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Performance of the Different Methods of Study Financing: A Measurement through the Data Envelopment Analysis Method

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Abstract:

Financial hardship can significantly undermine post-secondary students' ability to attain their academic goals: completing their training and obtaining degrees with good grades. This study considers which method of financing studies—loans and bursaries from the Government, student aid granted directly by universities, scholarships or on-campus jobs, off-campus jobs or parental financial contribution—will best help students attain academic success. For these purposes, we use a non-parametric data envelopment method, the Data Envelopment Analysis (DEA) which will enable us to determine a theoretically efficient production frontier against which the efficiency of students will be measured. Depending on the financing methods used, the conclusions of this study show efficiency differences.

Keywords: Data Envelopment Analysis, efficiency, student aid, university

JEL Codes: I23, I28.

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I. INTRODUCTION

An educated population constitutes an incomparable contribution to a society. This is particularly true for post-secondary education in a knowledge-based economy such as ours. For an individual, when we consider the economic aspect only, a graduate education can be treated like any other investment. Indeed, education, as an investment, implies costs: while some are obvious costs—tuition fees, accommodation expenses—others are implicit, or opportunity costs. Thus, students who study full time at university “forfeit” the wage high school graduates earn, ie the wage they would have earned if they had directly entered the labour market. Likewise, graduate education creates an expectation of benefits. We here only address economic and monetary benefits, such as the highest wage earned by an undergraduate student in comparison with a high school student’s wage¹. When comparing expected costs and benefits associated with a graduate education, we can define an education rate of return that can be compared with the yield of an investment or an interest rate. According to some studies, the rate of return to post-secondary education is 13% in Quebec (Fortin 2001). This equals the rate recorded in Canada and the OECD Member States (see, for example, Emery, 2005; Vaillancourt and Bourdeau-Primeau, 2002 and Lemelin, 1998). However, a more recent study provides a lower return of 10% for holders of a Bachelor’s degree, though with an advantage for women who recorded a rate of return of 12.6% in 2005/06 (MELS 2008). Holders of a high school diploma should thus invest in undergraduate studies as, from a strictly economic perspective, they could expect the yield to this diploma to exceed the current interest rate or even, generally, the return to investing the cost of education on the stock exchange. Moreover, if other advantages of education (social benefits, for example) could be valued financially, it is obvious that investment in education would be more economically profitable.

Yet, according to the Quebec Ministère de l’Éducation, du Loisir et du Sport (Ministry of Education, Leisure and Sport) (MELS 2009), more than 30%² of young Quebecers who

¹ It should be noticed that in the province of Quebec, the graduates of the secondary sector have to make two years of studies at the “CEGEP” (general and vocational college) before entering the university.

² In 2006/07, 64.5% of students completed an undergraduate program and obtained a diploma. The percentage has decreased relative to 2004/05, when the ratio was of 68.4%. (MELS, 2009).

registered for an undergraduate study program in 2006/2007 left without acquiring a diploma. By examining the causes of dropping out, the Ministry and universities are seeking to reduce this rate. Some universities envision solutions to enable students to improve their grades (see, for example, Pageau and Bujold, 2000). However, the real causes of dropping out in Quebec are still unclear, despite some attempts to understand them (Montmarquette *et al.*, 2001).

In this research, we intend to assess the extent to which specific forms of student aid (institutional bursaries, needs-based scholarships) can foster better success at the university than other types of financial resources, such as off-campus student jobs. We consider how various income sources can enhance students' performances and help them reach a certain level with respect to their overall grade average and the number of credits obtained. To do this we use a non-parametric performance measurement method, the Data Envelopment Analysis (DEA) method.

The remaining part of the paper is structured as follows: The second section describes the various financing sources by means of a parallel short literature review. The third section introduces the DEA method and the fourth section sets out the data. The fifth section analyzes the results and we finally conclude.

II. STUDENT AID AND SUCCESS

Many studies (see Parent, 2002; Dagenais *et al.*, 2001 for Canadian studies, for example) show that working while pursuing secondary education has been a significant contributor to dropping out. This result can also be verified for university students (Finnie and Qiu, 2008, who draw up unconventional training plans for students who work during their studies). Thus, we assume that the global cost of studies, including not only tuition fees and related costs but also accommodation expenses, force many students to take on full-time or part-time jobs during their studies, in particular those from modest backgrounds. Thus, 58% of university students who received loans and bursaries from the Ministry of Education in 2006/07, and 68% of those who didn't, worked an average of 17 hours per week. (AFE 2009). On the same order of magnitude, according to CREPAS (2002), in Saguenay, Lac-Saint-Jean 66% of university students worked for 17 hours per week in 2000/01. This sometimes required that students study on a part-time

basis. Pageau and Bujold (2000) found out that these elements contribute to academic failure. Thus, when students work more than 15 hours per week, their overall grades are likely to suffer (Université Laval, 2001). Moreover, Motte and Schwartz (2009) noted that students who persevere with their studies are less likely to work more than 20 hours per week than students who drop out. About 23% of non-completers (those who were not registered in any post-secondary curriculum at the beginning of their second year) worked 20 hours per week or more, versus 15% of those who persevered. Nevertheless, the income of over 40% of graduate students fell below the low-income threshold (Machabée, 2001). Likewise, considering a more specific example, more than 70% of the students from the Administration Faculty, Université de Sherbrooke, had a gross annual income below \$10,000, including loans and bursaries (Bédard and Viau, 2001).

One of the objectives of the Ministry of Education of Quebec was to make sure that, by 2010, 30% of the university-aged population could obtain a Bachelor's degree (MELS, 2006). This rate was achieved for years (30.2% of the population obtained a Bachelor's degree in 2005; MELS 2009), although it seemed to stagnate for over 10 years (this rate was 29.3% in 1996 and it reached 32.1% in 2007). However, this rate diverges significantly from the OECD average. Indeed, according to OECD estimates (OECD 2009), even though the tertiary graduation rate (tertiary-type A) is 30.6 % in Canada, it averaged 38.7% in 2007 among OECD Member States. To increase the number of university degrees granted in Quebec, it would thus be advisable to consider education financing methods that could allow better academic results to be achieved, which would result in more degrees being granted, by improving student retention.

Different financing methods should be evaluated, including, in the first place, needs-based loans and bursaries programs. Some studies have already assessed the impact of student aid (loans and/or bursaries programs) on access to studies, mainly in the USA (see Heller, 1997; Dynarski, 2000; Seftor and Turner, 2002; Linsenmeier, Rosen and Rouse, 2006) and Canada (Johnson and Rahman, 2005; Frenette, 2007). The role played by student aid in persistence in school has a little more recently been studied (Desjardins *et al.*, 2002; Dynarski, 2003; Bettinger, 2004; Kerkvliet and Nowell, 2005). However, few studies have been conducted in Canada, and these are mostly from the Canada Millennium Scholarship Foundation (for example, McElroy, 2005; Finnie and

Qiu, 2008). With regard to the specific case of Quebec, to the best of our knowledge a detailed analysis has never been undertaken (on the other hand, we may quote work by Claude Montmarquette on linking the income contingent repayment system to access to post-secondary education; Montmarquette, 2006, for example). Can we formally tie the level of financial assistance to successful university studies? *A priori*, beneficiaries of loans and the bursaries are less likely to work (AFE 2009). If they do work, they devote fewer hours on average to remunerative work³ than non-beneficiaries. Beneficiaries can, therefore, devote more time to their studies. All other things being equal—that is, controlled for differences in the parents' education level, for instance—it appears logical that they should post better results than non-beneficiaries.

Institutional bursaries can be a second source of financing. This category includes university scholarships, including merit scholarships (for example, recruitment bursaries or scholarships awarded for the best academic average in the program) or needs-based scholarships, but also on-campus jobs that universities usually offer to needy students. Scholarships offered by granting agencies to undergraduate students, either directly or through professorial research grants, can also be mentioned here. These institutional bursaries can also help improve academic outcomes. In fact, in addition to provide a student aid on a case-by-case basis that, in many cases, prevents students from dropping out, these bursaries foster a sense of belonging to a university community, thus constituting a factor in perseverance (CCAFE, 2004). Likewise, Desjardins *et al.* (2002) show that institutional bursaries (merit scholarships in their case) have a psychological impact on students besides the financial aspect. By showing its commitment to the students, an institution thus develops an exchange relation with students who, in return, intensify their commitment towards the institution. Ever since the work of Tinto (1975), we have known that the student commitment positively consolidates the persistence level in school.

³ While this is true on average and for women, this situation cannot be asserted for men.

Finally, as mentioned above, a last financing source ⁴ can be the wage that students earn through off-campus jobs. They can do these jobs outside usual study periods (usually in summer for most universities) or during conventional study periods outside of class hours or private study hours.

Therefore, we believe that the lack of financial resources drives students from a modest background to work in order to finance their academic studies, and this situation impairs their academic outcome. This paper will test to what extent students with either of these financing types are more efficient in their studies, that is, record better grades while accumulating credits. For these purposes, we will use the Data Envelopment Analysis (DEA) method.

III. DEA METHOD

To analyze the efficiency of students in reaching a certain level of education (in terms of grades obtained and courses completed), this study will compare students amongst themselves and the recorded level against the “ideal” level. The DEA method helps identify that ideal level as determined by the most performing students, given the invested resources. So we will assess technical efficiency, as defined by the model of Banker, Charnes and Cooper (BCC model) (1984). According to this model, a decision unit (Decision Making Unit or DMU) is efficient if it is on the production frontier. The idea here is that a DMU will seek to obtain the highest output given the invested inputs. We thus consider the academic results (outputs) of the students (DMU) on the basis of their financing sources (inputs). The DEA method also suggests an “input orientation”⁵ that seeks to minimize the inputs in view of the outputs. However, it is obvious that the input orientation is not adapted to our research objective.

We thus consider N decision units DMU_n ($n = 1$ to N). Each DMU uses R inputs X_r ($r = 1$ to R) to produce M outputs $y_{m,n}$ ($m = 1$ to M). We intend to assess the efficiency of the DMU_0 by solving the following model:

⁴ In this paper, we will not consider the income impact of co-op work terms due to a lack of data. However, subsequent paper will study this impact.

⁵ The method we selected is called “output-oriented.”

$$Max_{\phi, \lambda} \phi - \varepsilon \left(\sum_{r=1}^R s_r^- + \sum_{m=1}^M s_m^+ \right)$$

such that:

$$\sum_{n=1}^N \lambda_n y_{m,n} - s_m^+ = \phi y_{m,0} \quad m = 1 \dots M \quad (1)$$

$$\sum_{n=1}^N \lambda_n x_{r,n} + s_r^- = x_{r,0} \quad r = 1 \dots R \quad (2)$$

$$\sum_{n=1}^N \lambda_n = 1 \quad (3)$$

$$\lambda_n \geq 0 \quad n = 1 \dots N$$

Constraints (1) and (2) help draw a theoretical production frontier based on the free disposal assumption and the use of the coefficient vector λ_n . In constraint (1), the outputs of the DMU₀ are multiplied by coefficient ϕ , allowing this production frontier to be reached for given x . Constraint (3) makes it possible to locally convexify the free disposal hull and to obtain a technology with variable returns to scale. s_m^+ and s_r^- are slacks variables and ε is a non-Archimedean element that helps solve the objective equation in two stages (the maximization of ϕ being first). Technical efficiency will be measured with ϕ . An efficient unit will have efficiency $\phi = 1$, while an inefficient unit will have $\phi < 1$.

IV. DATA

Since our final objective was to analyze all the possible financing sources including cooperative internships, our study naturally targeted the Université de Sherbrooke which is, of Quebec and Canadian universities, the one that requires the highest proportion of students to go on cooperative workterms. Indeed, approximately 40% of undergraduate students are registered in a cooperative program of study at the Université de Sherbrooke.⁶ Therefore, we interviewed

⁶ <http://www.usherbrooke.ca/ssp/employeur/chiffres.html>. Visited online on November 1st, 2009.

students who registered in a Bachelor's degree or certificate program in autumn 2008 for the first time. Our objective was to follow these students until they obtain their Bachelor's degree (or certificate, where appropriate). Over 3,800 students were contacted through a survey in which they could provide their answers online. About 30% of them responded. We mainly collected data relating to the financial resources of the students and their socio-demographic characteristics through the survey. By coupling these data with the academic results provided by the Registrar's office, we obtained a sample of 1,106 students. Our calculations, which compare the sample with the university population, reveal an adequate representativeness of our sample, even though there are differences across sectors and genders. Table 1 describes the sample according to gender, study mode (full-time and part-time) and faculty attended, while comparing it with the entire population of the students attending an undergraduate program (Bachelor's degree and certificate) at the Université de Sherbrooke.

TABLE 1: Sample and population per faculty, study mode and gender. Autumn 2008

FACULTY	GENDER	MODE	POPULATION		SAMPLE	
			N	%	n	%
ADM	Male	Full time	259	7.11%	63	5.70%
		Part time	41	1.12%	7	0.63%
	Female	Full time	167	4.58%	67	6.06 %
		Part time	48	1.32%	5	0.45%
LAW	Male	Full time	108	2.96%	22	1.99%
		Part time	-	-	-	-
	Female	Full time	195	5.35%	56	5.06%
		Part time	-	-	-	-
EDU	Male	Full time	102	2.80 %	26	2.35%
		Part time	-	-	-	-
	Female	Full time	473	12.98%	173	15.64%
		Part time	56	1.54%	7	0.63 %
PES	Male	Full time	33	0.91%	9	0.81%
		Part time	33	0.91%	9	0.81%
	Female	Full time	62	1.70%	21	1.90%
		Part time	32	0.88%	11	0.99%
GEN	Male	Full time	290	7.96%	75	6.78%
		Part time	4	0.11%	2	0.18%
	Female	Full time	57	1.56%	17	1.54%
		Part time	-	-	-	-
ARTS	Male	Full time	208	5.71%	59	5.33%
		Part time	36	0.99%	7	0.63%
	Female	Full time	423	11.60%	137	12.39%
		Part time	91	2.50%	18	1.63%
MED	Male	Full time	136	3.73%	53	4.79%
		Part time	-	-	-	-
	Female	Full time	325	8.92%	115	10.40%
		Part time	117	3.21%	14	1.27%
SCI	Male	Full time	192	5.27%	66	5.97 %
		Part time	8	0.22%	3	0.27%
	Female	Full time	116	3.18%	55	4.97%
		Part time	-	-	-	-
THL	Male	Full time	21	0.58%	5	0.45%
		Part time	-	-	-	-
	Female	Full time	4	0.11%	2	0.18%
		Part time	8	0.22%	2	0.18%
Total			3645	100%	1106	100%

Out of 1,100 students we selected 583 for this research to assure homogeneity in the sample. These students were selected because they shared common characteristics. They were enrolled in a Bachelor's⁷ degree program full-time. They were evaluated for at least one exam, didn't fail *all* of their exams (grade point average above 0) and had no previous academic training. These students had French as their mother tongue; were Canadian citizens, did not have a spouse (they were bachelors, separated persons, divorcees, and widowers) or dependent children. Furthermore, they did not suffer from any disability.

We also selected students who reported an income equalling at least \$3,000 for the upcoming year. Even though this floor was very low and corresponded to a quarterly income below the low-income threshold, we considered this level reasonable, as most of the students in our sample either share accommodation expenses (by living with cotenants) or even completely eliminate this cost by living with their parents. We did not set an upper limit on incomes (except to control for outliers), even though the collected data indicated that some students were first and foremost workers who sometimes earned significant wages. Lastly, we excluded students who were offered a parental insurance plan, employment insurance, or a benefit, because we considered that these students differed significantly from the rest of the sample. In the end, this research therefore focussed on a total of 583 respondents, of whom 89% worked during the previous summer. Seventy-seven per cent (77%) of respondents received a parental contribution, 46% benefited from student aid (loans and/or bursaries from the Government of Quebec), 48% of them planned to work off-campus over the upcoming year and 5% were going to work on-campus or receive a needs-based bursary from the university. At least 15% of the students will receive merit-based scholarships from the university or another institution. Thus, they reported \$12,800 in income on average from all types of sources. After three reviewed semesters (autumn 2008, winter and summer 2009) they accumulated 32 credits on average with a grade point average of 3.04 (out of 4.3). Finally, men made up 35% of our sample. Table 2 provides the descriptive statistics of the different financing sources of the students.

⁷ We also selected students who studied to obtain a Ph.D. degree in medicine, a Master's degree in occupational and physical therapy, as well as all the undergraduate students. Students from certificate programs were excluded.

TABLE 2: Descriptive statistics of the students' resources from the restricted sample (amount in Canadian dollars)

	<i>AFE</i>	<i>Need-based UdeS</i>	<i>Summer Wages</i>	<i>Annual Wages</i>	<i>Parents</i>	<i>Merit Scholarship</i>	<i>Total</i>	<i>Average grade</i>	<i>Credits</i>
Average	5 048	2 340	4 771	3 924	3 925	3 444	12 815	3.04	32.19
Mean	4 000	1 550	4 000	3 000	3 000	2 300	11 500	3.11	31.00
Std deviation	3 370	2 095	3 238	3 941	3 561	3 239	5 910	0.66	6.93
Maximum	21 320	8 500	35 000	40 000	35 000	17 000	40 000	4.27	48.00
Minimum	355	100	400	70	5	500	3 000	0.40	3
Benef. number	266	32	518	278	451	89	583	583	583
% Beneficiaries	45.63%	5.49%	88.85%	47.68%	77.36%	15.27%	100.00%	100.00%	100.00%

AFE indicates loans and/or bursaries paid by the Aide Financière aux Etudes of the Government of Quebec. The “Needs-based UdeS” includes the “Université de Sherbrooke” bursaries for needy students and on-campus jobs. “Summer wages” and “annual wages” indicate income from student work undertaken during the summer that preceded the autumn 2008 term or during the academic year, respectively. “Parents” represents the parental contribution. Merit scholarship includes merit-based scholarships received from Université de Sherbrooke or other institutions. It should be underlined that average financial resources are estimated from the beneficiaries of each particular resource.

V. RESULTS

On average, our results indicate a student inefficiency rate of $\phi = 1.33$ in achieving their outputs in view of their global resources. This means that some students were efficient and managed to obtain very satisfactory results in terms of grade points averages and credits, even though they did not have significant resources.

Generally speaking, we observe that the inefficiency rate increases with the total resources that students say they have for the academic year. This is a logical finding according to the definition provided by technical efficiency. In Figure 1, we observe a slightly positive relationship between resources and ϕ ⁸. This relation is statistically significant (but only at the 10% level). In the same vein, the relationship between grade point averages and global resources is slightly negative and significant (5% level).

⁸ We recall that the more ϕ is, the more inefficient is the student.

Figure 1: Evolution of technical efficiency according to the students' global resources

When we estimate gender performance in attaining outputs, we notice that women are very slightly less inefficient than men on average (women $\phi < \text{men } \phi$). Nevertheless, this result is not confirmed by either a test on average difference or a Mann-Whiney test on distribution difference.

Efficiency differences also arose when we differentiated students by their sources of financing. Thus, the efficiency of students in reaching high outputs was calculated depending on whether these students received a parental contribution. Surprisingly, average efficiency did not significantly differ between these two groups. On the one hand, we may assume that the parental contribution can be underestimated by students who live with their parents and do not have to pay rent, for example, (about 25% of students who do not benefit from a parental contribution declare that they live with at least one of their parents or with other relatives) or, on the other hand, that parents who do not give any financial contribution to their children provide psychological or

motivational support (2/3 of students without any parental contribution say that they are “always” or “often” encouraged by their parents to continue their studies).

Another comparison can be made between students who worked off-campus over the year and those who declared that they didn’t work.⁹ As Figure 2 shows, a substantial difference in terms of efficiency seems to exist between the two groups. This difference is significant at the 1% level. In fact, this means that students who work while studying perform less well in achieving their academic objectives, a high grade point average combined with the number of credited courses. As we already know, working while studying may undermine academic outcomes, even if the students in our sample declare having worked less than 15 hours on average per week in their first job.

Figure 2: Technical efficiency depending on whether the student work off-campus during the year

Inefficiency differences can also be noticed depending on whether students receive need-based aid—that is, a loan or a bursary from the Government of Quebec. Figure 3 shows a significant difference in the average inefficiency level between beneficiary and non-beneficiary students.

⁹ Since a large majority of the students worked during the summer preceding the survey, we did not compare the efficiency results of the two groups (did, and did not, work during the summer).

AFE beneficiaries are less efficient in achieving their objectives than non-beneficiaries, probably because they belong to less fortunate families or their families provide them with less support.

Figure 3: Technical efficiency according to students who benefit or not from the Aide Financière aux Etudes (AFE)

Lastly, Table 3 provides a summary of average inefficiencies. The results show that, among all sub-groups, the most inefficient students are those who are helped by the University based on their need, even more than those who work during the year. However, there are no major differences between those who received a contribution from their parents or an institutional bursary, and those who worked during the previous summer. Finally, it is worth noting that the overall inefficiency level of the students is estimated at 1.329. This means that if all the students were efficient in using their resources, they could have improved their grade point average to 3.92 (out of 4.3) instead of the 3.04 they actually attained (with, of course, great differences between students). Such a result unquestionably has repercussions on the continuation of studies and the persistence of young people in university.

	<i>Women</i>	<i>Men</i>	<i>All</i>	
<i>Average Efficiency</i>	1,3289*	1,3284*	1,329	

	<i>AFE</i>	<i>No AFE</i>	<i>With Parents</i>	<i>Without Parents</i>	<i>Annual Work</i>	<i>No Work</i>	<i>Need-UdeS</i>	<i>No-Need-UdeS</i>	<i>Summer Job</i>	<i>No Summer Job</i>	<i>Merit-based</i>	<i>No Merit-Based</i>
<i>Average Efficiency</i>	1.369	1.294	1.321*	1.356*	1.380	1.282	1.388*	1.325*	1.334*	1.290*	1.305*	1.333*

* We tested the equality of the means and found no statistically significant difference (at 5%) between the two groups.

Table 3: Measurement of the technical efficiency according to the reference group¹⁰

A unique feature of the Université de Sherbrooke is that it allows the course load to be distributed over three semesters. The students in our sample carry two or three semester course-loads, depending on the program in which they are enrolled and also their willingness to pursue their studies during the summer. Some of them only took a single semester of courses. It seems self-evident that students who were enrolled in three consecutive semesters of courses will be in a weaker financial situation than those who only attended two or even, of course, only one semester of school. We initially accounted for this aspect (cf. above) by analysing efficiency in attaining two goals, the cumulative grade average, but also the number of credits accumulated. Second, to account for the different situations arising from the number of credits or semesters accumulated, we incorporate category variables into our model as suggested by Banker and Morey (1986). We introduce two additional, dichotomous, variables in order to control for the number of semesters enrolled. Thus, students who are deemed to be in the worst situation from the perspective of their finances (those enrolled in three semesters) are only compared with their own reference group (themselves), while those in a better situation are compared with others in like or worse situations. In this case, however, we only account for a single output, the cumulative mean grade, since differences in the number of credits or semesters are subsumed in the category variables.

¹⁰ As a reminder, AFE (no AFE) indicates students who did (didn't) receive loans and/or bursaries from the Government of Quebec. Parents (without parents) represents the parental contribution received (not received) by students. Annual work or Summer job indicates students who worked during academic year or summer. Need-UdeS (No need-UdeS) includes students receiving (no receiving) University's help for needy students. Merit-based (no merit-based) represents students who did (didn't) receive merit-based scholarships from the University or other institutions.

The results of the analysis reveal greater overall inefficiency when category variables are incorporated (mean inefficiency increased by 0.17). This is attributable to the fact that students who only studied during a single semester (20 students in our sample) have a much lower efficiency when they are compared to those who completed two or three terms. In fact, it is highly likely that at least half of the students who only completed one term were obliged to abandon their program of study, owing to an inadequate grade average. Figure 4 compares the efficiency of students by whether category variables representing the number of semesters are included.

Figure 4: Comparison of overall technical efficiency with and without category variables (dummy)

VI. CONCLUSION

This study attempts to measure students' efficiency in achieving their academic objectives in terms of grade point averages and accumulated course credits. We noticed that, in general,

students were somewhat inefficient in achieving optimal objectives in view of the available resources. However, there were efficiency differences according to how students financed their studies, and the most inefficient students were those who financed their studies with a paid job they held throughout the year (if we exclude students who receive need-based University help). These observations should provide governmental authorities and parents, who sometimes tend to leave their children to fend for themselves, with elements to ponder.

These results obviously need to be explained. Indeed, the poor performance of students who worked during the year could also be explained by a more difficult family environment with, for instance, less educated parents, more limited means, and/or families who offered less support to the continuation of higher education. These issues will be considered in subsequent papers.

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