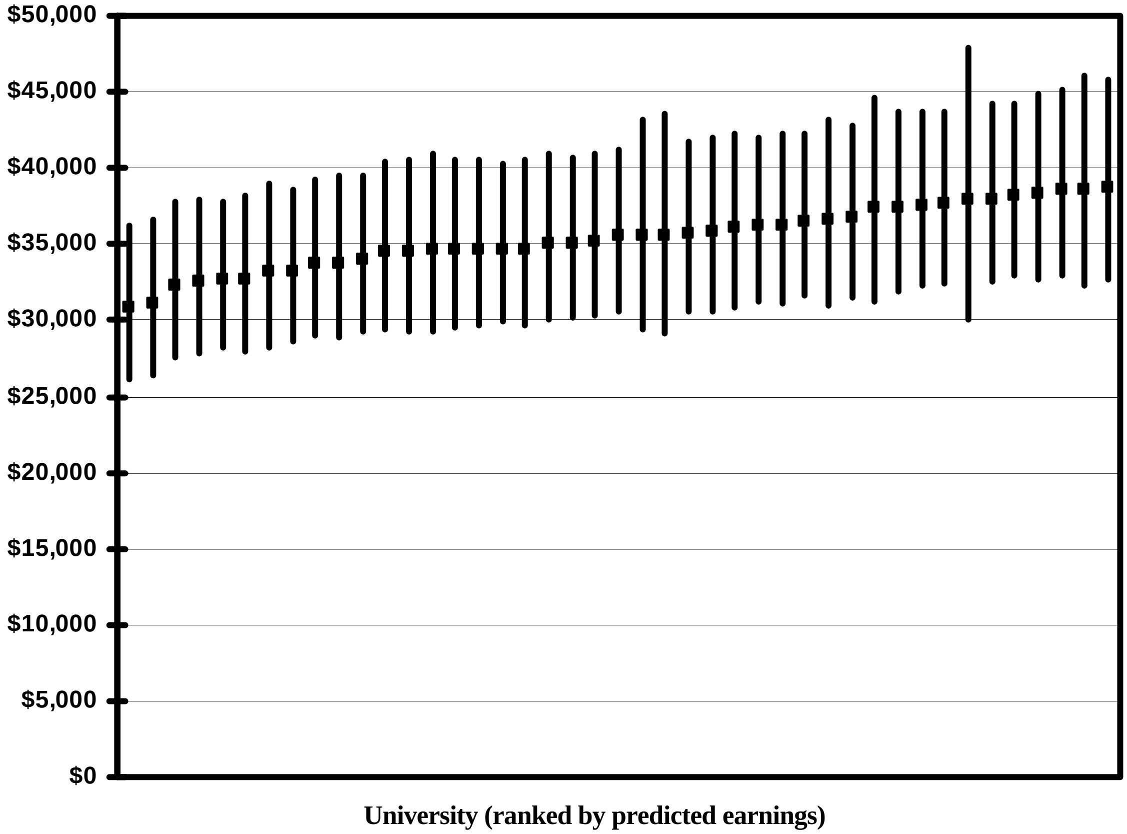
1. Observations.
2. Standard deviation.
Source: Statistics Canada, the 1982, 1986 and 1990 National Graduates Surveys.

Table A3 Standard deviations of key university characteristics overall, within and between universities based on regression sub-samples for men and women

Variable		Men	Women
Professor–student ratio	Overall	0.09	0.09
	Between	0.07	0.07
	Within	0.04	0.04
Median professor salary, per 1000	Overall	7.03	7.46
	Between	6.72	6.76
	Within	1.94	1.88
Undergraduate enrollment (full-time equivalent), per 1000	Overall	6.28	6.54
	Between	7.05	7.07
	Within	1.27	1.27
Graduate student share	Overall	0.08	0.08
	Between	0.08	0.08
	Within	0.04	0.04
Total arts tuition and fees, per 1000	Overall	1.42	1.48
	Between	1.05	1.04
	Within	0.74	0.77

Source: Statistics Canada, the 1982, 1986 and 1990 National Graduates Surveys.

Figure 1 Predicted earnings for average person based on graduating from each university in sample, and 95% confidence intervals



Notes: The predicted earnings for an average person had he or she attended each university in the sample was obtained by estimating the model in Table 1, but for both men and women, with the only university variable being the university dummy. In addition a dummy variable for gender was added. Earnings were predicted by taking the inner product of the sample average of all regressors except the university dummies and the corresponding coefficients, and then adding, one a time, the coefficient on the university dummy variables. The figure shows predicted earnings as well as the 95% onfidence interval, translated into 1995 dollars.

Source: Statistics Canada, the 1982, 1986 and 1990 National Graduates Surveys.

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