Gender and Competition:
From the Lab into the Classroom

Louis-Philippe Morin*†
University of Ottawa and IZA

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Abstract

Evidence from the experimental economics literature suggests that females perform less effectively than males in competitive environments. I assess the external validity of this finding in a regular non-experimental setting: that of the classroom. The 1997 Ontario Secondary School reform created a 'double cohort' of secondary school graduates, drastically increasing the number of university applicants in September 2003. Given the limited number of places available in universities, the quality of accepted students was significantly higher in that year than in previous years, significantly increasing competition for high grades in the classroom. Examining student academic performance of the 2001 and 2003 entering cohorts at a large Ontario university, I find that male students coped better with the increased competition than females. In particular, the male university average increased relative to females, as did the proportion of male students graduating 'on time'. These results emphasize the presence of gender differences in performance under increased competition in important real-life situations; supporting the findings of the experimental economics literature.

Keywords: competition, gender, higher education, performance.

JEL classification: J16, I21.

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†Disclaimer: The views, opinions, findings, and conclusions expressed in this paper are strictly those of the author. For confidentiality reasons, the data used in this paper cannot be released by the author. All requests about these data should be directed to the Faculty of Arts and Science at the University of Toronto.

1 Introduction

A growing number of studies, primarily from the experimental economics literature, suggest that males and females respond differently to competition. Especially noteworthy, experimental papers by Gneezy, Niederle and Rustichini (2003) and Gneezy and Rustichini (2004) indicate that males perform better in competitive environments than females. In turn, this suggests an alternative explanation, aside from discrimination and differences in preferences, as to why the highest paid executives in the U.S. are almost entirely composed of men (Gneezy, Niederle and Rustichini 2003).

Experimental designs are useful for measuring differences in performance in competitive environments since they can overcome the obvious selection problem whereby competitive environments attract competitive individuals (and repel non-competitive individuals) – a problem which is very difficult to deal with in settings with observational data. This is especially true if men and women have different tastes for competition. Against this, the external validity of the Gneezy, Niederle and Rustichini (2003) and Gneezy and Rustichini (2004) lab and field results has not been verified, which could limit the relevance of their findings. These experiments asked participants to perform uncommon tasks which might not be especially relevant in day-to-day life. For example, participants in Gneezy, Niederle and Rustichini (2003) were asked to solve computerized mazes, and in Gneezy and Rustichini (2004), they were asked to sprint over a short distance. These studies also concentrate on tasks performed over very short time spans, while real-life competitive environments (such as the workplace environment) typically require individuals to exert effort over long periods.[1] Hence, without support from important real-life situations, the gender differences found in the experimental economics literature may not be generalizable.

A recent Ontario secondary school reform allows us to investigate whether the findings from the experimental economics described above hold in a regular environment: the classroom. As a consequence of the abolition of Ontario's Grade 13 (announced in 1997), two cohorts of students graduated from high school in June 2003, drastically increasing competition for post-secondary institution places. This in turn increased the quality of students admitted to university, as measured by students' high school averages. If universities grade students on a fixed bell-curve, as many Ontario universities do, then it becomes harder to get high grades when learning with better quality students. In this case, the Ontario 'double cohort' represents a unique exogenous shock to the level of competition in university classrooms, and it becomes possible to see whether females and males perform similarly in a 'natural' competitive environment.

This study is the first to estimate the impact of competition on gender differences in performance in a natural environment for a sample of individuals representing a *large* portion of the population. Using administrative data from the University of Toronto, the largest University in Canada, I look at the impact of the increased competition (following the Ontario double cohort) on student (1st

[1] See Gneezy and List (2006) for evidence of important outcome differences between short run (*hot*) and long run (*cold*) decision making using a set of field experiments. Other often cited distortions are the size of the stakes of the experiments, participants' self-selection into experiments, group differences in their reaction to the lab environment, and 'Hawthorne' effects. Levitt and List (2007a, 2007b, 2009) discuss these potential problems for lab and field experiments.

through 4th year) academic performance.[2] While I focus mainly on student first year university averages, I also look at upper year student performance, course drop-out rates, university drop-out rates, and 'on-time' graduation rates.

The main finding of the paper is that, after controlling for ability, male students gained close to 1.1 points (on a 100 point scale) over female students during their first year in university as a consequence of the increased competition. While modest in size, the effect is still present in the fourth year. On-time graduation rates suggest that males significantly benefited from the increased competition, emphasizing that the estimated positive impact on males' university average (relative to females) is not due to differences in time taken to graduate. Overall, these results present evidence supporting the validity of the findings from the experimental economics literature.

The rest of the paper is structured as follows. The next section briefly surveys the experimental economics literature on competition and gender. Section 3 describes the Ontario double cohort in some detail, and Section 4 presents the data used to capture the effect of increased competition on academic performance. Evidence of increased competition for university admission is quantified in Section 5, while the estimation strategy is described in Section 6. Results and robustness checks are presented in Section 7. Finally, Section 8 concludes.

2 Background

The experimental economics literature on competition and gender performance differences has been mainly motivated by the findings of Bertrand and Hallock (2001). Bertrand and Hallock (2001) noted that women only represent 2.5% of the 1992-97 ExecuComp dataset, consisting of top five executives in each firm of the S&P 500, S&P Midcap 400, and S&P Smallcap 600. Gneezy, Niederle and Rustichini (2003) and Gneezy and Rustichini (2004) proposed and experimentally tested an alternative explanation – aside from discrimination and preferences – as to why we observe large gender differences in highly ranked (and highly competitive) labor market positions. Gneezy, Niederle and Rustichini (2003) conducted a laboratory experiment in which participants (university students) had to solve as many computer mazes as possible in a given amount of time. When put in a more competitive environment, men significantly improved their performance while women did not. Gneezy, Niederle and Rustichini (2003) conclude that "women may be less effective than men in competitive environments." Gneezy and Rustichini (2004) present evidence that this gender difference might hold at a young age as well, based on a field experiment in which children had to sprint over a certain distance in different competition settings. There again, boys' performance was enhanced by direct competition, while girls' was not.

Only a few papers look at the effect of competition on performance in natural environments, and they only concern *very specific* groups of individuals. Price (2008) looks at the effect of the instauration of the Graduate Education Initiative (GEI), which increased competition within Ph.D. programs, on time to candidacy for students attending elite U.S. universities. While males

[2] In 2005, 40 percent of Canadians aged 24 to 26 had attended or were attending university. Source: Shaienks, Gluszynski and Bayard (2008).

decreased their time to candidacy by ten percent, women were not affected by the GEI. Paserman (2007) looks at the effect of 'competitive pressure' on professional tennis players and finds that both female and male performance decreases as competitive pressure increases, but males are not as affected as females. To my knowledge, the only study looking at gender performance differences in a work-related competitive environment is Lavy (2008). Lavy (2008) studies the effects of the implementation in Israel of a pay scheme among teachers rewarding those who perform better than their peers. Contrary to previous studies, Lavy (2008) does not find gender performance differences in reaction to competition.

While the studies cited above were interested in potential gender differences in performance when individuals are 'forced' into a competitive environment, other studies investigated another potential explanation for Bertrand and Hallock's findings; namely taste for competition.[3] Gupta, Poulsen and Villeval (2005), and Niederle and Vesterlund (2007) found that males are more inclined to participate in competitive activities. Interestingly, Gneezy, Leonard and List (2009) found that females' and males' taste for competition differs whether we are looking at a patriarchal or matrilineal society. Males are more competitive than females in a patriarchal society, while the opposite is true in a matrilineal society. As a robustness check, I investigate in sections 7.2.3 and 7.3.2 the extent to which differences in taste for competition could affect my results.

3 The Ontario Double Cohort

As part of a major reform to its secondary school system, the government of Ontario announced, in 1997, the abolition Grade 13. Prior to this reform, Ontario students were entering college or university after completing Grade 13 which contrasted with most surrounding secondary school programs. Students would now be expected to complete secondary school in four years (after Grade 12), as in most Canadian provinces, instead of five.[4] The first cohort of the new program (G12 program) began secondary school (Grade 9) in September 1999. Since the new program is completed faster than its predecessor (G13 program), the first cohort of the G12 program and the last cohort of the abolished program were expected to graduate and apply to post-secondary institutions in spring 2003, giving birth to the Ontario 'double cohort'.

Figure 1 clearly shows the effect of the double cohort on the number of post-secondary institution applicants.[5] There is a significant spike in the number of applicants in 2003; increasing from about 60,000 to more than 100,000 between 2001 and 2003.

Since universities have limited capacities, this important increase in the number of applicants made university access more difficult in 2003; I present evidence of the increased competition for a specific university below. By increasing competition for university admission, the double cohort also affected the quality of students enrolled in university in 2003. It is natural to expect students admitted to a specific university during the double-cohort year to be better than students admitted

[3]See Croson and Gneezy (2009) for a more complete and general discussion on gender differences in preferences.
[4]See King et al. (2002, 2004, 2005) and Morin (2007) for more details.
[5]Figure 1 is from Morin (2007).

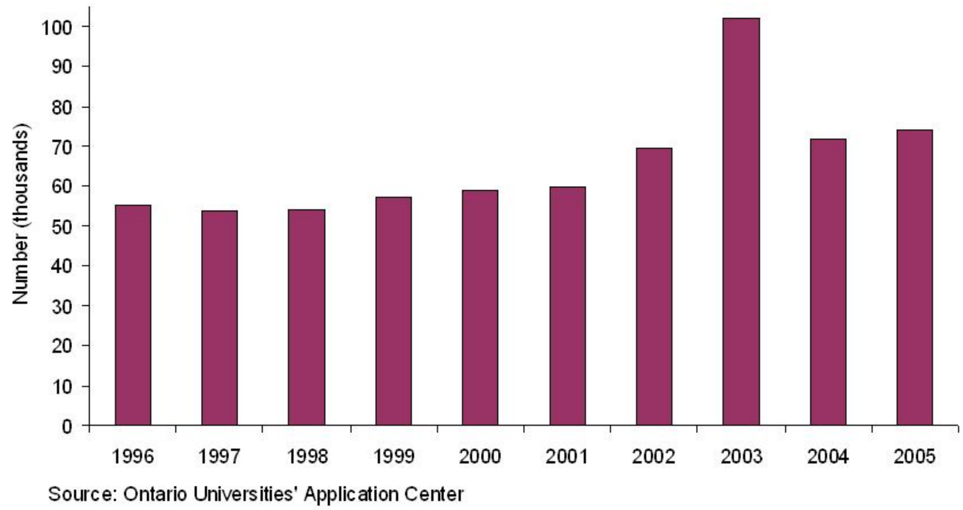

Figure 1: Number of Ontario University Applicants (in thousands)

to the same institution a few years before. The level of competition in university should also be greater since each student would be facing better classmates (in terms of high school average). This is especially true if universities grades are purely based on relative performance.

4 Data

In order to look at the effect of the increased competition in university classrooms on academic performance, I focus on students who enrolled at the University of Toronto – the largest Canadian university. I use an administrative data set provided by the University of Toronto Faculty of Arts and Science that is composed of first-year students who started in Arts and Science in September 2001 or September 2003.[6] Close to 22,000 undergraduate students attend the University of Toronto Faculty of Arts and Science – making it the largest faculty of the University.

The Faculty of Arts and Science combines two features necessary for the analysis of competition on grades: large introductory classes – some of them have more than 1,000 students – and subjects which were not affected by the Ontario Secondary School reform.[7] This is not the case with other faculties.

The data come from two major sources of information that were linked using students' identification numbers: pre-university admission information and university academic history. The university academic history contains 1) the numerical grades for all Arts and Science courses that the student completed, 2) the list of courses that the student dropped (along with the dates these courses were dropped), and 3) a dummy variable indicating whether the student had graduated

[6]Administrative data containing student grades are managed by faculties at the University of Toronto.

[7]The compression of the Ontario secondary school curriculum affected the delivery of material for some subjects and not others. For example, mathematics is believed to have been affected, while biology has not. See Morin (2007) for more details.

from university by July 1st of her fourth year (e.g. July 1st 2007 for 2003 students). These variables will be used as university performance measures.

Pre-university admission information is available for students that applied to the Faculty of Arts and Science, regardless of whether their application was accepted or rejected. Hence, this information will be used not only to control for students' background but also to look for evidence of increased competition for university admission. For each applicant, I have the following information: a student identification number, two high school averages (interim and final), the year and month of birth, and gender of the applicant, the name of the school attended by the applicant, the Faculty program applied to (Commerce, Computer Science, Humanities and Social Sciences, or Life Science), and an application status (enrolled, accepted, canceled, or refused).[8]

I restrict the sample to Ontario high-school graduates born in 1984 and 1985 for the 2003 student cohort, and in 1982 for the 2001 cohort in order to avoid having the results affected by older students.[9] Out-of-province students will be used for robustness checks.[10]

Finally, the data contain an indicator of the secondary school curriculum (Grade 12 or Grade 13) the student graduated from. As such, The G12/G13 indicator is necessary for performing the analysis with or without G12 students. There are pros and cons to including G12 students in the sample. The exclusion of G12 students guarantees that, aside for potential differences in academic ability, students from 2001 and 2003 should be quite similar in terms of academic background (e.g. they come from the same secondary school program), and other dimensions like maturity – since students have the same age. But, if Grade 13 had a significant impact on students' university preparation and if the gender composition differ across G12 and G13, then not including G12 students could over- or underestimate the effect of the double cohort on gender differences in performance. Subjects selected for this analysis have not been significantly affected by the Ontario secondary school reform.[11] This should mitigate any potential bias due to differences across G12 and G13 university preparation. Furthermore, Morin (2007) presents evidence that G12 students who entered university in 2003 were better-than-average students. Hence, in the presence of higher ability G12 students, a difference in gender composition across G12 and G13 students, and in the absence of differences in university preparation, excluding G12 students could also result in biased estimation of the competition effect. For this reason, the estimations were all done with, and

[8]Students submit an interim average in early January and a final average in early March. Students interested in a specific study program offered by the University of Toronto Faculty of Arts and Science have first to apply to one of the following general programs: Commerce, Computer Science, Humanities and Social Sciences, or Life Science. An applications has the 'accepted' status if the application was accepted by the Faculty of Arts and Science but the student decided not to enroll.

[9]The cut-off date in Ontario is December 31st. Hence, students from the first G12 cohort are supposed to be born in 1985, while students from the last cohort of the G13 program should be born in 1984. As a robustness check, I also estimated the regression model including older students. The inclusion of these students does not affect the results.

[10]Pre-admission information from many out-of-province students is missing since they do not necessarily apply through the same process as Ontario high-school graduates. Admission information for these out-of-province students is kept by the colleges to which they applied to, and not by the Faculty of Arts and Science.

[11]All Mathematics courses were excluded from the analysis. Including Mathematics courses in student university averages leaves the results unchanged.

Table 1: Descriptive Statistics

	2001	2003	
	G13	G12	G13
HS Average	85.4	88.2	87.9
	(4.85)	(4.41)	(4.43)
University Average	70.2	71.9	71.4
	(9.08)	(9.64)	(9.34)
Female Percentage	61.2	62.4	61.3
	(48.8)	(48.5)	(48.7)
Age	19.2	18.2	19.2
	(0.31)	(0.28)	(0.28)
Observations	2,483	1,702	1,835

Standard deviations in parentheses.

without G12 students. Results show that including or excluding G12 students give very similar results.

5 Evidence of Increased Competition

Table 1 presents descriptive statistics of the data used to look at the effect of increased competition on student university performance. One can notice that the average high school grade increased by close to 2.6 percentage points between 2001 and 2003, pointing to an increase in competition for university admission due to the double cohort.[12] This difference is statistically significant and considerable – representing an increase of 55 percent of a standard deviation (relative to 2001). The university average was around 70 percent in 2001 and increased by about 1.5 percentage points in 2003. The student population is composed of a majority of female, representing more than sixty percent of the population. Of note, the proportion of female did not change significantly between 2001 and 2003. As expected, G12 students are on average exactly one year younger than G13 students.

Table 2: University Applicants and Enrolment

	Applicants	Enrolment	Enr./App.	App. Increase	Enr. Increase
2001	10,349	7,300	0.71	-	-
2003	16,697	9,124	0.55	61.3 %	25.0 %

Source: University of Toronto Admissions and Awards.

University of Toronto application numbers for 2001 and 2003 are presented in Table 2.[13] The

[12]Results presented in this paper were obtained using the interim average, as the final average was missing for some enrolled students, but the analysis was also carried out using the final average and max(interim, final), with very similar results.

[13]This is the number of students that put the University of Toronto as their first choice institution when applying through the Ontario Universities' Application Centre (OUAC). The number of students that put U of T as their first, second, or third choice was 64,000 for 2003-2004. Source: University of Toronto Admissions and Awards.

increase in the number of applicants between 2001 and 2003 was approximately 62 % which is impressive compared to the increase in enrolment (25 %). This led the ratio enrolments-to-applicants to drop from 71 to 55 percent suggesting that university admission got much more competitive compared to the previous years.

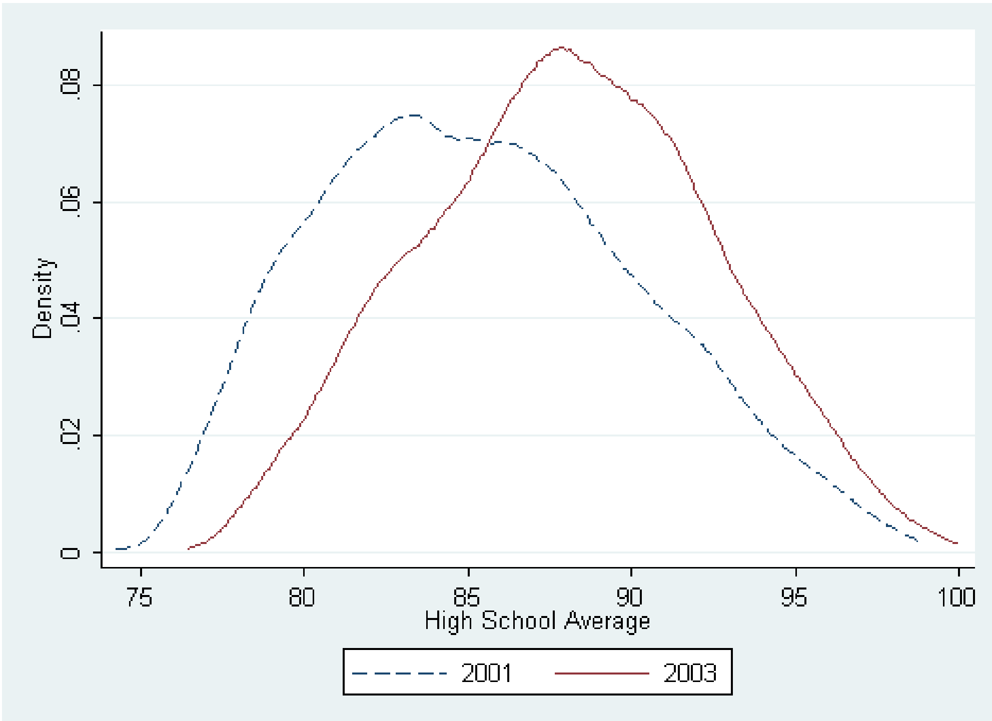

Figure 2: High School Average Marks Distribution

The increased competition can be clearly illustrated by comparing the distributions of enrolled students' high school averages. Figure 2 plots estimated densities of high school averages for students enrolled at the Faculty of Arts and Science in 2001 and 2003.[14] Clearly, students enrolled in 2003 have higher high school averages than students who enrolled in 2001. A Kolmogorov-Smirnov test for the equality of distribution functions rejects the null hypothesis that the data were drawn from the same distribution. Mean high school averages are 85.4 and 88.0 percent for students enrolled in 2001 and 2003, respectively.[15] The difference in averages across the two groups is more than half the standard deviation of averages. Evidence from Figure 2, and Tables 1 and 2 all suggest that competition in classrooms increased significantly as a consequence of the double cohort. The next two sections look more closely at the potential effects of increased competition on university performance and, more importantly, whether males and females were affected in similar fashion.

[14] High school averages presented in Figure 2 are interim averages submitted in early January – before students completed all their secondary school credits. This could explain why the left tail of the distribution is not drastically truncated.

[15] A t-test rejects the hypothesis of equality of averages across years (p-value=0.000).

6 Estimation

The main estimation strategy used to capture the effect of increased competition on gender performance differences is to regress student university performance measures (e.g. university average, dropped courses, on-time graduation) $U_{i,c,t}$ on a male dummy $Male_i$, a double-cohort dummy DC_t ($DC_t = 1$ if the student entered university in 2003), a measure of student ability (high school average) H_i, two interaction terms ($DC_t \times H_i$ and $DC_t \times Male_i$), and a vector of other personal characteristics $\boldsymbol{X_i}$[16]

$$U_{i,t} = \alpha + \gamma H_i + \pi DC_t + \rho(DC_t \times H_i) + \delta Male_i + \beta(DC_t \times Male_i) + \boldsymbol{X_i \Gamma} + \omega_{i,t} \quad (1)$$

The coefficient of interest is β and it represents the difference, across genders, in the effect of the double cohort. The coefficients π and ρ will capture common effects (to males and females) of the increased competition. Details about the expected signs of π and ρ are given below. δ allows one to test whether (*ceteris paribus*) males perform better than females in university. $\boldsymbol{X_i}$ will consist of controls like program fixed-effects and age which will be added to the equation in some specifications. Controlling for age could be useful when including G12 students in the analysis. The main explained variable of interest is students' first-year university average. One of the main benefits of looking at first-year performance is that during this year the choice of courses is not as large as for later years which can mitigate potential course selection issues. Furthermore, first-year courses usually have very large enrolment.

Before looking at the results, I provide a simple example that illustrates the expected changes in university grading-policy slope and intercept coefficients between 2001 and 2003 (π and ρ in equation (1)) if the university grades its students based on a bell-curve.

Imagine, for simplicity, that each year a university accepts five students. In a 'typical' year the high school grade distribution of accepted students is as follows: the weakest accepted student has a high school average of 60 percent while the best one has an average of 100 percent. The three other students have 70, 80, and 90 percent averages. If high school grades are good indicators of academic ability one would imagine that the better students will get the higher grades in university. Imagine that the university only gives five grades, 0, 20, 40, 60, and 80, respectively. The average will be 40 and the standard deviation 31.6. This situation is illustrated in the top panel of Table 3.

Now imagine that competition for university admission increases, making the lowest accepted average equal to 80 with other accepted students having 85, 90, 95, and 100 percent averages. If the university wants to keep the same average and standard deviation, it can simply rank these students from best to worst and give the same grades it did in previous years. As we can see in the bottom panel of Table 3, the grades given in this highly competitive year are the same as in the typical year – leaving the average and standard deviation unchanged. What would happen if one were to run

[16]Quantile regressions are also estimated in Section 7.2.1 to investigate the possibility of heterogeneous effects of competition on the university performance distribution.

Table 3: Hypothetical Effect of Competition on Grade Distribution

	Student Quality				
Typical Year	Worst				Best
High School Average	60	70	80	90	100
University Grade	0	20	40	60	80
Competitive Year	Worst				Best
High School Average	80	85	90	95	100
University Grade	0	20	40	60	80

two separate regressions of university grades on high-school grades for these two years – which is essentially what is done when running a regression on a restricted version of equation (1), imposing $\delta = \beta = \mathbf{\Gamma} = 0$? The high school grade slope coefficients would be equal to 2 for the typical year and 5 for the more competitive year. The intercept coefficients would be equal to -120 and -140 for typical and competitive years, respectively. This example predicts that, if the university grades on a bell-curve, we should expect the slope coefficient to be greater ($\rho > 0$) and the intercept smaller ($\pi < 0$) in competitive years than in typical years. Notice that the effect of increased competition is not homogeneous across student ability: the best student is not affected by increased competition while a student with an 80 percent high-school average suffers a 40 percentage point decrease by entering university in a competitive year.

7 Results

7.1 Competition and First-Year Performance

Figure 3 clearly shows the evolution of the university first-year average distributions between 2001 and 2003 for males and females separately – already pointing to gender differences in reactions to the increased competition following the double cohort. First, we notice that male and female pre-double cohort performance (2001) seem to have the same distribution. A Kolmorov-Smirnov test for equality of distribution suggests that the two distributions are identical. Things are different in 2003. We see a clear shift to the right for both males and females, suggesting that the unconditional student performance increased in 2003. More importantly, the males' distributional shift is more important – the male and female performance distributions are now statistically different.

Table 4 presents results from estimating equation (1) with student first year university average as dependent variable for different sets of controls and for different subsamples. The estimation was done using weighted least squares to account for the fact that student averages were not computed based on the same number of courses.[17] Columns (1) to (3) only include students who graduated from the G13 program while Columns (4) to (6) also include students who graduated from the G12 program. The effect of the increased competition on the university grading policy slope and intercept coefficients (π and ρ in equation (1)) are captured by 'Double Cohort' and 'HS Average

[17]OLS results are almost identical to the ones presented here.

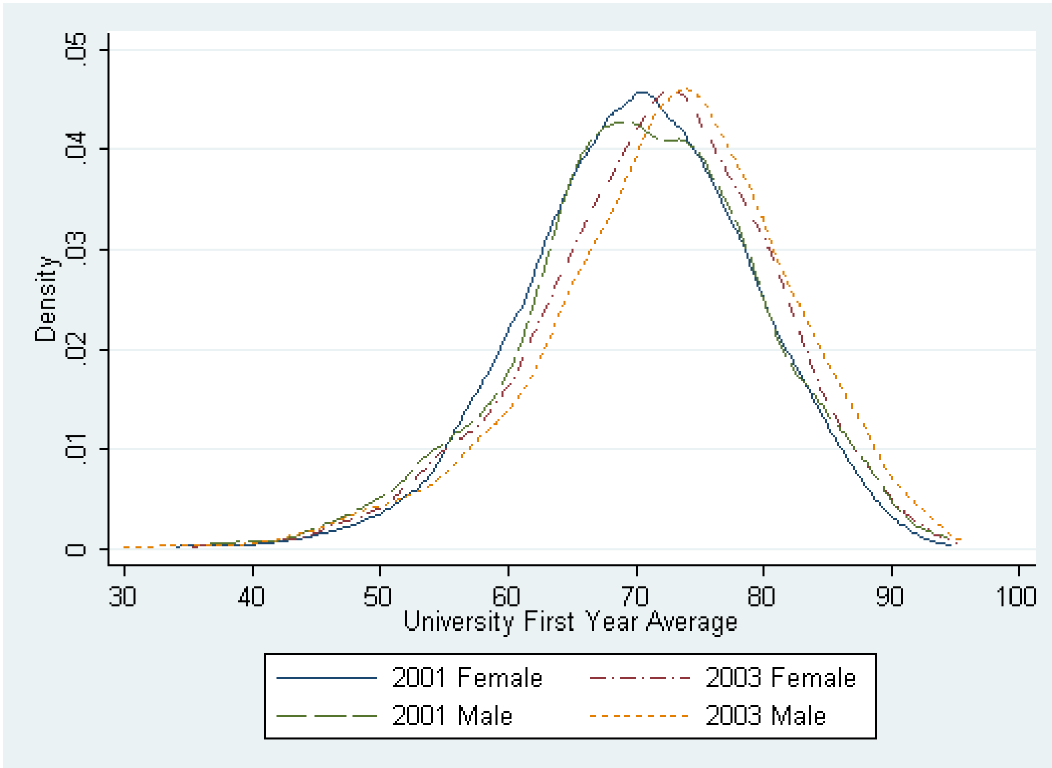

Figure 3: University Average Distribution

$\times$ DC' respectively. 'Male $\times$ DC' gives an estimate of the difference across genders in the effect of the increased competition (β).

Results under column (1) do not include any personal characteristics aside from student's high school average and gender, and assume that the link between high school averages and university grades is the same across programs. Results suggest that estimates of changes in the university grading policy slope and intercept coefficients have expected signs ($\rho > 0$ and $\pi < 0$) supporting the idea of increased competition in the classrooms in 2003. These results suggest that university grades did not fully adjust for the increased quality of students in their classrooms. This is not surprising if we think that many universities suggest implicitly (e.g. this university) or explicitly a bell-curve marking scheme.[18] The effect of the double cohort on university grades is statistically significant but economically modest. An 'average' 2003 female student – with an 88-percent high-school average – had a 1.55 percentage point (or 0.16 s.d.) disadvantage when compared to a similar student who entered in 2001.[19]

The estimate of the gender difference in performance due to the increased competition (1.09

[18] In "Academic Handbook: Course Information for Instructors" available on the University of Toronto Faculty of Arts and Science website (http://www.artsci.utoronto.ca) we can read that, although not required, experience suggests that there will normally be between 5% and 25% of A's, not over 75% of combined A's and B's, and not over 20% of combined E's and F's in large classes.

[19] $88 \times 0.101 - 10.438 = -1.55$. The null hypothesis $H_0 : \pi + 88\rho = 0$ is rejected at a 5 percent level. In order to convert the effect in terms of standard deviations, I use 9.48 as an estimate of the university average standard deviation as found in Table 1. $-1.55/9.48 = -0.164$.

Table 4: The Impact of the Double Cohort on the Gender Performance Gap

	G13 Students Only			G12 and G13 Students		
	(1)	(2)	(3)	(4)	(5)	(6)
HS Average	1.062	1.124	1.125	1.062	1.108	1.109
	(0.028)***	(0.029)***	(0.029)***	(0.028)***	(0.029)***	(0.029)***
Double Cohort	-10.438	-12.627	-12.478	-16.166	-18.043	-18.073
	(4.242)**	(4.280)***	(4.282)***	(3.501)***	(3.529)***	(3.528)***
Male	0.908	0.991	1.016	0.908	0.913	0.925
	(0.299)***	(0.303)***	(0.303)***	(0.299)***	(0.302)***	(0.302)***
HS Average × DC	0.101	0.123	0.122	0.166	0.186	0.184
	(0.048)**	(0.049)**	(0.049)**	(0.040)***	(0.040)***	(0.040)***
Male × DC	**1.086**	**1.079**	**1.060**	**1.093**	**1.111**	**1.109**
	(0.460)**	**(0.459)****	**(0.459)****	**(0.393)*****	**(0.392)*****	**(0.392)*****
Computer Science		0.040	-0.028		0.386	0.366
		(0.526)	(0.526)		(0.464)	(0.464)
Humanities		0.981	0.969		0.739	0.754
		(0.336)***	(0.336)***		(0.284)***	(0.284)***
Life Science		-0.950	-0.973		-0.679	-0.690
		(0.375)**	(0.375)***		(0.311)**	(0.311)**
Age			-0.818			-0.361
			(0.361)**			(0.194)*
Constant	-20.69	-26.20	-10.57	-20.69	-24.80	-17.97
	(2.45)***	(2.53)***	(7.29)	(2.45)***	(2.50)***	(4.43)***
Observations	4,318	4,318	4,318	6,020	6,020	6,020
R-squared	0.34	0.35	0.35	0.35	0.35	0.36

Dependent variable: 1^{st} Year University Average
Weighted standard errors in parentheses (based on the number of courses taken by students)
* significant at 10%; ** significant at 5%; *** significant at 1%

percentage points) is statistically significant at a 5 percent level but modest (0.11 s.d.). The effect on an average female is -1.55 while the effect on a male with a similar high school average is -0.46 (not statistically significant) suggesting that males have better coped with the increased competition than females, giving some support to the findings of Gneezy, Niederle and Rustichini (2003) and Gneezy and Rustichini (2004). Note that since the university seems to be grading on a bell-curve, it is impossible to measure the absolute change in performance due to competition as do Gneezy, Niederle and Rustichini (2003) and Gneezy and Rustichini (2004). Only a relative (female vs. male) change in performance can be measured.

Even though the effect of the double cohort is modest on an average female student, it varies significantly across the student population. Two female students, with high school averages one standard deviation (4.4 percentage points) below and above the 2003 mean high school average (88 percent) respectively would have had a 1.99 and 1.11 percentage point disadvantage from being part of the double cohort. Males with high school averages one standard deviation below the 'average' student would have suffered from a (statistically significant) 0.91 percentage point disadvantage from the increased competition.

High school average is a good indicator of students' university performance. A one-point difference in high school average is associated with a 1.06 point difference in university performance. Surprisingly, after controlling for student ability, males tend to do better in their first year in university than females. Anderson, Benjamin and Fuss (1994) found similar results when studying the determinants of success in university introductory economics at the University of Toronto. This finding could be explained if male students drop courses more easily than females, controlling for ability. I will discuss this issue in the next subsection.

Allowing for program-fixed effects and age control (columns (2) and (3)) does not alter the findings. Including program fixed-effects avoids having biased estimators due to changes in gender composition across programs between 2001 and 2003. We might expect such change in gender composition if some students reacted to the double cohort by choosing 'easier' programs than they would have in the absence increased competition. The coefficients of high-school average and 'Male $\times$ DC' are very stable across specifications. Marking schemes differ across programs. After controlling for high school average, the 'toughest' program would be Life Science while the 'easiest' would be Humanities and Social Sciences. Finally, the age effect is statistically significant but small and negative: when comparing the youngest and oldest student coming out of the G13 program, we expect the youngest student to have a 0.82 percentage point advantage over the oldest. Krashinsky (2006) and Morin (2007) also find similar negative age-effect when looking at university preparation of G12 and G13 students.

Columns (4) to (6) replicate the estimations done in columns (1) to (3) using the complete sample of Ontario students – including both G13 and G12 students. The inclusion of G12 students does not affect the estimated effect of increased competition on the gender difference in performance; it remains around 1.1 percentage points.

Since gender composition could have changed at the course level (even if it did not at the program level), I estimated similar regressions replacing student university average as dependent variable by individual course grades, and added course-fixed effects in some specifications to see whether the estimated effect of competition on female-male performance gap is affected by controlling for course selection. Results (not presented here) suggest that the inclusion of course fixed-effects does not affect the estimated impact of competition on the gender performance gap; it stays around 1.0 percentage point.[20]

7.2 Robustness Checks

Results presented so far suggest that male students better coped with the increased competition than females. These results do not take into account that the effect of the double cohort on the gender performance gap can vary across the student population, or that students are free to drop

[20] These results are available upon request.

out of courses (and programs). This section investigates for the possibility of heterogeneity in the effect of competition and for the presence of significant of self-selection problems.

7.2.1 Heterogeneity

The least-squares regressions capture the effect of increased competition on the *average* female-male performance difference. Although informative, it might also hide important heterogeneity in the impact of competition. The least-squares estimates could, for example, be driven by a specific group of students – such as male students in the upper tail of the performance distribution – that react more to competition than the rest of the student population. In this case, the increased competition would affect the shape of the performance distribution. In order to investigate this possibility, I estimated Specification (6) in Table 4 using a quantile regression methodology proposed by Firpo, Fortin and Lemieux (2009). This methodology allows one to estimate the impact of 'Male × DC' on the quantiles of the unconditional university performance distribution – shedding light on a possible increase in performance dispersion due to the increased competition.

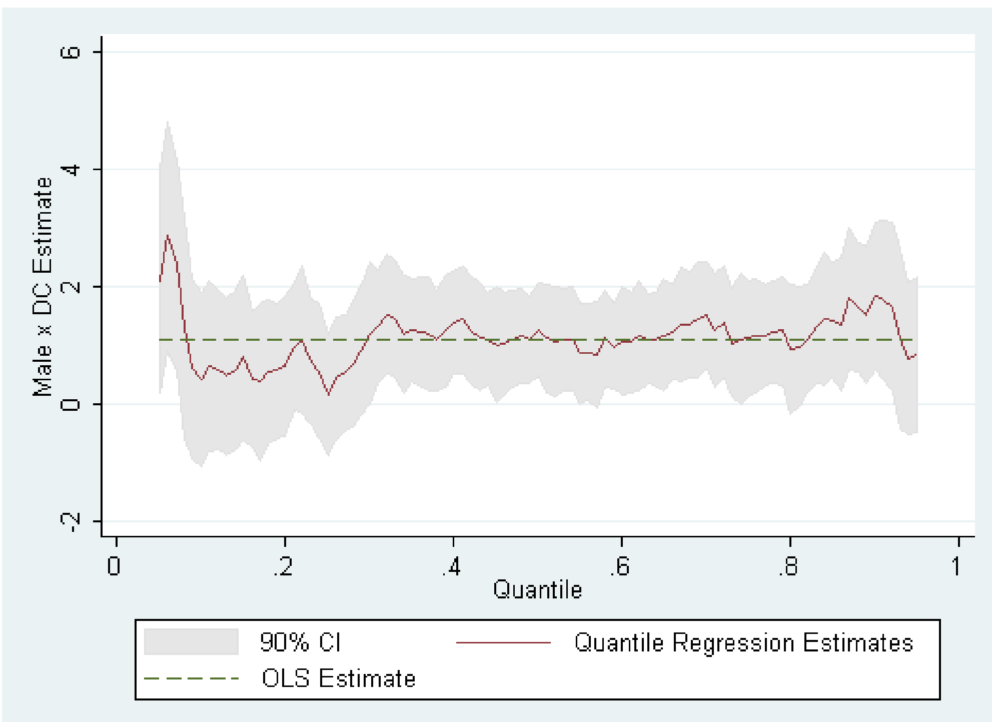

Figure 4: Quantile Regression Estimates

Figure 4 plots the quantile regression 'Male × DC' estimates for the 5th to the 95th quantiles and its 90 percent confidence interval band.[21] The effect of competition on the gender performance difference seems stable over the performance distribution as the least-squares point estimate is not only covered by most of the quantile regression band, but the quantile regression point estimates

[21]The 90 percent confidence band is based on bootstrapped standard errors.

are usually very close to the least-squares estimate. The quantile estimates seem to increase slightly close to the tails of the distribution. Unfortunately, this is is also where these estimates become fairly imprecise. What is clear from the quantile regression results above is that estimates of the gender performance difference effect found in Table 4 are not driven by a particular group of students (e.g. better than average students, or worse than average students).

7.2.2 Dropouts

If there are important gender differences when it comes to dropping a course, then the estimates presented above may over- or under-estimate the full impact of the increased competition on university performance. If 2003 male students dropped out of courses in a disproportionate way, then the findings presented in Section 7 could be entirely due to selection. In order to investigate this issue, I looked at individual courses, and constructed a dummy variable equal to 1 if a course was dropped and 0 otherwise. I then estimated a linear probability model – using the same six specifications used to estimate the effect of competition on grades – to test whether female and male dropping out decisions were affected differently by the increased competition.[22]

Table 5 shows that males did not drop out more than females when facing increased competition supporting the idea that the gender differences found above are not due to omitting students who failed to complete courses. The double cohort did increase the percentage of courses being dropped, all else equal. The estimated increase in dropout rates for an 'average' female student is between 0.9 and 1.8 percentage points. This is significant since dropped-out courses only represent about 8 percent of observed course outcomes in the sample. Finally, once controlling for enrolled programs, males do not seem to drop out more easily than females, and hence cannot explain the positive and significant estimates for "Male" found in Table 4. Overall, results from Table 5 do not suggest that results presented in Table 4 are due to gender differences in the dropping out decision process.

7.2.3 Participation

The experimental economics literature not only suggests that males perform better in competition than females, but also that females might shy away from it (e.g. Niederle and Vesterlund (2007)). If a large number of females avoided the double cohort (by delaying university application by a year for example), and these students would have been more likely to be adversely affected by the increased competition, then estimates presented in Table 4 might underestimate the impact of competition on gender performance gap. Table 6 presents numbers on the proportion of female students by status (i.e. applied, accepted, enrolled) and by year. For each student status, the proportion of female students did not drop between 2001 and 2003. Higher high school averages explain the significant increase in the female proportion of accepted students. These results are not sensitive to the inclusion or exclusion of G12 students. The cost of delaying university enrolment by a year might be large compared to the cost of entering a more competitive environment which could

[22] Probit estimation gives almost identical results.

Table 5: Competition and Dropped Courses

	G13 Students Only			G12 and G13 Students		
	(1)	(2)	(3)	(4)	(5)	(6)
HS Average	-0.008	-0.008	-0.008	-0.008	-0.008	-0.008
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Double Cohort	0.208	0.204	0.199	0.068	0.047	0.046
	(0.077)***	(0.078)***	(0.078)**	(0.063)	(0.063)	(0.063)
Male	0.005	-0.001	-0.001	0.005	-0.001	-0.001
	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)
HS Average × DC	-0.002	-0.002	-0.002	-0.001	0.000	0.000
	(0.001)**	(0.001)**	(0.001)**	(0.001)	(0.001)	(0.001)
Male × DC	**-0.000**	**0.002**	**0.003**	**-0.004**	**-0.002**	**-0.002**
	(0.008)	**(0.008)**	**(0.008)**	**(0.007)**	**(0.007)**	**(0.007)**
Computer Science		0.025	0.027		0.033	0.034
		(0.010)**	(0.010)***		(0.008)***	(0.008)***
Humanities		-0.008	-0.007		0.002	0.001
		(0.007)	(0.007)		(0.005)	(0.005)
Life Science		-0.006	-0.006		-0.003	-0.003
		(0.007)	(0.007)		(0.005)	(0.005)
Age			0.022			0.016
			(0.007)***			(0.003)***
Constant	0.764	0.763	0.340	0.764	0.744	0.437
	(0.046)***	(0.048)***	(0.139)**	(0.046)***	(0.047)***	(0.079)***
Observations	19,988	19,988	19,988	27,851	27,851	27,851
R-squared	0.02	0.02	0.02	0.01	0.02	0.02

Dependent variable: *Drop* = 1 if course was dropped; 0 otherwise.
Robust standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

explain why we do not see changes in the female proportions of applicants and enrolled students between 2001 and 2003.[23]

Table 6: Female Participation by Student Status and Year

Student Status	Number of Students		Female Proportion		Difference in Proportions
	2001	2003	2001	2003	$\%_{2003}$ - $\%_{2001}$
Applied	13,863	22,819	0.569	0.575	0.005
Accepted	8,700	13,219	0.585	0.603	0.018**
Enrolled	3,577	4,598	0.606	0.611	0.005

* significant at 10%; ** significant at 5%; *** significant at 1%.

[23] Demography could explain the change in the proportion in female applicants between 2001 and 2003 (48.5 percent of births in Ontario were females in 1982 while they were 48.6 and 48.8 percent in 1984 and 1985 respectively).

7.2.4 Pre-University Competition

Results presented so far assume that a student high school grade is a good indicator of academic ability. Since students knew (since 1997) that university admission would be more competitive in 2003 than in previous years, it is possible that they reacted by studying more in high school. The competition level would therefore increase not only in university, but also in high school. In this case, the link between academic ability and high school grade might have changed between 2001 and 2003 – representing a potential source a bias for the estimator. In order to have an idea of the sign of the potential bias, consider two possible scenarios.

First, assume that competition was intense at the high school level which stimulated males more than females – as suggested by the experimental economics literature – resulting in males outperforming females with similar academic ability. Consequently, 2003 male academic ability *could* be overestimated by their high school average which would then translate into underestimating the impact of increased competition on the gender university-performance gap. This situation should not be a major concern since I already find a positive effect, and it would only make it larger.

Another scenario would be that females were actually more stimulated by the increased high school competition than males.[24] In this case, it is possible that the 2003 high school average overestimates females' ability which could result in overestimating the impact of increased competition on the gender university-performance gap.

I used out-of-province students to investigate these two possibilities. I re-estimated the six specifications of Table 4 including out-of-province students. I added a set of controls (e.g. a dummy for out-of-province students (OUT), and a set of interaction terms (OUT $\times$ H, OUT $\times$ DC, and OUT $\times$ Male $\times$ DC)) allowing female and male Ontario high school average to measure ability differently in 2003. Regression results (not presented here) do not support the possible scenarios presented above. The coefficient estimates of 'Male $\times$ DC' are very similar to the ones obtained in Table 4, fluctuating between 1.07 and 1.12.[25] By and large, these results do not suggest that the estimator of the change in gender performance gap is severely biased by a potential increase in pre-university competition.

7.3 After the First Year

Results from Table 4 suggest that the increased competition following the Ontario double cohort had different effects on male and female first-year university performance. I now show that the double cohort affected the gender performance gap during most of these students' undergraduate years. Table 7 presents estimates of the competition effect on the gender performance gap for students' first (Year 1) to fourth year (Year 4) in university. Estimates next to 'Year 1' are taken

[24] Although unlikely given the results presented above, it would be possible in principle that females were more stimulated by competition in both high school and university. For that to be true and to find a positive coefficient to 'Male $\times$ DC' – as I do – females' high school performance would have to have improved significantly more than their university performance. The 2003 female high school average would have to severely underestimate ability.

[25] These results are available upon request.

Table 7: Evolution of the Impact of the Increased Competition on the Gender Performance Gap

	G13 Students Only			G12 and G13 Students		
	(1)	(2)	(3)	(4)	(5)	(6)
Year 1	1.086	1.079	1.060	1.093	1.111	1.109
	(0.460)**	(0.459)**	(0.459)**	(0.393)***	(0.392)***	(0.392)***
Observations	4,318	4,318	4,318	6,020	6,020	6,020
Year 2	1.170	1.127	1.089	1.110	1.069	1.076
	(0.477)**	(0.474)**	(0.473)**	(0.413)***	(0.411)***	(0.411)***
Observations	3,915	3,915	3,915	5,467	5,467	5,467
Year 3	0.675	0.598	0.575	0.852	0.724	0.730
	(0.485)	(0.483)	(0.482)	(0.442)*	(0.441)	(0.441)*
Observations	3,409	3,409	3,409	4,840	4,840	4,840
Year 4	1.266	1.135	1.128	0.962	0.804	0.811
	(0.485)***	(0.485)***	(0.484)**	(0.415)**	(0.416)*	(0.415)*
Observations	3,173	3,173	3,173	4,502	4,502	4,502

Weighted standard errors in parentheses.
Dependent variable: Annual University Average (e.g. for Year 2: Second Year Average).
* significant at 10%; ** significant at 5%; *** significant at 1%.

from Table 4. The estimation strategy is exactly the same as the one used above, except that the dependent variables are students' upper years averages. Aside from a small drop for students' third year, the effect of the increased competition is surprisingly stable across years. The estimated coefficients using students's fourth year averages vary between 0.8 and 1.3, being very close to the ones obtained using students' first year averages. Despite being of modest size initially, the competition effect could accumulate and affect attrition rates and on-time graduation rates.

7.3.1 Attrition

From year-to-year, the sample size of observed students decreases as can be seen in Table 7. Some students will change program, change university, or simply quit school. If males and females differ in the way they decide to stay in school (or in the Faculty), estimates found in Table 7 could misrepresent the evolution of the competition effect. In particular, if females were forced to change faculty or quit school due to a bad performance in their first year, then results from Table 7 might be underestimating the effect of competition on the gender performance gap. Table 8 investigates this possibility. Using a similar estimation strategy as above, I regress (using a linear probability model) a dummy variable equal to 1 if the student dropped out of the sample after one, two, or three years respectively. 18 estimates of the 'Male $\times$ DC' parameter are presented in Table 8. All estimates are relatively small, and statistically insignificant – suggesting that dropouts are not driving the results in Table 7, but also that the increased competition effect was not strong enough to significantly affect gender differences in attrition rates. While not strong enough to affect important decisions like dropping out of university, the competition effect might have been strong enough to slow down students and affect the probability that they graduate on time.

Table 8: Effect of Competition on Attrition Rates

	G13 Students Only			G12 and G13 Students		
	(1)	(2)	(3)	(4)	(5)	(6)
After 1 Year	-0.018	-0.016	-0.016	-0.009	-0.007	-0.007
	(0.018)	(0.018)	(0.018)	(0.016)	(0.016)	(0.016)
After 2 Years	-0.019	-0.020	-0.019	-0.007	-0.005	-0.005
	(0.025)	(0.025)	(0.025)	(0.021)	(0.022)	(0.022)
After 3 Years	-0.001	0.003	0.004	0.009	0.016	0.016
	(0.028)	(0.028)	(0.028)	(0.024)	(0.024)	(0.024)
Observations	4,318	4,318	4,318	6,020	6,020	6,020

Robust standard errors in parentheses.
Dependent variable: $Quit = 1$ if student dropped from sample; 0 otherwise.
* significant at 10%; ** significant at 5%; *** significant at 1%.

7.3.2 Graduation

One final aspect of the academic performance that I look at is on-time graduation. As the effect of increased competition are long-lasting, it could affect the probability that a student graduates on time (i.e. during the summer following her fourth year). In Table 9, I present results from regressing an "on-time-graduation" dummy variable on similar control variables used in the previous regressions.[26] The "on-time-graduation" variable is equal to 1 if the student has graduated from university by July 1st of her fourth year. Estimates of the double cohort effect on the gender difference in the probability of graduating on time are statistically significant and large. They range from 6.2 to 8.0 percentage points. To put the size of the estimates in perspective, about 40 percent of students observed in Table 4 graduated on time. Prior to the double cohort, male students were less likely to graduate on time than females – the difference being around 6 to 8 percentage points. This difference completely vanished for double-cohort students.[27] Note that the effect of the double cohort is not statistically significant based on the 'Double Cohort' and 'HS Average × DC' coefficient estimates. Once I drop the 'HS Average × DC' variable from the regression the 'Double Cohort' coefficient estimate changes to around -0.1 and becomes significant at 1% percent. The 'Male × DC' coefficient estimate remains unchanged at around 0.07.[28]

The estimates presented here must be interpreted with caution. As the abolition of Grade 13 affected university admission standards in 2003, so could it affect the admission standards for graduate school in 2007. Hence, while part of the effect estimated here can be due to performance, it is also possible that these estimates are capturing the effect of a strategic behavior. Some students may have been tempted to delay graduate school application by a year. As mention earlier, females may not 'embrace' competition as much as males. If graduate-school bound female students delayed more than males, part of the competition effect presented above would be due to

[26] Presented results are from a linear probability model. Probit results are very similar.

[27] The null hypothesis $H_0 : \delta + \beta = 0$ (the coefficients of 'Male' and 'Male × DC') is not rejected at conventional confidence levels in any of the six regressions.

[28] These results are not presented here but are available upon request.

Table 9: Effect of Competition on On-Time Graduation Rates

	G13 Students Only			G12 and G13 Students		
	(1)	(2)	(3)	(4)	(5)	(6)
HS Average	0.023	0.026	0.026	0.023	0.026	0.026
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
Double Cohort	-0.478	-0.330	-0.324	-0.529	-0.320	-0.322
	(0.265)*	(0.266)	(0.266)	(0.223)**	(0.225)	(0.224)
Male	-0.086	-0.065	-0.064	-0.086	-0.065	-0.064
	(0.019)***	(0.020)***	(0.020)***	(0.019)***	(0.020)***	(0.020)***
HS Average × DC	0.004	0.003	0.002	0.005	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.003)*	(0.003)	(0.003)
Male × DC	**0.080**	**0.069**	**0.068**	**0.073**	**0.062**	**0.062**
	(0.030)* **	**(0.030)** **	**(0.030)** **	**(0.025)*** **	**(0.025)** **	**(0.025)** **
Computer Science		-0.239	-0.242		-0.276	-0.277
		(0.030)***	(0.030)***		(0.026)***	(0.026)***
Humanities		-0.089	-0.090		-0.130	-0.129
		(0.024)***	(0.024)***		(0.021)***	(0.021)***
Life Science		-0.149	-0.150		-0.166	-0.167
		(0.026)***	(0.026)***		(0.022)***	(0.022)***
Age			-0.032			-0.031
			(0.024)			(0.013)**
Constant	-1.571	-1.707	-1.101	-1.571	-1.631	-1.047
	(0.165)***	(0.173)***	(0.485)**	(0.165)***	(0.171)***	(0.295)***
Observations	4,318	4,318	4,318	6,020	6,020	6,020
R-squared	0.06	0.08	0.08	0.07	0.08	0.08

Robust standard errors in parentheses.
Dependent variable: *Grad-on-time* = 1 if student graduated by July 1st ; 0 otherwise.
* significant at 10%; ** significant at 5%; *** significant at 1%.

this behavior. Note that this behavior is not likely to explain all of the effect since only a fraction of undergraduate students will apply to graduate school. In order to have an idea of how much of the estimates found above can be due to a strategic behavior, I estimated similar regressions as those presented in Table 9 excluding students with high school average above 87 percent to concentrate on students who are less likely to apply to graduate school. The 'Male × DC' coefficient estimates are actually larger for 'lower-ability' students, suggesting that the results presented in Table 9 are not due to the strategic behavior.[29] Interestingly, changes in unconditional on-time graduation proportions between 2001 and 2003 for females and males show that males' on-time graduation rate increased significantly (from 33.7 to 38.1 percent) while females' decreased slightly (43.8 to 41.4 percent). While comparison of changes in unconditional on-time graduation rates suggest that males' performance increased while females' did not change, comparison of changes in conditional graduation rates (results from Table 9) suggest that females' graduation rate was significantly (negatively) affected by the increased competition while males' was not. Overall, results from

[29]Detailed results for higher- and lower-ability students are available upon request.

Table 9 suggest a clear difference in the reaction to increased competition by females and males, and that results from Table 7 are certainly not due to male students taking more time to graduate.

8 Conclusion

In this paper, I investigate the external validity of recent findings from the experimental economics literature. In particular, I look at the possibility that females perform worse than males in a competitive environment. The 1997 Ontario Secondary School reform allows me to observe the effect of an exogenous increase in the level of competition in university classrooms on gender differences in academic performance. Hence, this reform allows me to verify whether the findings from the experimental economics literature can be replicated for a natural and long-lasting task: classroom performance. Results from this paper confirm the presence of gender differences in performance under increased competition previously found in lab and field experiments by Gneezy, Niederle and Rustichini (2003) and Gneezy and Rustichini (2004). While modest in size, the effect is persistent and not likely to be due to self-selection. Furthermore, the increased competition had a large positive impact on males' on-time graduation rates.

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