Issues in Education Demand: The Ontario Experience

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Abstract

Estimating a market model for university enrollments is always a tricky exercise. Estimating such models in the Canadian context is even more difficult since Canadian universities generally charge less than the market-clearing tuition price, resulting in excess demand. We combine data from the annual *Maclean's* rankings of Canadian universities with applications and enrollment data from the Council of Ontario Universities to estimate a model where student high school grades are used as the rationing mechanism. We show the impact of excess demand, the *Maclean's* rankings, and other variables on entry grades. We also estimate simple demand models for different types of students applying to Ontario universities. We find that students are not a homogenous group and different factors influence different groups of potential students. We also discover that, despite their shortcomings, the *Maclean's* rankings are important and do have an influence on demand for university spots.

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1. Introduction

Canada's public university system is facing a potential crisis as demand for a university education steadily increases while supply remains relatively stagnant. More students who manage to enroll in a Canadian university are finishing their degrees; the secondary school dropout rate fell from 18 per cent in 1991 to only 12 per cent in 1999 across Canada.[1] Employers are demanding workers with higher education. The share of the workforce with at least an undergraduate degree increased from 18.4 per cent in 1991 to 23.2 per cent in 2001. University enrollment increased by slightly less than seven per cent over the same sample period, however this modest growth has been coupled with rising admission standards, suggesting that enrollment growth could have been much larger.

Over the period 1992-2002, only Saskatchewan and Manitoba have benefited from increases in real funding per full-time enrollment (17 per cent and 19 per cent, respectively). All other provinces have experienced reductions in funding, ranging from – one per cent for Quebec to –36 per cent for Prince Edward Island. Ontario has experienced a 33 per cent drop in real funding. The student-faculty ratio has increased only slightly from 17.5 students in 1991 to 19.7 students in 2000, but this masks the impending cascade of retiring faculty members over the next ten years. Across all disciplines, 35.2 per cent of tenured male faculty members fell in the 55-65 age group in the year 2000, or a total[2] of 3,772 male faculty members who will need to be replaced. Only 18.9 per cent of tenured female faculty members fell in the 55-65 age group, or a total of 679 faculty members. In total, some 4,451 faculty members could be retiring over the next ten years.

[1] All statistics in this section are taken from the CAUT 2003 Almanac, except where noted.

Even some back-of-the-napkin calculations reveal a hiring problem. The AUCC suggests that up to 30,000 new faculty members will need to be hired by 2011 to meet retirements and growing demand. This figure seems to be overstated since it would roughly double the number of faculty in the scenario of greatest student growth (30 per cent). To maintain the same student-faculty ratio as in 2000, the number of faculty would need to increase by roughly 30 per cent over and above retirements – still a substantial increase of roughly 7,500 faculty.

Government and universities responded to rapid increases in demand in the 1960s by building new universities and colleges and expanding existing ones. Since that time, the post-secondary infrastructure in Canada has grown very modestly, despite large increases in demand in the 1990s. Besides hiring new faculty, budget dollars are also needed to replace and expand a crumbling infrastructure. The AUCC and the Canadian Association of University Business Officers (CAUBO) estimated in the year 2000 that $3.58 billion would be needed for repairs and new facilities (AUCC, 2001). With inaction and inflation, this figure will surely rise over the next decade.

It does not seem likely that Canada will experience the same expansion in its post-secondary capacity that it witnessed in the 1960s. With this in mind, it is very important for post-secondary institutions to manage the increasing excess demand by employing their resources in the most efficient manner possible, while lobbying for greater funding. Understanding how changes in the economy and the demography of Canada affect university demand is now more critical than ever for the university administrator. The purpose of this paper is threefold: to provide some background into models of education demand that have been researched in the economics literature for other countries; to consider unique methodological and econometric problems in estimating post-secondary education demand for Canada, and; to summarize some of our own research for Ontario universities. The structure of the paper is as follows: In Section 2,

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[2] This total does not include Bishop's University, Concordia University, Dalhousie University, McGill University and Ryerson.

we outline three approaches to estimating university demand that have been developed in theory and used in practice. Section 3 discusses econometric issues in estimating university demand models. Section 4 discusses the unique features of Canada's post-secondary education system and develops a rationing model that is empirically estimated. Section 5 develops and estimates a model of university demand that distinguishes between two different types of students. Section 6 summarizes and concludes.

2. Approaches to Modeling Post-Secondary Demand

In our view, the demand for post-secondary education should be measured by the number of applications, whether adjusted or not for students applying to more than one institution. Most of the papers we consider here use actual enrollments, which is only accurate if all students who apply are admitted and actually attend the institution. In some European countries, this is in fact the case, but in Canada, this would grossly underestimate demand, owing to the fact that not all applicants are admitted.

There are three distinct approaches to modeling post-secondary education demand. The simplest and most naïve approach utilizes projection techniques. These are useful for their simplicity in calculation, rather low data requirements, and immediate results for enrollment decisions. University administrators can and do formulate their own enrollment projections using past enrollment data for their institutions. In the United States, the National Center for Education Statistics (NCES, 2002) produces estimates of national and regional post-secondary enrollments. These extrapolations are based on ten-year projections of the 18-year-old population obtained from the U. S. Bureau of the Census. The percentage of each annual 18-year-old cohort that enrolled in post-secondary education over the years since 1972 is calculated, and then projected ten years into the future. These projections are then applied to the population projections obtained from the Bureau of the Census to arrive at the final enrollment projections. To project the percentage of the current cohort that will enroll, a simple exponential smoothing model, such as the following, is used:

$$P_{t+j} = aP_{t+j-1} + (1-a)P_{t+j-2} \qquad (1)$$

where P represents the population of 18-year-olds and the subscripts denote time.

The smoothing constant α is set at some value such as 0.4 for enrollment projections, suggesting a lack of confidence in the most current projected value. Often several sets of projections are provided, each set based on a different set of assumptions regarding population growth and other factors. The mean absolute percentage error is typically between two per cent and five per cent (NCES, 2002) for any given year in the projection, low enough to conclude that this technique produces reliable enrollment projections.[3] A multiple regression technique is used to project the number of earned degrees, expenditures and the number of teachers, utilizing the natural logs of the enrollment projections and a set of independent variables. Of course, reliable and accurate projections for the independent variables must be available.

The second approach, computing the student “matrix”, does not provide projections; rather it only addresses the issue of optimal current enrollment when the institution is attempting to achieve a revenue target. The matrix approach is useful primarily for private post-secondary institutions that rely on tuition revenue and large endowments (Hardwick Day Consultants, 2003). Here the overall objective is to achieve a revenue target by admitting students of different backgrounds and needs. Student pools are segmented according to levels of financial need and academic desirability that can be identified. Institutions then examine the number of students they are admitting and matriculating in each cell of the needs-ability matrix and, based on the financial

[3] A multiple regression technique is used to project the number of earned degrees, expenditures and the number of teachers, utilizing the natural logs of the enrollment projections and a set of independent variables. Of course, reliable and accurate projections for the independent variables must be available.

aid provided, calculate net revenue and attempt to manage and project enrollment and revenue. Price responsiveness is also taken into account for each cell, but only in a general way that does not claim to reflect willingness-to-pay. The advantage of the matrix approach over projection methods is that it recognizes that student aid budgets and academic standards must fit within an overall revenue requirement. Its disadvantage is its lack of statistical testing to determine if the student cells are significantly different.

The third method, the econometric approach, is perhaps the most familiar to the practicing economist, but least familiar to the post-secondary administrator. Economic theory is used to specify regression equations representing the demand and supply of university enrollment. The Canadian system is a special case due to its heavy reliance on public funding and constraints on the ability to raise tuition revenue. A Canadian university typically faces an excess demand where applications outstrip the number of available slots. The market for new university admissions is not cleared by the price of tuition, necessitating a disequilibrium econometric model. Studies of higher education demand for other countries typically assume that the supply of seats for newly admitted students is infinitely elastic at the market price of tuition. This allows the aggregate education demand function to be identified and estimated using least squares. Examples of this approach are Paulsen and Pogue (1988), King (1993), Duschesne and Nonneman (1998), and Ehrenberg and Monks (1999).

The econometric specifications are usually straightforward: The dependent variable is annual enrollment and the independent variables include such relevant measures as of real family income, the population size and unemployment rate of the relevant age group, real tuition fees, salaries for degree and non-degree holders over all age groups, and lagged enrollment. Real income measures both the ability to pay for university education and the opportunity cost of attending university; population size is a scale factor; the unemployment rate measures the probability of finding employment instead of attending university; real tuition measures the price for university education; salaries capture the return to a degree; and, lagged enrollment captures any partial adjustment to the other independent variables.

The results of the econometric demand models are mixed and are largely specific to the questions being asked. Paulsen and Pogue (1988) find that, when economic conditions are improving, students tend to enroll in U.S. colleges that emphasize traditional arts and science programs. When economic conditions are worsening, students tend to enroll in U.S. colleges that emphasize occupational programs. King (1993), using data from Puerto Rico, finds that students tend to have short time horizons when considering whether to attend university, contrary to the forward-looking permanent income model. Duchesne and Nonneman (1998) find that enrollment at non-university post-secondary institutions is more sensitive to real income and opportunity costs than university enrollment using data from Belgium. Ehrenberg and Monks (1999) conclude that private U.S. universities that receive low quality rankings, as computed by *U.S. News and World Report*, must lower tuition fees and increase student aid in order to maintain enrollment.[4]

3. Econometric Issues

a. Choice of Demand Measure

All of the papers we surveyed use actual enrollments as the quantity measure of post-secondary education demand. This is perfectly acceptable if the post-secondary allows universities to charge market clearing tuition fees, as is the case in private U.S. colleges and universities. Using enrollment as the measure of demand for Canadian universities could result in serious estimation problems. Since tuition fees are held below market clearing levels, enrollments are determined by supply considerations, such as increases in operating grants, alumni and

[4] An alternative approach to estimating education demand is to use survey data to isolate determinants of institutional choice by individual students (Pissarides (1982)). Typically multinomial logit functions are estimated where students face a choice to enroll or not to enroll. Once enrolled, the student may also choose the particular institution and the type of program to study. The independent variables are similar to those used in the education demand studies. Endogeneity of enrollment demand with supply is not treated in this literature. Surveys can be found in Ordovensky (1995) and Corman and Davidson (1984).

endowment funding, and regulated increases in tuition fees. If real incomes are highly correlated with post-secondary funding, it may appear that real incomes are affecting enrollments, when in fact, the correlation is spurious.

The number of applications is a better measure of demand, but is not without its problems. Students may apply to any number of universities they like, but ultimately attend only one. This will inflate applications and may make it appear that demand is increasing quickly, when in fact, students are simply being more broad-minded in where they apply. Some students might apply to institutions for which they have no intention of actually attending. Mueller and Rockerbie (2002b) use application data for Ontario universities by considering only the number of top three choices for each university. Obviously, using enrollments as the measure of demand avoids this problem, but enrollments are not the correct measure of demand. Thus one is left with a tricky measurement problem, but not an insurmountable one.

b. Simultaneity

Many papers do not consider the simultaneity of education demand and supply. This of course results in biased estimates of all demand coefficients and can create very small price elasticities, akin to the “elasticity pessimism” of early export and import demand functions. Duschesne and Nonneman (1998) argue that the supply of enrollment spots in Belgium is infinitely elastic since all students who apply to a university are admitted as a matter of policy. This in itself is not enough to obtain a proper estimate of the demand curve. Variables that shift the supply curve vertically must be included to properly identify the demand specification. This is an old econometric problem, yet rather surprisingly; it has been poorly treated in the education demand literature.

c. Disequilibrium Models

Proper estimation of a demand specification cannot be performed if the system is in a persistent disequilbrium. A good survey is Quandt (1985). Often the short-side rule is invoked to determine if the observed quantity sold of a good represents demand or supply. With falling prices, observed quantities reflect demand, with rising prices, observed quantities reflect supply. If enough data is available on prices, demand and supply, specifications can be estimated using least squares. With regulated tuition fees that rise only slowly to alleviate excess demand, least squares estimates using Canadian enrollment data will likely reflect supply. Maximum likelihood techniques have been developed to handle cases where sufficient observations are unavailable or the periods of disequilibrium are unknown (Mayer, 1989). The estimation problem largely arises from not having observations for quantities demanded *and* supplied at each observed price. Mueller and Rockerbie (2003a, 2003b) avoid the difficulty of disequilibrium techniques by utilizing application (demand) *and* enrollment (supply) data.

4. Excess Demand and Rationing

A typical Canadian university faces a number of constraints that do not exist in a competitive market. The major source of operating revenue is a grant received from a provincial government. A university is not allowed to charge a market-clearing tuition fee. Alberta universities, for example, are not allowed to assess total tuition fees in excess of 30 percent of total operating revenues. Thus, in order to increase its tuition fees, the provincial government must provide a larger annual operating grant, or the institution must increase other sources of funding such as research grants and private contributions. In Quebec, tuition fees have been frozen for a number of years. Other provinces use similar legislation under their Universities Acts. Hence provincial governments largely control tuition fees either directly, by setting tuition fees, or indirectly, by controlling the size of the operating grant. Given the university cost function, this implies that provincial governments also largely control enrollments. This leaves the university with little to choose in its maximization problem, other than how funds will be allocated across different faculties and administrative units.

Since the university is forced to charge a tuition fee that is below the market-clearing fee, the result is excess demand. This takes the form of a larger number of applications being received than available spots (i.e., quantity demanded exceeds quantity supplied). The university must then ration the number of newly admitted students according to some measure of quality, such as grade point average (GPA).[5] This is a necessary consequence of the inability of Canadian universities to adjust tuition fees to their market clearing rates due to legislated tuition ceilings.

Empirical evidence for Ontario (Table 1) shows that the number of new applicants far exceeds the available supply of new seats. Using the ratio of total applications to total acceptances, demand exceeded supply by between 3.98 (Lakehead University) and 6.85 (Ryerson) times over the period 1991-2000. We do not know if this is typical of all Canadian universities due to a lack of detailed data for many institutions. We also do not know how many students applied to each university who had little intention of actually attending if accepted. Perhaps they apply to more than one university so they can rank their choices if accepted.[6] Nevertheless the data are suggestive that excess demand can and does occur.

The demand models surveyed earlier in this paper typically assume that tuition fees adjust to equate demand and supply, or they assume that all who apply are admitted. In contrast, Mueller and Rockerbie (2002b) assume that there is always an excess demand for spots at current tuition levels. This allows them to restrict the focus to the portion of the typical demand-supply diagram that is below the market-clearing price. The university is assumed to adjust the minimum entry-level grade point average (GPA*) to equate demand and supply *ex post*. The university may also resort to other measures of student quality, such as letters of reference or interviews, to ration

[5] In fact, Canadian universities currently ration available slots almost exclusively on the basis of high school grades. A recent article in the *National Post* (Sokoloff, 2002), for example, notes that ". . . admissions decisions in Canadian universities have been made by a computer rather than a person, based on information supplied on standardized applications forms and a high school transcript." The same article, however, notes that other criteria along the lines of the American model (e.g., SAT scores, extra-curricular activities, etc.) are beginning to be used in admissions decisions in light of the increased competition for slots, especially at high-profile programs at prestigious universities.

the number of students applying. As long as these measures are strongly correlated with GPA*, using GPA* as the only measure of student quality is not unreasonable. Unfortunately GPA* is not reported in easily obtainable university statistics, so we approximate it using the average GPA for all newly entering students as reported in the annual *Maclean's* rankings.[7]

The rationing model can be more clearly explained using Figure 1 which plots the value of GPA* for any given level of *ex ante* excess demand for student slots. The line is a schedule representing all rationing equilibria where *ex post* demand and supply are equated by setting an appropriate value for GPA*. It is drawn as linear for convenience.[8] The intercept with the vertical axis gives the minimum grade point average for entry if there is no excess demand for student slots. We assume that this does not change so that a university will enforce a minimum quality standard that is specific to that university, regardless of shifts in application demand or slot supply.[9] In this case, changes in any of the exogenous variables, except tuition fees, in the demand or supply functions serve to pivot the equilibrium schedule around the intercept.

Using data for Ontario universities over the period 1992-2001, Mueller and Rockerbie (2002b) estimated a rationing function that takes the regression form

$$GPA_{it}^{*} = a + b_1 (Q_{dit} - Q_{sit}) + \tilde{\boldsymbol{\beta}} (Q_{dit} - Q_{sit}) \boldsymbol{X_{it}} + e_{it} \qquad (2)$$

[6] Ontario universities and B.C. universities use a standardized application form that allows students to choose more than one university. This makes the marginal cost of applying to more than one university essentially zero.
[7] See Mueller and Rockerbie (2002b) for a detailed discussion of the issues in measuring and using GPA*.
[8] The rationing equilibria schedule is essentially an excess demand curve that is inverted with the implicit price, GPA*, on the vertical axis.
[9] Without this assumption, it is impossible to predict what will happen to GPA* given a shift in demand or supply that results in a new long-run equilibrium tuition fee. Consider a shift in application demand in Figure 1. The long-run tuition fee will increase as will student slots. If the supply curve is elastic, then the long-run GPA* may increase since tuition fees will not rise by very much. The opposite is true if the supply curve is inelastic. We assume GPA* does not change. The intercept can also represent the minimum GPA to apply if other quality measures are used.

where Q_{dit} and Q_{sit} denote the number of applications and the number actually enrolled for university i in year t. The minimum entry GPA* serves as the implicit price in the short-run, given the tuition fee charged by each university. The excess number of new applications, Q_{dit} - Q_{sit}, is endogenous and hence an instrumental variable (i.e., predicted excess demand or PXD) is constructed in its place. The matrix $\mathbf{X_{it}}$ contains a set of independent variables that shift the demand curve for new applications and the supply curve of new spots in Figure 1. The vector $\tilde{\boldsymbol{\beta}}$ contains coefficients for each of the interaction terms, which are shifts in the slope of the equilibria schedule, displayed in Figure 1.

The independent variables determining application demand are quite standard and include

$$GPA^*_{it} = f\left(Q_{dit}, P_{it}, Y_t, POP_t, R_t, S_{it}, URATE_t, RANK_{it-1}, ORANK_{it-1}\right) \qquad (3)$$

where P_{it} is the full-time real tuition fee, Y_t is provincial real per capita disposable income, POP_t is the provincial population of 18-24 year olds, R_t is the real interest rate, S_{it} is the average real scholarship and bursary awards per student enrolled, $URATE_t$ is the provincial unemployment rate for 18-24 year olds, $RANK_{it-1}$ is last year's *Maclean's* ranking, and $ORANK_{it-1}$ is the lagged median *Maclean's* ranking of all non-Ontario universities. Mayer-Foulkes (2002) develops a theoretical model of a university that tailors its academic standards (GPA and other measures) to maximize the achievement of current students and minimizes the costs of failure to the students. The result is that the university chooses a reputation level that attracts a corresponding quality of students. We use the *Maclean's* ranking as a measure of quality that will contribute to a university's reputation. Dummy variables were included that represent the three university categories specified by *Maclean's* magazine: medical and doctoral, comprehensive and primarily undergraduate.

Only one independent variable unique to the supply of enrollment spots was specified, the real net operating budget which is the total real operating grant less real tuition revenue. The supply of enrollment spots was specified as

$$GPA_{it}^{*} = f\left(Q_{sit}, P_{it}, NOB_{it}, POP_{t}\right) \tag{4}$$

Equations (3) and (4) are used to construct an instrumental variable for excess demand which is then used as a measure of predicted excess demand (PXD) in Equation (2). The estimates of the rationing function (Equation (2)) suggest a number of interesting findings. Table 2 summarizes the regression estimates for the effect of the *Maclean's* ranking, controlling for other factors, on excess demand. In columns (1) and (3), the full model is estimated for males and females, respectively. In columns (2) and (4), variables with estimated coefficient values that have t-statistics less than one in absolute value are eliminated. For both sexes, the factors that put the strongest pressure on universities to ration included a reduction in the net operating budget (NOB), an increase in the real interest rate (R), and an improvement in the *Maclean's* ranking (RANK). Each of these has the theoretically appropriate sign and is statistically significant at at least the 10 per cent level. In the case of females, real scholarships (S) also exert a positive influence on average entering GPA. In terms of the *Maclean's* ranking, the coefficient estimates show that an improvement of one position (a decrease in RANK) increases the slope of the rationing schedule by 0.172 and 0.133 for males and females, respectively.

We further investigate the impact of excess demand the rankings on average entering GPA by computing the marginal effects. Table 3 shows these as changes in excess demand (PXD) and the *Maclean's* ranking (RANK) on GPA for the three types of universities under consideration. The effect of the *Maclean's* ranking is strongest (in percentage terms) for medical/doctoral schools, followed by comprehensive schools and primarily undergraduate schools. In fact, the effect of the *Maclean's* ranking was the most important factor in determining application demand. Despite their many statistical shortcomings and claims of irrelevance by university administrators and faculty, students and parents do appear to use the rankings when facing the very important choice of where to obtain a degree.

The effect of excess demand on average entering GPA also differs by university type. Here the results are opposite in magnitude to those of the rankings with primarily undergraduate universities rationing more at the margin than either comprehensive or medical/doctoral universities. These results are summarized in Figure 2. Medical/doctoral universities have the highest estimate of GPA* with zero excess demand, followed by comprehensive universities, and finally primarily undergraduate universities. However, primarily undergraduate universities ration the most at the margin. In other words, as excess demand increases, the value of GPA* increases the most rapidly in comparison to the two other university categories. These results suggest that, while medical/doctoral universities have the highest admission standards overall, there is little room for them to raise standards further in response to greater application demand. Instead they must resort to other rationing devices. Rationing at the margin is less stringent for female applicants, although the male-female differential is only marginally statistically significant.

5. Student Attributes in Determining Demand

University applicants are a diverse group. As such, it seems plausible that different groups could be influenced differently by the many factors which affect demand for a university education. To address this possibility, Mueller and Rockerbie (2002a) estimate separate application demand specifications for high-school applicants (almost all from Ontario) and "other" applicants for the years 1992-2001 for all 17 Ontario universities. The latter category of applicants includes out-of-province high school students, college transfer students, mature students, and foreign students. The demand and supply equations are similar to those already outlined above.[10] Again the *Maclean's* ranking was utilized as a measure of university quality.

Table 4 shows that males who are applying to university directly from an Ontario high school consider the *Maclean's* ranking when deciding where to apply. A one-place increase in the ranking, regardless of school category, resulted in 1.5 per cent more applications, statistically significant at 95 per cent confidence.[11] Since the mean number of applications received from this group of males was about 4600 in the sample, this represents approximately 69 more applications in the subsequent year for each one-place increase in ranking, holding all other variables constant. Other coefficient estimates generally displayed reasonable coefficient values. The income elasticity of application demand for high school males in Ontario is 1.269, suggesting that university education is a normal good (indeed a luxury good) for Ontario high school graduates. The price elasticity of real tuition was found to be quite inelastic at -0.273, so it appears that Ontario high school graduates are not very price sensitive when choosing which university to attend. Real weekly earnings, the unemployment rate and the real interest rate were not statistically significant. Thus, the state of the economy was found to be only a minor factor for graduating Ontario high school students when choosing if and where to attend university, although the authors result caution this finding due to the shortness of the sample period.[12]

The results for the "other" applicants generally mirrored those of the estimates for male secondary-school applicants, although the magnitude of the coefficients was found to be somewhat larger. These results are especially interesting in the cases of real tuition and real disposable income (elasticities of -0.589 and 2.934 respectively). The former result suggests that these individuals possess much more price elastic demand for education than their secondary-

[10] See Mueller and Rockerbie (2002b) for specific issues on identification, aggregation of application data and other detailed issues.
[11] In this table, the number of applications, real tuition, real disposable income, and real weekly earnings were logged before estimation. As such, the coefficients can be interpreted as elasticities.
[12] Mueller and Rockerbie (2002a) also break down the results using the *Maclean's* university categories as well as different student types.

school applicant counterparts. Given that the bulk of these applicants are from out-of-province or are transferring from other post-secondary institutions, one might expect greater sensitivity to price. The latter result also makes sense. Insofar as there are likely to be monetary benefits to attending institutions that are better ranked and the opportunity costs of attending for this group is somewhat larger compared to secondary school applicants.[13] Also this group may consider all of Canada as the market for a university education, hence they will conduct a more careful search. Mueller and Rockerbie (2002a) concluded that “other” males and Ontario high school graduate males are different groups whose university choices are influenced by different factors; the “other” group is somewhat more likely to be affected by both real tuition levels and real disposable income. This result for Ontario is consistent with results found by Noorbakhsh and Culp (2002) for Pennsylvania.

Mueller and Rockerbie (2002a) also found important differences between male and female applicants. Female applicants (Table 4) were found to be more price-inelastic than their male counterparts, and university choice appears to be less influenced by both the *Maclean’s* rankings and real disposable income. It could be that the rate of return to a university degree is higher for a female than a male, hence females are willing to spend more for tuition. One cannot say for sure, however the authors note that significantly more females applied to most Ontario universities than males, suggesting their rate of return may be higher. Regardless of gender, Ontario secondary school applicants tend to be more price-inelastic than “other” applicants and their income elasticities are smaller. None of the groups (male, female, secondary students, others) appear to be sensitive to economic conditions or opportunity costs.

[13] Regarding the benefits of attending a higher ranked institution, Bloom and Szykman (1998) show that higher program rankings are related to higher starting salaries among MBA graduates in the U.S. Unfortunately, data limitations prohibited the authors from estimating a similar model for undergraduate starting salaries. The magnitude of the opportunity costs for the “other” group is probably the greatest for the mature students.

Mueller and Rockerbie (2002a) also break down the results using the *Maclean's* university categories.[14] These results are shown in Tables 5 and 6. For males applying directly from secondary schools, the estimated price elasticities of demand for male Ontario high school graduates varied from -0.562 for primarily undergraduate schools, to -0.255 and zero for comprehensive and medical/doctoral schools, respectively. It would appear that students view primarily undergraduate schools as relatively more homogeneous in quality and attributes and therefore shop around more than the other categories using tuition. Students who choose a medical/doctoral school do not consider tuition to as great a degree. The income effect is the largest for medical/doctoral schools at 2.11, followed closely by comprehensive schools at 2.03. Primarily undergraduate schools have the smallest income elasticity at 1.017. Higher real incomes create the greatest increase in demand for medical/doctoral schools in Ontario, everything else constant. With economic growth over time, the distribution of applications should become more skewed towards medical/doctoral schools and put more pressure on them to raise admissions standards.

Mueller and Rockerbie (2002a) conclude by noting that real tuition might have a less powerful effect on the number of applications than the lagged *Maclean's* ranking: a 10 per cent reduction in tuition results in an increase in applications of between 1.5 and 5.9 per cent, while a one position improvement in the ranking increases applications by roughly 1.5 per cent (excluding female "other" applicants). If in fact the goal is to increase the number of applicants, university administrators might consider focusing on both improving the quality of their programs and obtaining new resources, as reflected (accurately or not) in the *Maclean's* rankings.[15] Lowering real tuition costs is only of minor concern.

[14] As above, in each of the following cases, we estimate the equations with all regressors and then drop the variables, in stepwise fashion, where the absolute value of the z statistic is less than 1.00. It is these results that are reported in the text.
[15] See Ehrenberg (2000) for an interesting discussion of how some university administrators in the U.S. have attempted to improve their institution's ranking in *U.S. News & World Report*. The *Maclean's* rankings also seem to be having a similar effect in Canada. A recent *National Post* article (Schmidt, 2004)

6. Summary and Conclusions

Based on our current research we have shown a number of influences on university demand and supply that have hitherto remained uninvestigated in Canada. In particular, we have argued that, in the absence of a market clearing tuition, universities in Ontario will use high school marks to ration the supply of available slots. Thus, these marks serve as "quasi prices" so that the number of applications (demand) will be equated to the limited number of spots available for incoming students (supply). We find that excess demand for university admissions results in increased high school marks for entering students. We also find that the *Maclean's* magazine rankings have a statistically significant effect on student quality (as measured by high school marks) since a higher ranking will result in an increase in the entry marks of students to these institutions.

There are also differential effects by type of university. Medical/doctoral institutions followed by comprehensive and primarily undergraduate institutions, respectively, have the highest average entering high school grades when excess demand for admissions does not exist. However, on the margin it is primarily undergraduate institutions that have the highest increases in grades as admission demand increases.

We also find that students entering directly from Ontario secondary school are different from "other" students (i.e., out-of-province, foreign, transfer and mature students). This latter group has a much higher income elasticity of demand and a higher price elasticity of demand than their secondary school counterparts. Also, males tend to have higher elasticities as a group compared to females. Finally, the *Maclean's* rankings have a positive effect on university applications amongst all groups with the exception of other females.

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outlines how senior administrators at the University of British Columbia altered class sizes to improve the overall ranking of the university.

We are currently in the process of obtaining better data to improve our estimates. Still, the results presented above are suggestive of many factors that are important in the market for university education. These should be of importance for Ontario university administrators and policymakers as well as administrators in other jurisdictions where students come from diverse backgrounds and tuition does not function to clear the market.

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Figure 1

The Schedule of Rationing Equilibria

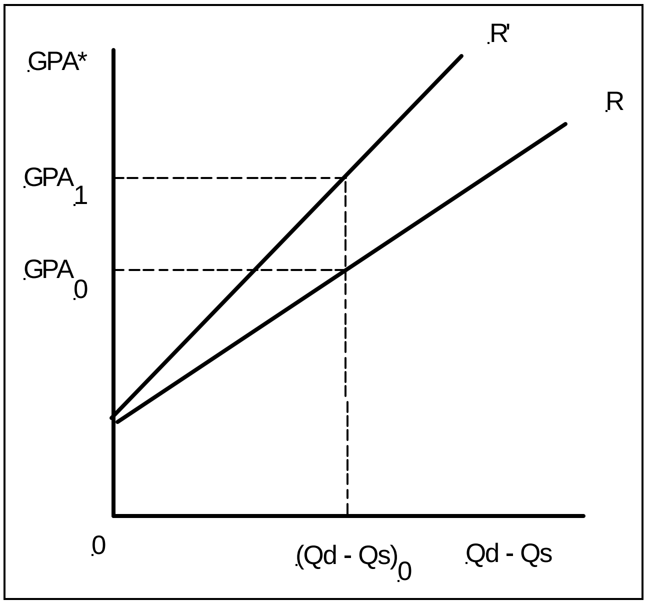

Figure 2

Fitted Values for Rationing Schedules

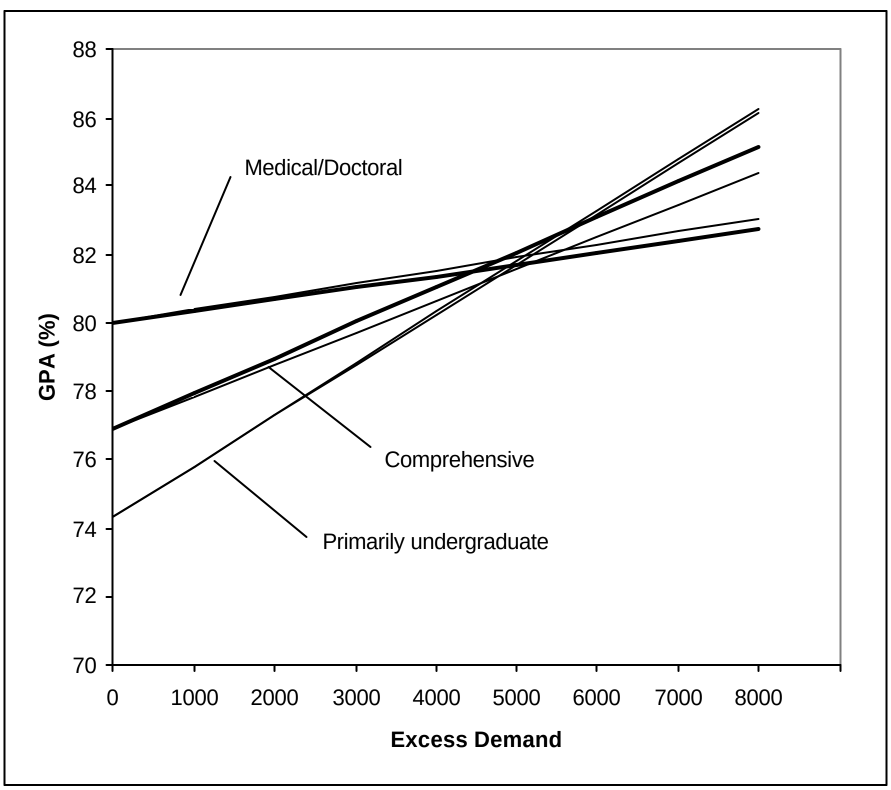

Table 1: Ratio of Total Applications to Total Registrations, Secondary School Students, Ontario Universities, 1991-2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Average 1991-2000
Brock	5.75	5.07	5.12	4.69	4.22	4.55	4.53	4.19	4.46	6.06	4.86
Carleton	3.41	3.32	3.22	3.67	4.45	4.19	3.99	4.51	4.77	5.25	4.08
Guelph	5.74	5.54	5.57	4.93	5.01	3.84	4.64	4.64	5.11	5.04	5.01
Lakehead	3.92	3.77	3.97	4.02	4.11	3.66	3.38	3.73	4.60	4.67	3.98
Laurentian	3.31	3.59	3.93	3.88	3.85	3.79	3.62	4.06	4.86	5.03	3.99
McMaster	4.43	5.68	4.74	5.86	4.89	4.72	4.93	5.39	6.42	5.71	5.28
Nipissing			2.61	4.20	3.80	4.38	3.88	3.51	4.82	4.93	4.02
Ottawa	4.21	4.60	4.57	4.89	4.49	4.31	4.61	4.23	4.71	5.41	4.60
Queen's	4.87	5.05	4.77	4.14	4.76	4.66	4.44	5.26	5.97	6.44	5.04
Ryerson	5.91	5.55	5.76	8.05	7.38	6.22	6.26	7.26	7.90	8.18	6.85
Toronto	3.49	4.18	4.06	3.88	3.09	3.45	3.76	3.93	4.82	5.47	4.01
Trent	5.70	5.66	6.00	5.37	4.26	4.48	4.13	4.51	4.24	5.14	4.95
Waterloo	4.09	4.71	4.83	4.26	3.72	3.99	3.34	4.56	4.53	5.28	4.33
Western Ontario	4.36	4.46	3.92	4.12	4.33	4.31	3.87	4.88	5.26	5.82	4.53
Windsor	4.15	3.81	4.15	3.65	3.98	3.94	4.00	3.91	4.99	4.58	4.11
Wilfrid Laurier	6.40	5.57	6.13	5.08	4.78	4.11	4.42	3.83	4.73	5.12	5.02
York	3.61	3.63	4.44	3.64	3.84	3.90	3.72	4.50	4.87	5.26	4.14
Average	4.59	4.64	4.58	4.61	4.41	4.26	4.21	4.52	5.12	5.49	4.64

Note: Nipissing did not became an independent university until 1993.

Source: Council of Ontario Universities.

Table 2: Estimation of Average Entering Grades, Males and Females

(heterosckedasticity corrected z statistics are in parentheses)

	Males		Females	
	(1)	(2)	(3)	(4)
Predicted excess demand (PXD)	2.427	2.736	1.273	0.582
	(0.57)	(0.65)	(0.33)	(0.35)
Ranking lagged interaction (PXD*RANK)	-0.172 *	-0.172 *	-0.134 *	-0.133 *
	(10.34)	(10.34)	(9.52)	(9.66)
Outside ranking lagged interaction (PXD*ORANK)	-0.065	-.060	-0.047	-0.040
	(1.81)	(1.78)	(1.61)	(1.55)
Population interaction (PXD*POP)	0.003		0.010	0.014
	(0.44)		(0.77)	(1.47)
Unemployment rate interaction (PXD*URATE)	0.079	0.08	0.069	0.056
	(1.31)	-1.33	(1.51)	(1.46)
Real scholarships interaction (PXD*S)	0.831	0.809	1.173 **	1.342 *
	(1.47)	(1.45)	(2.06)	(2.75)
Net operating budget interaction (PXD*NOB)	-0.007 *	-0.006 *	-0.006 *	-0.007 *
	(3.14)	(3.13)	(3.41)	(4.09)
Real interst rate interaction (PXD*R)	0.058 **	0.059 **	0.091 *	0.088 **
	(2.20)	(2.25)	(2.75)	(2.69)
Real disposable income per capita interaction (PXD*Y)	0.249	0.289	0.121	
	(1.21)	(1.54)	(0.53)	
Medical/doctoral interaction (PXD*MD)	-1.825 *	-1.811 *	-1.519 *	-1.446 *
	(3.13)	(3.11)	(2.99)	(2.98)
Comprehensive interaction (PXD*COMP)	-1.717 *	-1.706 *	-1.330 *	-1.261 *
	(4.04)	(4.02)	(3.45)	(3.55)
Comprehensive (COMP)	2.559 **	2.571 **	2.500 **	2.311 **
	(2.19)	(2.20)	(2.14)	(2.10)
Medical/doctoral (MD)	5.671 *	5.645 *	5.285 *	4.879 *
	(2.66)	(2.65)	(2.45)	(2.41)
Constant	74.339 *	74.345 *	73.823 *	73.769 *
	(130.45)	(130.18)	(140.24)	(140.14)
Observations	110	110	110	110
R^2	0.79	0.79	0.81	0.81

Note: * and ** denote significance at the 1 and 5% levels, respectively.

Source: Mueller and Rockerbie (2002b: Table 5)

Table 3: Partial Derivatives by University Type
(partial derivatives calculated at university-type means)

	Medical/Doctoral	Comprehensive	Primarily Undegraduate
	Males (all variables included)		
δGPA/δPXD	0.3867 *	0.9343 *	1.4942 *
δGPA/δRANK	-0.9594 *	-0.7042 *	-0.3263 *
	Males (only significant variables included in second-stage regression)		
δGPA/δPXD	0.3905 *	0.9296 *	1.4902 *
δGPA/δRANK	-0.9586 *	-0.7036 *	-0.3260 *
	Females (all variables included)		
δGPA/δPXD	0.2932 *	0.9710 *	1.4429 *
δGPA/δRANK	-0.8530 *	-0.6087 *	-0.2909 *
	Females (only significant variables included in second-stage regression)		
δGPA/δPXD	0.3434 *	1.0300 *	1.4744 *
δGPA/δRANK	-0.8458 *	-0.6036 *	-0.2884 *

Notes: (1) These figures give the effects of a 1,000 person increase in excess demand or a one position decline in the rankings on the average high school entering grade in percentage points.
(2) These are calculated using the mean values and the coefficient estimates from Table 2.
(3) * denotes significance at the 1% level.

Source: Mueller and Rockerbie (2002b: Table 6)

Table 4: Estimates of Ontario University Applications, by Sex and Student Type
(absolute value of z-statistics are in parentheses)

	Males				Females			
	Secondary		Others		Secondary		Others	
	(1)	(1a)	(2)	(2a)	(3)	(3a)	(4)	(4a)
Ranking lagged	-0.015	-0.015	-0.016	-0.016	-0.013	-0.013	-0.005	-0.007
	(2.39)*	(2.44)*	(2.79)**	(2.85)**	(2.29)*	(2.56)*	(1.11)	(1.40)
Real disposable income per capita ('000s)	1.702	1.269	3.054	2.934	-0.025		-0.421	
	(2.72)**	(4.15)**	(5.07)**	(8.90)**	(0.03)		(0.28)	
Real tuition ('000s)	-0.258	-0.273	-0.578	-0.589	-0.157	-0.151	-0.294	-0.294
	(6.63)**	(10.29)**	(14.37)**	(20.16)**	(3.59)**	(7.03)**	(4.03)**	(7.12)**
Real unskilled weekly earnings	0.338		0.351	0.271	0.124		0.131	
	(0.84)		(0.93)	(1.61)	(0.61)		(0.38)	
Unemployment rate, 17-19 year olds	0.011		0.004		-0.018	-0.017	-0.032	-0.024
	(0.75)		(0.28)		(1.47)	(4.42)**	(1.50)	(3.19)**
Real interest rate	0.010	0.011	0.002		-0.004		-0.010	
	(1.55)	(1.95)	(0.26)		(0.68)		(1.03)	
Constant	1.502	4.741	-3.225	-2.368	8.313	8.858	8.282	7.604
	(0.38)	(5.43)**	(0.85)	(1.63)	(2.28)*	(79.88)**	(1.34)	(49.73)**
R^2	0.9762	0.9762	0.9808	0.9808	0.9743	0.9742	0.9816	0.9814
Observations	148	148	148	148	148	148	148	148
Number of universities	17	17	17	17	17	17	17	17

Note: * denotes significance at 5% and ** denotes significance at 1%.

Source: Mueller and Rockerbie (2002a: Tables 2-5).

Table 5: Estimates of Ontario University Applications, by University and Student Type, Males
(absolute value of z-statistics are in parentheses)

	Secondary						Others					
	MD Only		COMP Only		PU Only		MD Only		COMP Only		PU Only	
	(1)	(1a)	(2)	(2a)	(3)	(3a)	(4)	(4a)	(5)	(5a)	(6)	(6a)
Ranking lagged	-0.015	-0.015	0.010	0.010	-0.010	-0.010	-0.028	-0.029	0.013	0.013	-0.011	-0.011
	(2.12)*	(2.20)*	(0.65)	(0.67)	(1.30)	(1.28)	(3.06)**	(3.38)**	(1.45)	(1.42)	(1.63)	(1.66)
Real disposable income per capita ('000s)	1.808	2.110	2.806	2.030	1.127	1.017	3.678	3.551	4.199	3.579	2.230	2.293
	(4.41)**	(8.71)**	(3.00)**	(4.17)**	(1.36)	(1.89)	(3.41)**	(6.25)**	(6.02)**	(9.40)**	(3.11)**	(5.15)**
Real tuition ('000s)	-0.009		-0.212	-0.255	-0.539	-0.562	-0.320	-0.310	-0.574	-0.593	-0.835	-0.837
	(0.34)		(3.69)**	(6.88)**	(8.15)**	(10.90)**	(4.46)**	(5.86)**	(12.41)**	(18.53)**	(14.66)**	(19.13)**
Real unskilled weekly earnings	-0.228		0.490		0.585	0.511	0.090		0.806	0.399	0.222	0.265
	(0.89)		(0.85)		(1.09)	(1.98)*	(0.13)		(1.87)	(2.03)*	(0.48)	(1.24)
Unemployment rate, 17-19 year olds	0.005	0.013	0.023		0.005		0.002		0.016		-0.001	
	(0.55)	(3.08)**	(1.10)		(0.25)		(0.07)		(1.00)		(0.08)	
Real interest rate	0.010	0.010	0.000		0.005		-0.007		-0.004		0.002	
	(2.36)*	(2.23)*	(0.02)		(0.54)		(0.61)		(0.59)		(0.20)	
Constant	5.067	2.851	-2.165	3.139	2.258	3.090	-2.516	-1.676	-8.331	-4.092	0.152	-0.280
	(1.94)	(3.75)**	(0.37)	(2.21)*	(0.44)	(1.58)	(0.37)	(1.03)	(1.91)	(2.34)*	(0.03)	(0.17)
R^2	0.9589	0.9588	0.8891	0.8877	0.9742	0.9742	0.9041	0.9036	0.9730	0.9727	0.9817	0.9817
Observations	45	45	44	44	59	59	45	45	44	44	59	59
Number of universities	5	5	5	5	7	7	5	5	5	5	7	7

Note: * denotes significance at 5% and ** denotes significance at 1%.

Source: Mueller and Rockerbie (2002a: Tables 2 and 3).

Table 6: Estimates of Ontario University Applications, by University and Student Type, Females
(absolute value of z-statistics are in parentheses)

	Secondary						Others					
	MD Only		COMP Only		PU Only		MD Only		COMP Only		PU Only	
	(1)	(1a)	(2)	(2a)	(3)	(3a)	(4)	(4a)	(5)	(5a)	(6)	(6a)
Ranking lagged	-0.021	-0.021	0.009	0.009	-0.007	-0.007	-0.011	-0.013	0.023	0.023	-0.005	-0.006
	(2.70)**	(2.78)**	(0.57)	(0.61)	(1.01)	(1.00)	(1.06)	(1.33)	(2.38)*	(2.35)*	(0.72)	(0.89)
Real disposable income per capita ('000s)	-0.116		2.165	1.477	-1.387	-1.713	-0.282		-0.864		-0.092	
	(0.18)		(1.28)	(2.74)**	(0.90)	(1.41)	(0.16)		(0.79)		(0.05)	
Real tuition ('000s)	0.103	0.096	-0.230	-0.202	-0.354	-0.340	-0.047	-0.048	-0.289	-0.324	-0.523	-0.525
	(3.10)**	(7.45)**	(2.92)**	(4.98)**	(3.97)**	(4.10)**	(0.54)	(1.13)	(5.72)**	(12.74)**	(6.11)**	(11.73)**
Real unskilled weekly earnings	-0.220	-0.192	0.400	0.280	0.107		-0.190		0.230	0.379	0.190	
	(1.54)	(2.40)*	(1.05)	(1.07)	(0.29)		(0.48)		(0.92)	(2.29)*	(0.50)	
Unemployment rate, 17-19 year olds	-0.020	-0.019	0.010		-0.041	-0.045	-0.015	-0.009	-0.049	-0.038	-0.035	-0.035
	(2.24)*	(8.38)**	(0.41)		(2.01)*	(3.00)**	(0.63)	(1.28)	(3.22)**	(7.44)**	(1.51)	(4.18)**
Real interest rate	0.001		0.002		-0.022	-0.023	-0.009		-0.012	-0.010	-0.019	-0.018
	(0.29)		(0.17)		(2.12)*	(2.12)*	(0.76)		(1.69)	(1.48)	(1.73)	(1.62)
Constant	11.097	10.604	0.316	3.077	12.921	14.485	10.511	8.578	9.846	6.398	7.342	8.053
	(4.15)**	(25.14)**	(0.05)	(1.29)	(2.12)*	(3.97)**	(1.48)	(66.10)**	(2.22)*	(7.47)**	(1.08)	(39.19)**
R^2	0.9568	0.9568	0.9191	0.9190	0.9693	0.9692	0.8323	0.8306	0.9780	0.9779	0.9804	0.9803
Observations	45	45	44	44	59	59	45	45	44	44	59	59
Number of universities	5	5	5	5	7	7	5	5	5	5	7	7

Note: * denotes significance at 5% and ** denotes significance at 1%.

Source: Mueller and Rockerbie (2002a: Tables 4 and 5).