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ABSTRACT

Breadth of University Curriculum and Labor Market Outcomes

We explore whether the choice of broad versus specialized university curricula affects subsequent labor market outcomes, as measured by earnings, full-time permanent employment, and unemployment six months after university graduation. We exploit a unique episode in the history of the National University of Singapore, in which a university-wide revision in graduation requirements in 2007 prompted students in one of the largest faculties to read a narrower, more specialized, curriculum. Using a difference-in-differences strategy, we compare changes in the labor market outcomes of graduate cohorts from the affected faculty, before-and-after the curriculum revision, to changes in the labor market outcomes of graduate cohorts from the other faculties. We do not find evidence that curriculum breadth matters for these labor market outcomes. Similar conclusions are obtained using regression-control strategies and rich administrative data on student characteristics and academic ability for the broader population of undergraduates at NUS.

JEL Classification: I21, J31

Keywords: university curriculum, curriculum breadth, difference-in-differences, earnings, employment

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"A broad-based curriculum is very critical to help you adapt to the economy of the future. Many employers are attracted to graduates with a broad-based education because they will have knowledge and skills in multiple fields that can be applied to the workplace"

~ Linette Lim, Director of Admissions Strategy and Outreach, Singapore Management University[1]

1. Introduction

It is not uncommon to hear official claims that reading a broader curriculum will help to improve a person's position in the labor market. The above quote by a senior representative of one of the largest public universities in Singapore, exemplifies this point. Several other universities have made similar assertions. One university declares on its website that "we are moving away from the rigid curriculum structure to a flexible, broad-based curriculum in order *to develop high quality and resilient graduates*"[2] while another asserts "…we need well-rounded graduates in all fields *if we are to create a prosperous, healthy state and a vibrant society*. That's why it's crucial that we provide our students a broad-based education that prepares them for successful careers…".[3] Such statements indicate that senior university administrators believe that reading a broader curriculum is helpful in the labor market.

Despite the boldness of these assertions, the academic literature has been largely silent about their validity. While a number of studies have attempted to estimate the relationship between breadth of curriculum and individuals' subsequent labor market performance, these have hitherto focused on curriculums read at the secondary school level (Dolton and Vignoles, 2002; Johnes, 2005; Oosterbeek and Webbink, 2007; Malamud and Pop-Eleches, 2010; Malamud, 2012; Hall, 2012, 2016). The majority of these studies do not find much evidence that the breadth of the curriculum taken in secondary school matters for individuals' subsequent labor market outcomes, whether these outcomes are measured by earnings (Dolton and Vignoles, 2002; Johnes, 2005; Oosterbeek and Webbink, 2007; Malamud and Pop-Eleches, 2010; Hall, 2012), employment (Hall, 2016), or labor market participation (Malamud and Pop-Eleches, 2010).[4]

To our knowledge, much less research exists on the labor market impacts of curriculum breadth at the tertiary level. Yet, for tertiary-educated workers, there is reason to expect that

[1] Quote obtained through the Singapore Management University's admissions webpage. Available online from: https://admissions.smu.edu.sg/blog/future-multidisciplinary-what-consider-when-choosing-your-degree.
[2] Available online from: https://www.taylors.edu.my/taylors-university-launches-curriculum-framework.html.
[3] Available online from: https://chancellor.ku.edu/messages/2013/nov25.
[4] A notable exception is Malamud (2012), who finds that reading a broader curriculum in the General Certificate of Education A levels reduces the risk of unemployment. His analysis includes two different measures of curriculum breadth: (i) the range of subjects taken by a person in the A levels and (ii) whether a person took general studies – an A level subject meant to impart general skills. Using data on college-bound students from high schools in England and exploiting variation in curriculum breadth between schools and across cohorts within schools, he finds that reading a broader range of courses in the A levels is associated with a lower probability of being unemployed six months after leaving university. Reading the general studies subject, however, does not seem to affect a person's probability of being unemployed. These findings suggest that while taking a course meant to impart general skills does not help, studying a broader range of subjects can help to insure recent graduates against negative labor market shocks.

the effect of curriculum breadth read at the secondary school level may be different from that read at the tertiary level. This may be the case if the skills and knowledge acquired in higher education and in secondary school are valued differently in the labor market or if employers place greater emphasis on more recent qualifications when making hiring and promotion decisions. Consequently, the findings from studies focusing on the secondary school context may not generalize well to higher education. The purpose of this paper is therefore to fill the gap in the literature by exploring whether the breadth of courses taken in university matters for one's future labor market outcomes. Specifically, we seek to address the question, "What are the labor market returns to taking a broader curriculum in university?".

Why might school curricula matter for people's subsequent labor market outcomes? A short answer is that they are one of the key inputs in the production of education. By shaping what individuals are exposed to, they influence the type and quantity of skills and knowledge students acquire. To the extent that skills and knowledge acquired in school affects a person's subsequent labor market productivity (Becker, 1962, 1964), curriculums could therefore matter. While a narrower curriculum may provide students with more in-depth training and knowledge in a specific area, a broader curriculum potentially exposes students to training and knowledge in a greater variety of areas, but may do so at the expense of reduced specialization. Contrary to the above arguments put forth by universities, it is not clear that reading a broader curriculum will necessarily provide graduates with an edge in the labor market. Though it might help graduates acquire greater diversity in skills and knowledge of value in the labor market, increase the range of job options open to graduates[5], and provide individuals with more time to gather information about their abilities and preferences before settling on a particular specialization in school[6], it might not prepare them sufficiently to meet the needs of specific jobs, especially if these jobs require in-depth specialized knowledge in specific areas (Silos and Smith, 2015).[7]

[5] A recent study by Herz (2019) shows that the specificity of human capital can have implications for unemployment. He shows that the greater the occupation-specific human capital a worker invests in, the higher the wage loss faced by the worker when switching occupations upon displacement. Consequently, the larger the investment made by a worker in acquiring occupation-specific human capital, the greater the incentive to wait through a spell of unemployment, rather than seek employment in an unrelated occupation, when the worker is displaced. This suggests that curriculum breadth may have implications for the likelihood and duration of unemployment. Individuals who have invested in a narrower curriculum, tailored to a specific occupation, may have more incentive to wait out for a related job. The likelihood and duration of unemployment may thus be higher for these individuals.

[6] Many studies have considered how the acquisition of information about students' abilities, preferences, and aptitudes for different fields of study informs their choices of major (Arcidiacono, 2004; Malamud, 2010, 2011; Bordon and Fu, 2015; Kinsler and Pavan, 2015; Fricke et al., 2018) and whether to complete school (Altonji, 1993; Arcidiacono, 2004; Stange, 2012; Stinebrickner and Stinebrickner, 2014), when students face uncertainty about the quality of matches in their underlying skills to different fields of study. There is some evidence that the informational content on abilities provided through academic grades varies by field of study, with grades in some fields providing more information than others (Thomas, 2019). A broader curriculum, which provides students with more time to gather information about their abilities and preferences before settling on a particular specialization may lessen mismatch problems and lead to higher college retention rates and welfare gains (Bordon and Fu, 2015). To the extent that match quality is improved, a broader curriculum can also reduce the likelihood that individuals will select occupations unrelated to their fields of study, on entering the labor market, and hence affect earnings (Malamud, 2010, 2011).

[7] In addition, the type of peers to which students are exposed may differ depending on curriculum breadth (Bordon and Fu, 2015). Under a system in which students must take a narrower portfolio of courses from within one's major, there is greater likelihood of exposure to peers from the same major – and therefore exposure to

The few existing studies which investigate the labor market impacts of curriculum breadth at the post-secondary school level include Silos and Smith (2015), Lazear (2005), and Malamud (2010, 2011). Silos and Smith (2015) consider the choice of the optimal mix of skills acquired through postsecondary education, when there is uncertainty about how different occupations fit individuals, and the implications that this choice has for earning dynamics. They find that while acquiring a broad set of skills generates higher income for people who switch occupations, acquiring a specialized set of skills benefits those who stick with one type of job. Lazear (2005) builds a model of the choice to become an entrepreneur and shows that students who study a more varied curriculum are more likely to become entrepreneurs. Malamud (2010) and Malamud (2011) examine the labor market implications of early versus late specialization in higher education by comparing across the English and Scottish undergraduate systems in the United Kingdom. Because late specialization reduces the opportunity for students to acquire field-specific skills, these studies essentially compare between specialized (early specialization) and broad (late specialization) curricula. Malamud (2010) finds that average earnings do not differ significantly across the two systems while Malamud (2011) finds that individuals who specialize early are more likely to switch to an occupation unrelated to their field of study. While these findings are informative, and suggest that the benefits from better matches to fields of study arising from later specialization are sufficiently large to outweigh the costs from the loss of specialized skills, it is hard to draw causal conclusions from them given that students in the English and Scottish systems may differ in unobservable ways.

Our analysis is based on rich administrative data, collected from several cohorts of undergraduates from the National University of Singapore (NUS), Singapore's largest public university. These data include detailed information on each student's background characteristics, university transcript, including the list of courses taken and the grades received, and responses to an employment survey conducted by the university which provides each student's gross monthly earnings and labor force status six months after graduation. We exploit a unique episode in the history of the university, in which a revision of graduation requirements in 2007 prompted one of the largest faculties to increase major requirements, which raised the share of modules students need to take in their area of specialization, compelling them to read a narrower, more specialized, curriculum. On the other hand, other faculties increased the number of electives students can take outside their major, thereby allowing students greater flexibility to read a broader, less specialized, curriculum.

Simple bivariate regressions show a negative relationship between curriculum breadth and labor market outcomes, with a 0.17% decrease in monthly earnings with every 1 percentage point increase in the share of modules read outside one's major. However, the effects are weaker after controlling for student socio-demographic characteristics, entry route and pre-university academic achievement. In fact, after controlling for differences in university academic achievement, including class of honors and cumulative average point (CAP), we find that curriculum breadth has little association with labor market outcomes six months after leaving university. Our results suggest that, at least at this early-career stage, while employers

peers with similar comparative advantages. On the other hand, under a system in which students take a broader set of courses, the composition of peers to which a student is exposed is likely to be more diverse.

place weight on academic performance, little additional consideration is given to course diversity.

Next, using the exogenous change in curriculum structure across faculties and over time, we obtain difference-in-differences results for the impact of curriculum breadth on labor market outcomes. Specifically, we compare the change in labor market outcomes across cohorts from faculties which compelled their students to read a narrower curriculum against the change across cohorts from faculties which offered their students more flexibility to read a broader curriculum, before-and-after the imposition of these curricular revisions. Our results suggest that the curricular revisions led to a decline in curriculum breadth by around 10% among affected students in the first set of faculties, but no significant change among students in the second set of faculties. We estimate that the former group saw a 0.8% decline in entry earnings, 0.7 percentage points decline in probability of full-time employment and 1.15 percentage points increase in probability of unemployment, but that none of these effects are statistically significant at the 10% level. We conclude that the impact of taking a more diverse curriculum is generally weak, consistent with our multivariate analysis.

Our study offers several contributions to the breadth-of-study literature. First, it examines the causal returns to curriculum breadth at the university level, an area of inquiry which has hitherto been understudied. Second, unlike most previous studies, we have rich background information on students, including their socio-demographic, pre-university, and university-level characteristics, as well as measures of academic ability in university and prior to university, allowing us to control extensively for an array of student characteristics which are likely correlated with curriculum breadth and labor market performance. Finally, we exploit the unique policy change at NUS, which produced plausibly exogenous variation in curriculum breadth to identify the impact of reading a broader curriculum, and in so doing, address concerns over the endogeneity in curriculum breadth.[8]

The structure of the rest of the paper is as follows. Section 2 provides information on institutional background while Section 3 presents the data sources and summary statistics. Section 4 describes our empirical methodology. Section 5 shows the results. Section 6 summarizes and concludes.

2. Institutional Background

[8] All studies that examine the impact of curriculum breadth share a common challenge. Specifically, curriculum breadth is not randomly assigned to students but rather involves a choice. Because students who take a broader curriculum are likely to differ in many ways from students who take a narrower curriculum, including unobserved characteristics and preferences, simple comparisons of individuals who take a broader and a narrower curriculum cannot be relied on to provide good estimates of the causal effect of curriculum breadth, even if observable characteristics are controlled for. Existing studies have tried to address the possible endogeneity in curriculum breadth to varying degrees of success. While some have exploited policy changes that plausibly give rise to exogenous changes in curriculum breadth (see, for example, Oosterbeek and Webbink, 2007; Malamud and Pop-Eleches, 2010; and Hall, 2012, 2016), others have used only OLS with control variables (see, for instance, Dolton and Vignoles, 2002 and Johnes, 2005). Given that the latter group of studies are unable to control for differences in unobservable individual traits, and typically do not contain rich observable controls, it is unclear how reliable the estimates from those studies are.

The analysis in this paper uses data on undergraduate students admitted between 2003 and 2010 to the National University of Singapore (NUS), a large public university in Singapore.

During these years, NUS comprised 12 different faculties for undergraduate study, with the largest being the faculties of Arts and Social Sciences (FASS), Engineering (FoE), Science (FoS), Business (BIZ), and Computing (SoC). Together, these 5 faculties accounted for more than 80% of the undergraduate enrollment.[9]

Admission to NUS works through a general applications process, where the first stage involves students selecting and ranking their faculty choices in order of preference. Following this, students are offered admission to their most preferred faculty (and course, for some faculties) that they qualify for, based on the cut-off points for each faculty/course.[10] If successful in their application to NUS, a student would receive an offer of admission to a single faculty from her list of choices. By and large, most students remain in their offered faculty after enrollment and switching between faculties is rare. In the years considered, the percentage of students who switched between faculties after enrollment averaged at a low 1.5%.

NUS awards two types of undergraduate degrees. Each student graduates with either a three-year bachelor's degree without honors or a four-year degree with honors[11]. The "honors" degree is used as a signal to indicate that a student has read a larger volume of material than required for a three-year bachelor's program. Students must meet strict cumulative academic performance thresholds, evaluated at an advanced stage of their academic career (no earlier than the second year of study) to qualify for the honors track. Otherwise, they will graduate with a three-year bachelor's degree.[12] Roughly 60% of students graduate with an honors degree.

NUS follows a modular system where students have the flexibility to choose the modules they wish to read in order to fulfill their degree requirements. A Modular Credit (MC) is a unit of time and effort expected of a student: 1 MC corresponds to approximately 2.5 hours of study and preparation per week. Thus, a 4-MC module would require a student to commit to 10 hours of work a week, including lectures, tutorials, and self-study in the form of preparatory work and completing assignments. Over the course of their undergraduate career,

[9] Specifically, FASS, FoE, FoS, BIZ, and SoC accounted respectively for 23.9%, 22.0%, 20.0%, 9.7%, and 6.2% of the NUS undergraduate population.

[10] Each year, each faculty has a targeted number of students to admit and whether a student gets into her preferred faculty is based on academic merit, subject to meeting the admission scores required for entry into the faculty/academic program. These admission scores are set prior to the start of the admission exercise each year and are determined based on the targeted intake for each program and the expected demand from students. Students are not aware of these admission thresholds when they apply to NUS.

[11] The normal candidature period – that is, the normal duration that students are expected to take to complete a bachelor's and an honors degree – is three and four years respectively. However, in practice, some students do not complete their degrees in these time frames. A student may take longer than expected to complete the degree requirements if he/she takes time off from NUS due to medical, academic, or personal reasons. A student may take less time than expected to complete the requirements if he/she has received formal exemption from certain courses, having completed an identical/similar course prior to NUS admission.

[12] With some exceptions, students generally need to achieve a CAP of at least 3.5 (i.e. an average of B), evaluated at an advanced stage of their academic careers (no earlier than the second year), to qualify for the honors track. This CAP requirement is stringent and is only slightly below what a student at the 40th percentile in each cohort would achieve. Details of the computation of the CAP are provided in footnote 19.

students complete a pre-determined number of MCs: this is usually 120 MCs for the three-year (Bachelor's) degree and 160 MCs for the four-year (Honors) degree. These MCs are broadly divided into three categories: university-level requirements, program requirements, and unrestricted electives (UE).

University-level requirements consist of General Education Modules (GEM), Singapore Studies (SS) and breadth modules. A breadth module is any module which is not from a student's home faculty. In 2007, the university revised its university-level requirement for the honors degree so that students need only read 8 MC instead of 16 MC of modules to fulfill the breadth requirement. This revision occurred because the university wanted to align the university-level requirements for its honors (4 year) and non-honors (3 year) programs so that they would be identical. In response to this, there was some heterogeneity in how faculties allocated the additional 8 MC. While the Faculty of Arts and Social Sciences (FASS) increased their major requirement (thereby compelling students to read a greater share of modules in their major discipline), other faculties increased their UE requirement instead (so students were effectively allowed to choose whatever modules they wished to read to fulfill the additional 8 MC).[13] We exploit this exogenous change in course structure to investigate the impact of curriculum breadth on students' subsequent labor market outcomes. Appendix 1 provides more information on the various categories of requirements that students have to fulfill in order to graduate and describes how these requirements changed after 2007.

Appendix Table A2 shows the majors belonging to each of these 5 largest faculties in NUS. There were no majors added to or removed from each faculty around the reform period of 2007. There was also no reallocation of majors across the different faculties around this time.[14] By and large, majors within the same faculty share a similar set of graduation requirements and structure.[15] Hence, ordinarily, and in the absence of the 2007 reforms, much of the variation in curriculum breadth within faculties arises from the individual choices made by students. This makes the 2007 reform a particularly useful event for generating the exogenous variation in curriculum breadth required for causal identification.

[13] Major requirement for FASS increased by a total of 12 MC in 2007 (of which 8 MC came from the decrease in breadth requirement). Details concerning the changes in graduation requirements are provided in Appendix 1. Note that an increase in the unrestricted elective module requirement does not mean that students *have to* take more courses outside of their major. However, students have more flexibility to take courses outside of their major if they wish and hence have more flexibility to increase their curriculum breadth. This is in contrast to an increase in the major requirement, where students are *forced to* take more courses in their major discipline and are hence compelled to decrease their curriculum breadth.

[14] Because we rely on variation in curriculum breadth produced by the 2007 policy reform across faculties for identification, changes in student sorting across faculties around 2007 would be problematic. One potential channel through which such student sorting might occur is through movements in entire majors across faculties. The fact that no majors were added to, removed from, or moved across faculties around 2007 serves to lessen concerns regarding student sorting from this channel.

[15] With the exception of BIZ, and for FoE and FoS – students entering through the polytechnic route, where students choose their majors during the admissions process, students generally choose their majors only after enrollment. The exact timing of when students choose their major varies by faculty. With the exception of FASS and FoS where students can choose their majors freely, students in the other faculties have less freedom over major choice because each major typically has a limited number of seats. Where limited seats are available, allocation is either by academic performance (in the case of FOE and BIZ) or indicated ranking preference (in the case of SoC).

3. Data and Descriptive Statistics

The NUS administrative records include all undergraduates who were admitted to the university between 2003 and 2010. It contains information on each student's major and faculty as well as detailed transcript information listing the modules read by the student and the grades received. We restrict our analysis to undergraduates from the following 5 faculties: FASS, BIZ, SoC, FoE, and FoS, because undergraduates from these faculties were bounded by more comparable curricular guidelines.[16]

The dataset provides a rich set of variables on each student, including socio-demographic characteristics (sex, race, month and year of birth, residency status), pre-university characteristics (entry route into university[17], including junior college, polytechnic, international baccalaureate, or other qualifications; undergraduate admission score (UAS), measuring academic performance prior to university admission[18]), and university-level characteristics (year of admission and completion; number of years spent studying in the university; number of modules read in the university; student CAP[19]; and whether the student received an honors degree[20]). We also use the transcript data to construct three measures of curriculum breadth, specifically: (1) the share of modules taken outside a student's major, (2) the share of modules taken outside a student's major but within the student's faculty, and (3) the share of modules taken outside both a student's major and faculty.

Finally, we link each student to his/her subsequent labor market outcomes by matching the university records to their responses to the university's graduate employment survey (GES), which is conducted every November to collect information on the employment statuses and performance of fresh graduates. The survey is deliberately timed so that recent graduates are asked the questions six months after they have completed their final examinations. It collects information on each graduate's labor market status and gross monthly salary. We use the labor market status information to construct two measures of employment. The first measure is

[16] Students from other faculties, such as dentistry, medicine, and law, were excluded because of the specialized nature of these disciplines. Students from these faculties read a curriculum which is more prescribed and different in structure from the one shown in Appendix Table A1.

[17] The three routes to university admission – namely polytechnic, junior college, and international baccalaureate – are quite different. Polytechnic education is more applied and practice-oriented in nature and aims to equip students with industry-relevant skills. Junior college education, in contrast, is more academically-oriented and leads to the GCE A levels exams. The vast majority of students entering NUS come either through the junior college or polytechnic routes. There is also a very small minority (less than 1%) that enters NUS through the international baccalaureate route, which is more similar to the junior college route.

[18] These measure a student's academic performance in either the Singapore-Cambridge GCE A-Level examinations, polytechnic examinations, international baccalaureate examinations, or some other entry examination. These admissions scores are standardized within application year and entry route to take into account the fact that admission decisions are based on application year and entry route.

[19] Academic performance in the university is measured by the cumulative average point (CAP). This is a weighted average grade point of all modules taken by a student. The CAP is computed as follows: $CAP = \frac{sum(module\ grade\ point \times modular\ credits\ assigned\ to\ module)}{sum(modular\ credits\ assigned\ to\ all\ modules\ used\ in\ calculating\ the\ numerator)}$. The maximum CAP achievable is 5.0.

[20] Students need to fulfill the requirements described in Appendix Table A1 to receive an honors degree. The requirements to achieve an honors degree are markedly higher than those of a non-honors degree.

whether a person is working in full-time permanent employment,[21] and is missing for persons not in the labor force.[22] The second measure is whether a person is unemployed, defined as not working and actively looking for a job and is missing for persons not in the labor force. Gross monthly salary is reported in the survey if a person is in full-time permanent employment.[23] We adjust all salaries to real terms by dividing them by the annual consumer price index.[24] The response rates obtained for the GES are high and stable each year, averaging 60.7% across the survey years.

3.1 Descriptive Statistics

The sample we use for our main analysis to estimate the causal effect of curriculum breadth on subsequent labor market outcomes is restricted to undergraduates who were enrolled in single degree programs.[25] Panel A of Table 1 presents the descriptive statistics for this sample.

Because a number of key control variables, including UAS, entry route into the university, and the number of years enrolled in the university, were missing for students admitted in 2003 and 2004, we drop students from these two cohorts when running multivariate regressions to preliminarily evaluate the relationship between curriculum breadth and labor market outcomes. Panel B of Table 1 presents the descriptive statistics for this sub-sample.

<Insert Table 1 here>

Although the majority of graduates provided responses to the earnings and labor force status questions, the fact that not all of them responded may raise concerns over sample selection. Therefore, we tested to see whether the average characteristics of graduates who

[21] Individuals may fall into 1 of 6 categories with regard to labor market status: working in full-time permanent employment, working in full-time temporary employment, working in part-time employment, not currently working but have either accepted a job or in the process of starting a business and will therefore commence work soon, not working and actively looking for a job, or not working and not looking for a job. Full-time permanent employment refers to employment of at least 35 hours a week and where the employment is not temporary. It includes contracts of one year or more.

[22] A person is in the labor force if he or she is working either in full-time permanent employment, full-time temporary employment, part-time employment, is commencing work soon, or is not working and actively looking for a job. A person is out of the labor force if he or she is not working and not actively looking for a job.

[23] Gross monthly salary comprises basic salary, overtime payments, commissions, fixed allowances and other regular cash payments, before deductions of the employee's Central Provident Fund contributions and personal income tax. Employer's Central Provident Fund contributions, bonuses, stock options, lump sum payments, and payments-in-kind are excluded.

[24] Consumer price indices were obtained from the Singapore Department of Statistics. Available online at: https://www.singstat.gov.sg/find-data/search-by-theme/economy/prices-and-price-indices/latest-data

[25] Students enrolled in concurrent, double, and joint degree programs as well as combined master's degree programs are excluded from the sample because the course requirements for these programs are markedly different from those of single degree programs and do not follow the curricular structure presented in Appendix Table A1. In all analyses using the 2005-2010 sample, we also dropped students if they did not enter the university through either the junior college, polytechnic, or international baccalaureate route. This restriction meant that international students who entered with international qualifications were dropped. Because entry route information was unavailable for students who were admitted in 2003 and 2004, in analyses using the 2003-2010 sample, we did not drop students even if they did not enter through the junior college, polytechnic, or international baccalaureate routes. This meant that international students who entered with international qualifications were not dropped in the 2003-2010 sample.

responded and who did not respond to the earnings and labor force status questions are the same. If so, this should lessen concerns over sample selection. The results of these tests are presented in Appendix Table A3 and they show that while several of the characteristics are statistically significantly different between graduates who provided a response and graduates who did not, the magnitudes of the differences are generally small (apart from the difference in residency distributions between both groups). That many of the differences are statistically significantly different is likely due to the relatively large sample size. Hence, the sample of graduates on which we have labor market status and earnings information appears to be broadly representative of the full population of undergraduates.

Since we are interested to examine the labor market implications of curriculum breadth, it is instructive to know whether there is self-selection into curriculum breadth.[26] If so, which types of students are more likely to graduate with a broader course portfolio? To answer this, we ran simple multivariate regressions of measures of curriculum breadth on a vector of observed student characteristics.[27]

The results from these regressions are shown in Table 2. Column (1) indicates that selection into broad versus deep curricula does not vary by gender. Also, there is virtually zero selection by pre-university admission scores, indicating similar levels of preparedness. However, students who choose a broader curriculum are more likely to enter the university through an academically-oriented route rather than a vocationally-oriented one (they are more likely to enter through the academically-intensive junior college route, rather than the vocationally-oriented polytechnic route). A possible explanation is that while academically-oriented preparatory programs expose students to a wider range of intellectual disciplines, vocationally-oriented programs emphasize industry-oriented skills. Hence, students who enter through the latter route might already have developed more well-defined career plans and academic interests.

[26] The breadth of a student's course portfolio is not exogeneous. Students choose their portfolios based on several considerations, including ability in the chosen major, interest and likely performance in courses taken outside their major and within their major, and labor market considerations. A student who is interested to pursue an occupation in which her major discipline provides training for will have a greater incentive to take a narrower portfolio of courses, focused on her major. Conversely, a student with a lower preference for such occupations or who would like the flexibility of pursuing an occupation which requires a more general set of skills (either at the point of labor market entry or at a future stage) would have a greater incentive to take on broader portfolio of courses (Kinsler and Pavan, 2015; Silos and Smith, 2015). Ability, interest, and likely performance in the chosen major are potentially important factors as well. Students face uncertainty about their suitability for various majors at the point of enrollment (Arcidiacono, 2004; Malamud, 2010, 2011; Stinebrickner and Stinebrickner, 2014; Bordon and Fu, 2015) but may be reluctant to switch majors even after learning that their chosen major is unsuitable because of switching costs (they might have to read more modules because those previously taken cannot be transferred over to satisfy the new program requirements. Consequently, transferring might require students to spend a longer time in school; Indeed in Section 2, we noted how the percentage of students who switched between faculties after enrollment was very low, averaging at only 1.5%). Students who learn that their ability in the chosen major is weak or that the chosen major is unsuitable will have a greater incentive to take courses out of major and pursue a broader course portfolio.

[27] The observed student characteristics fall under 3 broad groups: the first includes socio-demographic characteristics such as age, gender, race, and residency (citizenship). The second includes pre-university characteristics such as UAS and entry route into university. The third includes university-level characteristics such as student CAP, number of modules read, number of years spent studying in the university, whether the student received a bachelor's degree with honors, the student's major, and the year the student was admitted to the university.

<Insert Table 2 here>

Since modules which fall outside of a student's major can be sub-divided into those that fall outside of a student's major but within the student's faculty and those that fall outside both the student's major and faculty (with the latter group of modules less likely to contain relevant content for the student's major), we consider these alternative measures for curriculum breadth in columns (2) and (3). We find that the threshold for adventurism differs by race and residency status. While minority race (Indian or Malay) students and local citizens tend to choose a greater share of modules which are outside their major but still within their faculty, majority race (Chinese) students and non-citizens (including permanent residents) are more likely to choose a greater share of modules which are both outside of their major and faculty.

Curriculum breadth also appears to be related to the academic performance in university. Students who read a broader curriculum are less likely to have an honors degree, which is expected given that students are required to fulfill a greater share of modules within their major if they wish to graduate with an honors degree (see Appendix Table A1). Interestingly, students who choose a greater share of modules which are outside their major but still within their faculty have higher CAPs on average, while the reverse is true for students who take a greater share of modules which are both outside of their major and faculty.

The regressions in Table 2 control for students' choice of major and admission cohort. Hence, they describe how curriculum breadth varies with student characteristics for students within the same majors and admission cohort. Controlling for choice of major is important, for otherwise, correlations could just be reflecting student sorting into majors and the fact that different majors have different breadth-of-study requirements. Controlling for admission cohort is important for analogous reasons.

4 Methodology

In this section, we provide details on the methods used to evaluate the causal impact of reading a broader curriculum on future labor market outcomes.

4.1 Measuring Curriculum Breadth

Although there are considerable differences in the way undergraduate education is provided across universities around the world, most universities structure their curriculums in a way that aims to combine depth of specialization in a chosen field with some degree of broad-based learning. In these settings, students read a combination of modules which comprise courses which provide the essential knowledge and abilities expected of a graduate majoring in the discipline ("modules within a student's major") as well as courses that are aimed at broadening a student's knowledge beyond his/her area of specialization ("modules outside a student's major"). One way of measuring the breadth of a curriculum is therefore to use (1) the share of modules (i.e. courses) taken outside a student's major. A higher share of modules taken

outside a student's major and hence outside of his/her specialized field of study, the broader his/her curriculum.

Because modules which are outside of a student's major but within the faculty to which the student belongs are likely to bear closer relation to the student's specialized area of study than modules which are outside both the student's major and faculty, it is possible to further sub-divide the share of modules taken outside the major into the following 2 categories:

(2) The share of modules taken outside a student's major but within the student's faculty
(3) The share of modules taken outside both a student's major and faculty

4.2 Breadth of Curriculum and Labor Market Outcomes

We examine the impact of taking a broader curriculum in university on future labor market outcomes in two ways.

First, we employ a multivariate analysis to examine the association between breadth of university curriculum and future labor market outcomes. Here, we build on the descriptive analysis of self-selection into curriculum breadth (described in Section 3.1), and use the extensive background information available on students in the NUS data to control for observable student characteristics which are likely to be correlated with curriculum breadth and future outcomes. Specifically, we estimate the following specification:

$$Y_i = \propto + \delta D_i + \boldsymbol{X}_i'\beta + \epsilon_i \qquad (1)$$

where Y_i denotes the labor market outcome for individual i, D_i is a measure of curriculum breadth, $\boldsymbol{X}_i$ is a vector of observed student characteristics (including age, gender, race, residency, entry route into university, whether student received an honors degree, number of years enrolled in the university, number of modules read in university, academic achievement prior to entering university, academic achievement in university, year of admission, and major), and ϵ_i represents unobserved factors influencing labor market outcomes (e.g. motivation or dimensions of ability not captured by the academic ability measures contained in $\boldsymbol{X}_i$). Estimates of δ inform us about how the labor market outcomes differ among individuals with a broader and narrower curriculum, who are otherwise similar in terms of observed characteristics. Because we include major and admission cohort as controls in equation (1), this specification describes how labor market outcomes vary with curriculum breadth for observationally-similar students within the same major and admission cohort. Controlling for major and admission cohort is important, because otherwise, correlations may just be reflecting differences in labor market outcomes across majors and admission cohorts.

While multivariate regressions are generally not well suited for the estimation of causal effects especially in the case where the key independent variable of interest is a choice variable (i.e. course-taking diversity in our case), the unique nature of our dataset makes it a reasonable starting point. In particular, our data contain detailed background information on students, including their socio-demographic, pre-university, and university-level characteristics, as well as rich proxies for student academic ability – including students' academic achievement in university and prior to university, allowing us to control extensively for an array of student

attributes. Our controls are rich, and much of the non-random sorting of students into deeper or broader curriculums is likely to be accounted for by this battery of characteristics. Hence, the multivariate analysis potentially yields insights on how labor market outcomes and curriculum breadth are associated, conditional on this extensive set of observed student characteristics and cognitive measures.

Nonetheless, estimates from the multivariate analysis may be unreliable if there is a large degree of selection into broader versus narrower curricula based on unobserved characteristics (such as student motivation or dimensions of ability not well captured by the ability proxies). Furthermore, students who anticipate higher returns from reading a broader curriculum may be more likely to take courses outside their intended major, which may potentially bias upward the estimates from a multivariate approach.

To circumvent the problem of selection into broader versus narrower curricula based on unobservables, we employ a second approach, which exploits an exogenous source of variation in curriculum breadth (see Section 2). Specifically, a difference-in-differences design is used. The first difference is along the time dimension, where we compare student cohorts admitted to the university before the 2007 revision with student cohorts admitted after (the change in graduation requirements affected only the cohorts admitted from 2007). The second difference is along the faculty dimension: We compare students from faculties which increased their major requirements with students from faculties which increased their UE requirements instead. In essence, the causal effect is identified by comparing the change in labor market outcomes for student cohorts admitted before the 2007 revision to those student cohorts admitted after, in faculties which compelled their students to take a smaller share of courses outside their major (treatment group) and in faculties which provided their students more flexibility to take a larger share of courses outside their major (control group). The difference-in-differences design uses the change in labor market outcomes between the pre 2007 cohorts and the post 2007 cohorts in the latter group of faculties (control group) as a counterfactual for how the labor market outcomes between these same cohorts in the former group of faculties (treatment group) would have changed, had major requirements not increased. A divergence in the change across the treated and the control faculties would be indicative of a treatment effect.

We combine difference-in-differences with instrumental variable methods to identify the causal impact of curriculum breadth. The first stage examines the impact of the policy change on the breadth of the curriculum:

$$D_{ijc} = \propto + \delta_{FS}^{*}\left(Treat_j \times Post_c\right) + \boldsymbol{X}_{ijc}'\rho + \gamma_c + \theta_j + \epsilon_{ijc} \qquad (2)$$

where i denotes an individual, j denotes a faculty, and c denotes the cohort. $Treat_j$ is a dummy variable equal to 1 if a given faculty increases its major requirements, thereby compelling students to read a smaller share of courses outside their major, and equal to 0 otherwise. $Post_c$ is a dummy variable for cohorts that were affected by the change in major requirements (i.e. cohorts admitted from 2007). γ_c and θ_j are cohort fixed effects and faculty fixed effects, which capture fixed differences across cohorts and faculties, respectively. $\boldsymbol{X}_{ijc}$ denotes a vector of observed student characteristics. The coefficient of interest, δ_{FS}, captures the effect of curricular changes on the breadth of course portfolio.

In the second stage, we use the interaction of the treatment dummy and the cohort exposure dummy $(Treat_j \times Post_c)$ to instrument for curriculum breadth (D_{ijc}) in the following regression:

$$Y_{ijct} = \propto + \delta_{IV}^{*} D_{ijc} + \boldsymbol{X}_{ijc}' \rho + \gamma_c + \theta_j + \varphi_t + \epsilon_{ijc} \quad (3)$$

The key coefficient of interest, δ_{IV}^{*}, is the estimated impact of a unit change in curriculum breadth on labor market outcomes, identified through the policy change. Since there is only one endogenous variable (curriculum breadth) and one instrument, the estimate of δ_{IV}^{*} is simply the ratio of the coefficient estimate from the following reduced form difference-in-difference estimate of the effect of the policy change on future earnings (δ_{RF}^{*} from equation 4 below) and the estimate of the first-stage coefficient (δ_{FS}^{*}).

$$Y_{ijct} = \propto + \delta_{RF}^{*} (Treat_j \times Post_c) + \boldsymbol{X}_{ijc}' \rho + \gamma_c + \theta_j + \varphi_t + \epsilon_{ijc} \quad (4)$$

where Y_{ijct} denotes the labor market outcome for individual i, from faculty j and cohort c, in time t, and φ_t represents survey year fixed effects. Here, *t* represents the year in which the student took the post-graduation survey while *c* represents the year in which the student entered NUS. Cohort and survey year fixed effects are not collinear and can be separately identified because some students completed the degree earlier/later than expected. To address the possibility that regression errors are potentially correlated within faculty, cohort, and honors (versus non-honors) groupings, we cluster all standard errors in this paper at the faculty-cohort-honors level to allow for heteroskedasticity and arbitrary correlation of regression errors within these groupings.

Since the difference-in-differences design relies importantly on the identifying assumption that the change in labor market outcomes between the pre 2007 cohorts and the post 2007 cohorts in the control faculties represents how labor market outcomes between these same cohorts would have changed in the treated faculties, absent the treatment, care should be taken to check if the common trends assumption is plausibly threatened (since only one faculty – FASS – was treated, in what follows, we will refer to it as the "treated faculty". The other faculties – FoE, FoS, BIZ, and SoC – are the "control faculties"). Indeed, there are several potential reasons why labor market outcomes may have evolved differentially for graduates from the treated and the control faculties, even in the absence of treatment.

Firstly, the 2007 curricular reform could have altered student sorting into faculties or majors. It is conceivable that some students who would have chosen certain faculties or majors prior to the reform may switch their preferences after the share of modules in their majors was adjusted. If so, the change in the labor market outcomes between the pre-2007 cohorts and the post-2007 cohorts for the control faculties could be partly reflecting this. For instance, if the proportion of highly productive students rises in the control faculties relative to the treated faculty because of a tendency for some highly productive students to sort toward the control faculties after the reform, then the change in labor market outcomes for the control faculties would not be a good counterfactual for the treated faculty. In particular, the difference-in-differences estimator of the effect of taking a narrower curriculum would be biased downward. The converse is true if there is a tendency for less productive students to sort toward the control

faculties after the reform.[28] In Section 5.3, we conduct several checks for student sorting due to the reform.

Secondly, other faculty-specific policies which influence labor market outcomes could have occurred as well, in or around, the time of the 2007 reform. If this were the case, the difference-in-differences estimator would be partly reflecting the effect of these other policies. For instance, if the treated faculty had implemented other programs or reforms which had the effect of making its post 2007 cohorts more productive than its pre-2007 cohorts (or had the effect of boosting the employment opportunities of its post 2007 cohorts), this would impart an upward bias in the difference-in-differences estimator of the effect of taking a narrower curriculum. In Section 2, we noted how the 2007 curricular revisions were an isolated reform, motivated by the university's desire to align the university-level requirements for its honors and non-honors programs so that they would be identical. Since the curricular revisions were not part of a larger package of reforms, this serves to somewhat lessen (but not eliminate) the concern that the treated faculty might also have been implementing other reforms during this time. Nonetheless, to probe further, in Section 5.3, we also check to see if other institutional inputs such as average class sizes might have changed at the treated faculties relative to the control faculties, after the 2007 reform. Confidence in the internal validity of our estimates would be bolstered if there is no evidence of such changes.

Thirdly, graduates from the treated and the control faculties could have experienced differential changes in their labor market outcomes before and after the reform owing to industry-specific labor market trends or shocks, unrelated to the curricular reform. Again, in Section 5.3, we implement several tests to check if such concerns are valid.

Assuming the aforementioned potential threats are not an issue and that the identifying assumptions for the difference-in-difference approach are valid, the 2007 policy reform provides the exogenous variation in course-taking required to address the problem of non-random selection of students into broader versus narrower course portfolios.

5 Results

5.1 Relationship Between Breadth of Curriculum and Future Labor Market Outcomes

We now examine if there is any association between future labor market outcomes and breadth of university curriculum, controlling for number of modules read by the student,

[28] Since the reform affected only the honors degrees, it is possible that the reform could have differentially affected decisions to pursue honors degrees at FASS relative to the other faculties. However, as noted in Section 2, students are sorted into bachelor's and honors degrees only at an advanced stage of their undergraduate careers (with this sorting based on their accumulated academic performance measured at that time), and not at the time of enrollment. Since students face uncertainty over their subsequent academic performance and have limited freedoms to choose between a bachelor's degree and an honors degree *at the time of enrollment*, the reform is unlikely to have differentially affected decisions to pursue an honors degree at FASS relative to other faculties at the time of enrollment. Indeed, we find no significant effects on probability of obtaining an honors degree with the same difference-in-differences model used in our main analysis.

admission year fixed effects, survey year fixed effects, and major fixed effects. Table 3 summarizes the results from the multivariate regressions.[29] We consider three measures of labor market outcomes, namely labor market earnings (measured using the logarithm of gross monthly income) (Panel A), full-time permanent employment (Panel B), and unemployment (Panel C), all measured six months after graduation. Column (1) of Panel A shows that a 1 percentage point increase in the share of modules read outside one's major is associated with a 0.17% decrease in monthly earnings. This negative association is statistically significant at the 1% level.

In columns (2)-(4) of Panel A, we further control for student socio-demographic characteristics (gender, race, and residency), pre-university characteristics (entry route to the university and pre-university admission scores) and university academic achievement (whether they graduated with an honors degree, and the number of years spent studying in university). When socio-demographic controls are added, the magnitude of the coefficient falls by 28% (to -0.124), though the negative association between earnings and the share of modules read outside the major remains statistically significant at the 1% level. The coefficient further falls by another 18% (to -0.102) when controls for pre-university characteristics are added, though it remains statistically significant at the 5% level. Finally, when controls for university-level performance are included, the coefficient falls to essentially zero. The results indicate that among students with similar observable characteristics prior to university entry, those who read a larger share of modules outside their major tend to have significantly lower wages, possibly due to a lower probability of obtaining an honors degree. However, while employers place weight on academic performance, we find no evidence that they exhibit preferences for more diverse or more specialized coursework, at least as reflected by entry job wages.

<Insert Table 3 here>

Columns (5) to (8) of Panel A repeats the analysis, but decomposes share of modules outside the major into share of modules outside the student's major but within the student's faculty and share of modules outside both the student's major and faculty. We see the same familiar pattern of results, with column (5) showing negative and statistically significant results. As more controls are added, the coefficients on the share variables decrease in magnitude and finally reach zero in column (8). Taking a higher share of modules outside both the major and faculty is associated with significantly lower wages in column (7), consistent with the lower average CAPs observed above; however, we do not see any positive returns for the higher average CAPs for taking modules outside the major but within the faculty, possibly offset by the negative associations with obtaining honors.

Panels B and C of Table 3 show the results respectively for full-time permanent work and unemployment. The results paint a similar picture to those described in Panel A, with fewer significant results for column (1)-(3) and (5)-(7), and again suggest that there is no association

[29] Because we include major fixed effects and admission year fixed effects as controls in all regressions, these regressions examine how labor market outcomes vary with curriculum breadth for observationally-similar students within the same major and admission cohort. Controlling for major and admission cohort is important, because otherwise, correlations may just be reflecting differences in labor market outcomes across majors and admission cohorts.

between the share of modules read outside of one's major and these labor market outcomes, once differences in students' observable characteristics are accounted for. Columns (4) of Panels B and C indicate that among students with the same observable characteristics, those who take a 1 percentage point higher share of modules outside their major are 0.001 percentage points more likely to be in full-time permanent employment and are 0.019 percentage points more likely to be unemployed. These estimates are tiny in magnitude and statistically insignificant.[30]

To allow for possible non-linearities in the relationships between the share of modules outside the major and labor market outcomes, we also tried including a quadratic specification in the fraction of modules read outside the major. However, we did not find any evidence of a nonlinear relationship between the fraction of modules outside major and labor market outcomes. In all cases, the hypothesis that the coefficient on the quadratic term is equal to zero cannot be rejected at the 10% significance level.[31] In the remainder of the analysis, we adopt a linear specification in the fraction of modules read outside one's major.

5.2 What is the Causal Impact of Reading a Broader Curriculum on Future Labor Market Outcomes?

To account for the possibility of selection into choice of broader versus narrower course portfolios, we turn to the instrumental variables model. Our source of exogenous variation is faculty-specific revisions in student graduation requirements for cohorts admitted from 2007, which compelled affected FASS students to reduce the proportion of courses taken outside their specific area of study, while simultaneously offering non-FASS students the opportunity to take a broader diversity of modules.

<Insert Figure 1 here>

Fig. 1 shows that the curricular revisions led to a decline in the share of modules taken outside major among FASS students, from around 0.5 among students admitted in 2006 to 0.45 among students admitted in 2007, or a decline of approximately 10% (see Panel A). Prior to the episode, the share of modules taken outside the faculty had been on a downward trajectory which stabilized among the 2005 and 2006 cohorts, the first cohorts included in our final sample, before falling again after the revisions. By contrast, there is a much weaker trend among students from other faculties prior to the revisions. Panels B and C further show that affected FASS students took fewer non-major modules both within and outside faculty,

[30] Although the results in Table 3 suggest that there is no relationship between breadth of university curriculum and subsequent labor market outcomes, it is possible that these results might mask interesting heterogeneities by faculty. When we examine the effects separately by faculty, we nevertheless find that the effects are insignificant for all faculties, though the effect sizes are somewhat larger for computing and engineering students, with curriculum breadth associated with higher entry wages but lower probability of full-time employment for the former group, and higher probability of full-time employment for the latter group. For brevity, we do not report results from specifications which allow for faculty heterogeneity. They are, however, available upon request.

[31] For brevity, we do not report results from these specifications in this paper. They are, however, available upon request.

whereas their contemporaries in other departments followed a gradual trend of switching from modules outside faculty to modules outside major but within faculty.

<Insert Table 4 here>

We explore the impact of these faculty-specific changes in curriculum diversity on employment outcomes, controlling for student socio-demographic characteristics, pre-university characteristics and university academic achievement. The first three columns of Table 4 show the results of the instrumental variables model, which estimates the impact of a unit change in curriculum breadth (from zero percent to 100 percent of modules). Given a decline in curriculum breadth by around 0.05 units, the increase in FASS major requirements corresponds to a decline in entry earnings by around 0.8% (= -0.05 × 0.167), a decline in probability of full-time permanent employment by around 0.7 percentage points (= -0.05 × 0.146) , and an increase in probability of unemployment among affected graduates by around 1.15 percentage points (= -0.05 × 0.23 × 100). The estimates are all statistically insignificant at the 10% level.

<Insert Figure 2 here>

The model estimates are consistent with Fig. 2, which shows a lack of divergence in employment outcomes among students from FASS and non-FASS faculties. Income and probability of full-time permanent employment peaked among cohorts admitted in 2004 before dipping for later cohorts, reflecting the impact of the global recession from late 2008. There is no break between cohorts admitted in 2007 and 2008 among FASS graduates or those from other faculties. Similarly, Fig 3 confirms that after controlling for individual characteristics (with the exception of university entry route, pre-university academic achievement and years of study, which are not available in the dataset prior to 2005), the differences in year fixed effects between FASS and non-FASS students, relative to differences in 2006, are generally small and insignificant both prior to and after the curricular revisions.

<Insert Figure 3 here>

First-stage results based on the Cragg-Donald F-statistic indicate that the insignificant results are unlikely to be driven by instrument weakness, in line with evidence of reduced curriculum breadth among FASS students from Fig. 1 (Table A4). To check the consistency of our model results, we show that the results from the reduced form difference-in-differences model (columns 4-6) yield similar quantitative insights. The difference-in-difference specification shows that as expected, affected FASS graduates had lower entry earnings of around 0.7%, lower probability of full-time permanent employment by around 0.6 percentage points, and higher probability of unemployment by around 0.95 percentage points, similar to the earlier set of estimates, and that none of these results are significant.

The precision of the null results is instructive by allowing us to rule out economically significant impacts of curriculum breadth. Our 50% and 75% confidence intervals, respectively, are [-.083, 0.418] and [-0.259, 0.594]. Hence, an even more substantial change in curriculum breadth by 10 percentage points, twice what was seen with the NUS reform, yields an impact on entry wages by between -0.8% to 4.2% with 50% probability, and by between -

2.6% to 5.9% with 75% probability. Hence, barring drastic revisions to university curricula, the impact on wages is expected to be very weak.

5.3 Robustness Checks

5.3.1 Student sorting into faculties and majors

The difference-in-differences design relies importantly on the identifying assumption that the change in labor market outcomes between the pre-2007 cohorts and the post-2007 cohorts in the control faculties represents how labor market outcomes between these same cohorts would have changed among FASS students, absent the curriculum reform. We consider whether the 2007 reform could have altered student sorting into faculties or majors. If so, the change in the labor market outcomes between the pre 2007 cohorts and the post 2007 cohorts for the control faculties would partly reflect the impact of sorting.

Our difference-in-difference analysis shows that while none of the student demographics changed at FASS relative to other faculties after the 2007 reform, there was a significant difference in university admission scores at the 1% level (Table A5). Nevertheless, we note that the absolute magnitude of effects of university admission scores on wages are small, and precisely zero in the case of employment status (Table 4). As a result, our instrumental variable results are highly similar whether or not we control for these characteristics (Table A6).

We also checked the share of students choosing each major within FASS. Four of the majors (Communications, Economics, Psychology and Sociology) constitute around two-thirds of FASS students. For all of these main majors, we find no trend break in the share of students in these majors that coincide with the 2007 reform.

5.3.2 Other reforms coinciding with curriculum requirements

We also consider the possibility that other faculty-specific policies which influence labor market outcomes could have occurred in or around the time of the 2007 reform. If this were the case, the difference-in-differences estimator would partly reflect the effect of these other policies. To address this identification threat, we note in Section 2 that the 2007 curricular revisions were an isolated reform, motivated by the university's desire to align the university-level requirements for its honors and non-honors programs so that they would be identical.

To further check that the curricular revisions were not part of a larger package of reforms implemented at FASS or the other faculties in or around 2007, we look into changes in average module class sizes. We find similar trends across time for FASS and other faculties, with an increase between 2005 and 2006 and a downward trend thereafter, with the exception of the Business School where class sizes continued to increase until 2010 (Fig. A2 Panel A). The results do not support the hypothesis that FASS instituted additional concurrent reforms that affected teaching inputs, relative to other faculties.

5.3.3 Differential changes in labor market conditions

Our identifying assumptions could be violated if graduates from the treated and the control faculties experienced differential changes in their labor market outcomes before and after the reform owing to industry-specific labor market trends or shocks, unrelated to the curricular reform. Figs. 2 and 3 show that year fixed effects for labor market outcomes between FASS and non-FASS students, relative to differences in 2006, are generally small and insignificant prior to and after the curricular revisions.

We further address these concerns by providing two additional pieces of evidence. First, we looked into the relative share of FASS graduates compared to other faculties. The vast majority (93.2%) of the students in our sample graduated between 2009 and 2014, so we focus on these years. We find similar trends in cohort sizes across multiple faculties, with a rise from 2010 to 2011 and a sharp dip in the size of the graduating cohort in 2014, which reflects the sample restriction to students admitted by 2010 rather than differences in admission or graduation rates (Panel B of Fig. A2 Panel B).

Second, in lieu of industry-specific data on salary and employment data at the national level which we did not manage to collect, we repeated our analysis and restricted our sample to the main four industries that FASS graduates are most likely to enter, accounting for 64.3% of all FASS graduates and 35.5% of all non-FASS graduates who were employed in the sample. By restricting the analysis to these industries, our results are less likely to be driven by differential industry trends. We continue to find null results for wages and full-time employment based on this restricted sample (industry-specific results are not available for unemployment) (Table A7).

In summary, our causal analysis supports the general finding of a weak relationship between curriculum diversity and employment outcomes. At the same time, we note that these causal estimates are local to FASS graduates, particularly with regard to the proportion of coursework taken outside major but within faculty. The economic returns to a broader course portfolio may plausibly differ for other faculties, especially if they are targeted by industries that seek specialized technical skills. Nevertheless, it is worth noting that the similarity of the findings for the broader population of undergraduates based on regression-control strategies and rich controls for students' background characteristics and academic ability suggest that the weak relationship between the diversity of course-taking and early labor market outcomes may indeed be generalizable to the general undergraduate population.

6 Conclusion

This paper investigates how breadth of the university curriculum affects subsequent labor market outcomes, as measured by earnings, full-time permanent employment, and unemployment six months after graduation. Our study contributes to the existing literature, which has largely been limited to studying the effects of curricula at the secondary school level.

Using multivariate regression analysis as well as an exogenous change in curriculum structure across faculties and over time, we find that after controlling for student socio-demographic characteristics, entry route and pre-university academic achievement, curriculum breadth is associated with significantly lower entry wages, but that after controlling for university academic performance, the effects disappear. Our results suggest that while employers place weight on academic performance, little additional consideration is given to course diversity. Our findings are in line with the majority of studies which have examined the impacts of curriculums read at the secondary school level.

One limitation of our results is that the dataset only contains information on labor market earnings and employment of workers six months after graduation. Yet, there are good reasons to believe that the effect of the university curriculum may vary over a person's life cycle (Delaney and Devereux, 2019). In particular, while reading a narrower portfolio of courses may smooth the initial entry into the labor market by providing individuals with more specialized knowledge and skills to take on specific jobs, these skills may also become obsolete more quickly, especially if there are rapid changes in technology. A broader curriculum, which equips individuals with the skills and knowledge in a more diverse range of areas, may provide more insurance against such adverse labor market shocks, by increasing the range of job options available to graduates. Hence, it is possible that any labor market advantage (in terms of say higher earnings levels, higher likelihood of employment, or lower earnings volatility) conferred in reading a broader curriculum may grow over a person's life cycle. We leave this important question for future work.

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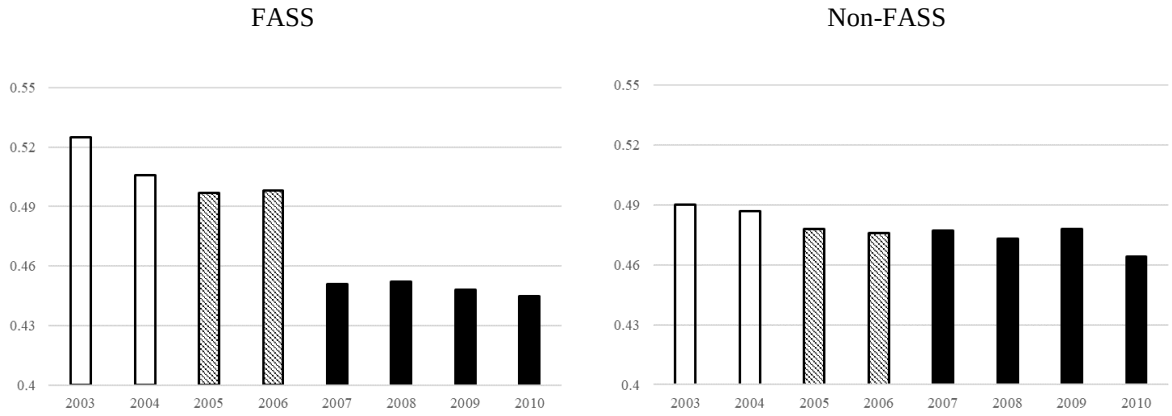
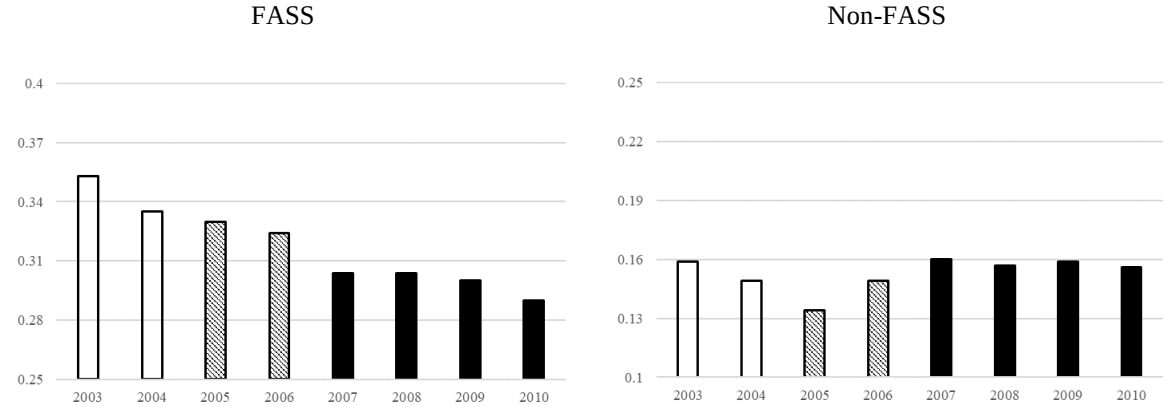
Figure 1: Proportion of modules taken outside major, within faculty and outside faculty

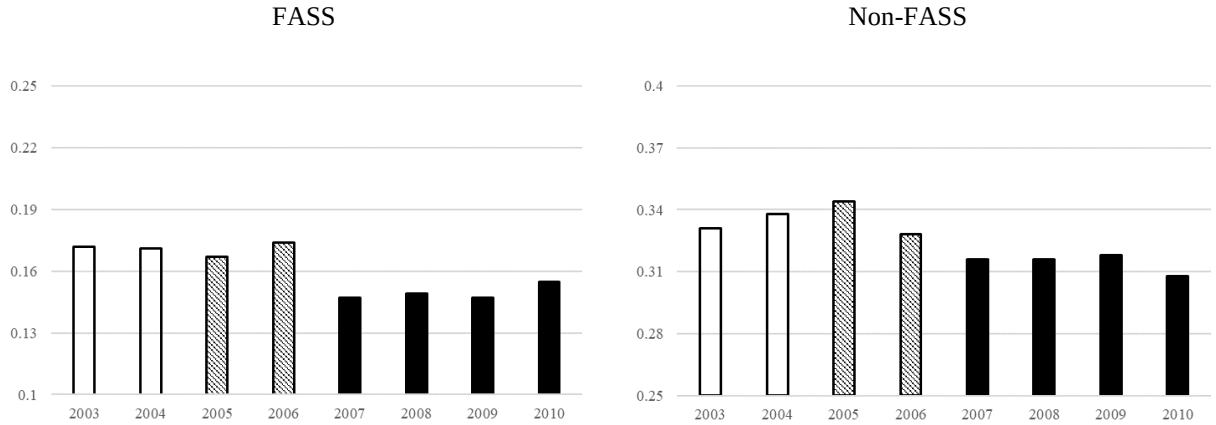
Panel A: Outside major



Panel B: Outside major, within faculty



Panel C: Outside major, outside faculty

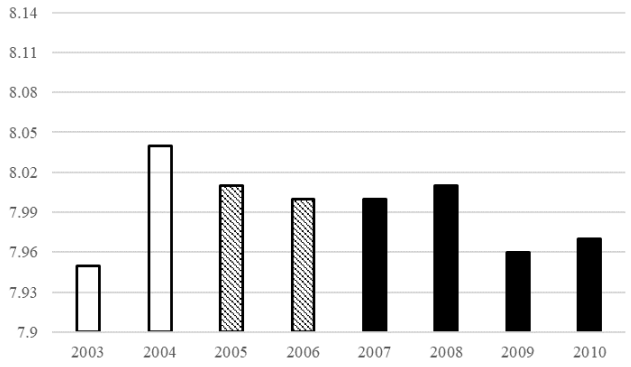


Notes: Hollow bars refer to years which are not included in the sample, striped bars are included in the sample and prior to the curriculum reforms, and solid bars are included in the sample and after the curriculum reforms.

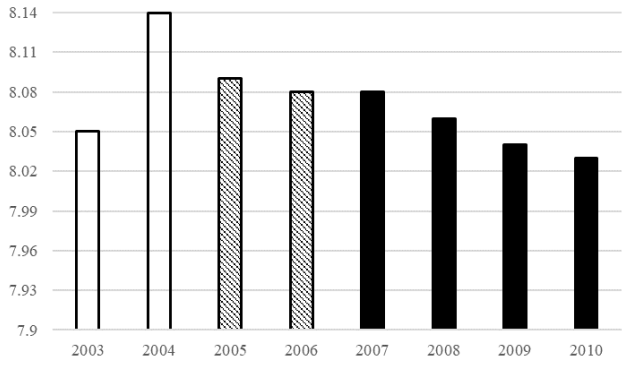
Figure 2: Real gross income, probability of full-time permanent employment and employment post-graduation

Panel A: Real gross income (log)

FASS

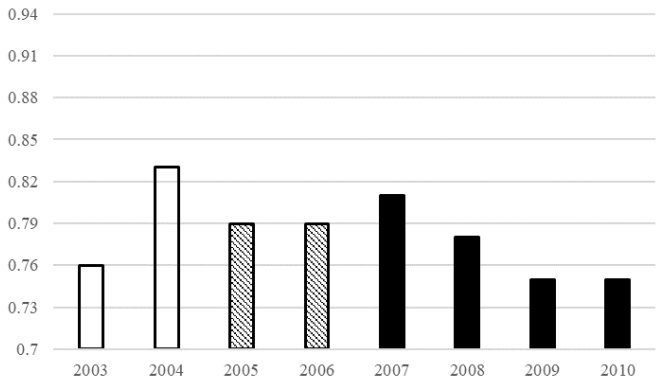


Non-FASS

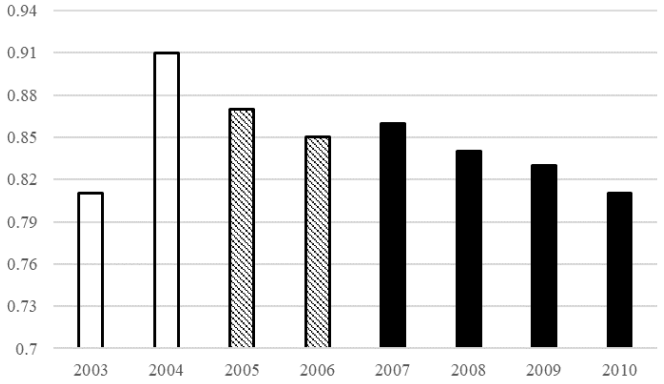


Panel B: Probability of full-time permanent employment

FASS

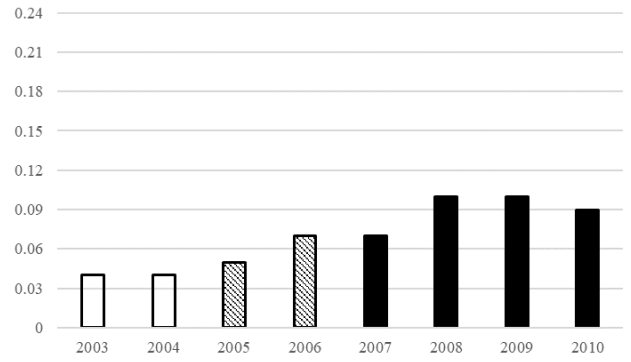


Non-FASS

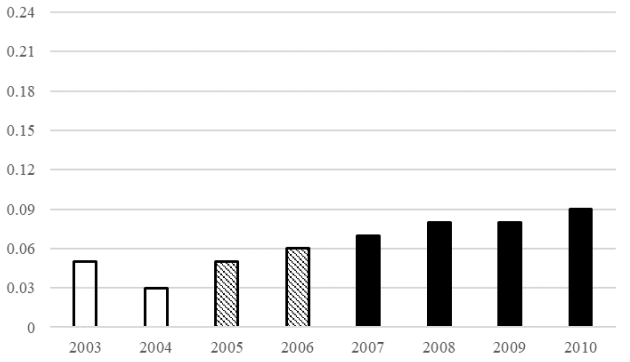


Panel C: Probability of unemployment

FASS



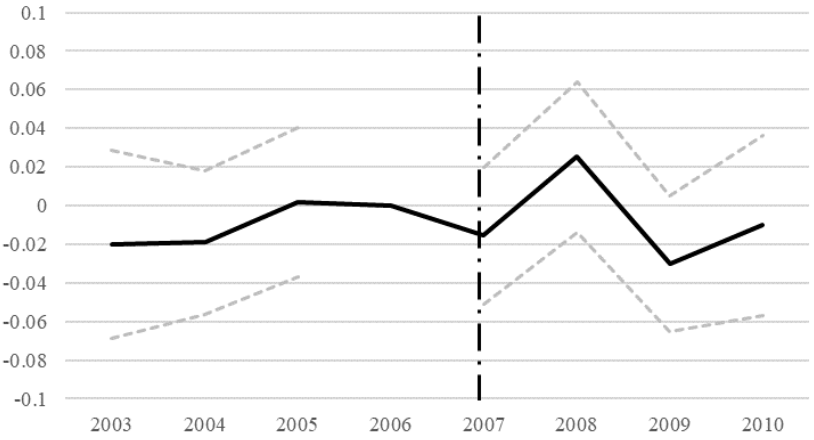
Non-FASS



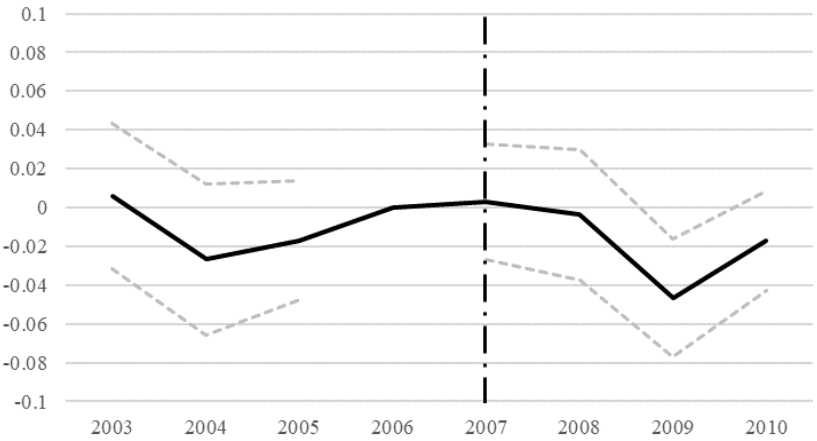
Notes: Hollow bars refer to years which are not included in the sample, striped bars are included in the sample and prior to the curriculum reforms, and solid bars are included in the sample and after the curriculum reforms.

Figure 3: Labor market outcomes of treatment group relative to the control group over time, controlling for individual level characteristics

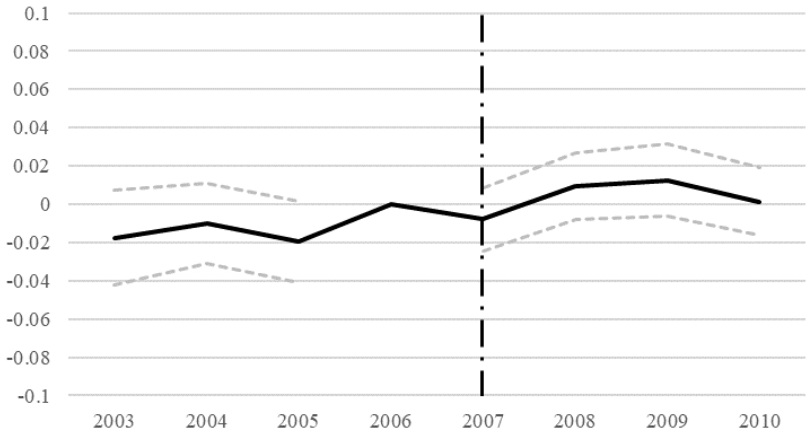
Panel A: Real gross income (log)



Panel B: Probability of full-time permanent employment



Panel C: Probability of unemployment



Notes: Estimates are based on OLS regressions controlling for individual characteristics except for university entry route, admission score and entry year fixed effects. Solid lines refer to coefficient estimates for differences in year fixed effects between FASS and non-FASS students relative to 2006, and dotted lines refer to the 95% confidence interval.

Table 1: Descriptive statistics

	Panel A (2003-2010 cohort)			Panel B (2005-2010 cohort)		
Variable	Mean	Standard Deviation	Sample Size	Mean	Standard Deviation	Sample Size
Female	0.529	0.499	38,331	0.541	0.498	24,808
Chinese	0.866	0.341	38,331	0.892	0.310	24,808
Indian	0.055	0.228	38,331	0.046	0.210	24,808
Malay	0.027	0.162	38,331	0.031	0.172	24,808
Others	0.052	0.223	38,331	0.031	0.174	24,808
Age Admitted to University (years)	20.047	1.267	38,331	20.168	1.272	24,808
Singapore Citizen	0.749	0.434	38,331	0.860	0.347	24,808
Permanent Resident	0.059	0.236	38,331	0.074	0.262	24,808
International	0.192	0.394	38,331	0.066	0.248	24,808
Junior College	-	-	-	0.843	0.364	23,503
Polytechnic	-	-	-	0.150	0.357	23,503
International Baccalaureate	-	-	-	0.007	0.080	23,503
Standardized UAS	-	-	-	0.000	1.000	23,505
CAP	3.636	0.584	38,331	3.660	0.570	24,808
Have an Honors	0.605	0.489	38,331	0.615	0.487	24,808
Years of Study	-	-	-	3.721	0.582	24,808
Number of Modules Taken	36.403	5.654	38,331	35.563	5.443	24,808
Fraction of Modules Outside Major	0.478	0.104	38,331	0.469	0.092	24,808
Fraction of Modules Outside Major Within Faculty	0.201	0.130	38,331	0.207	0.126	24,808
Fraction of Modules Outside Major Outside Faculty	0.277	0.123	38,331	0.263	0.121	24,808
Log Real Gross Monthly Salary	8.045	0.261	18,218	8.038	0.262	13,630
Full-time Permanent Employment	0.824	0.381	21,003	0.824	0.381	15,763
Unemployment	0.070	0.256	21,003	0.070	0.256	15,763

Table 2: Who takes more diverse courses?

Regressor	Fraction of Modules Outside Major (1)	Fraction of Modules Outside Major Within Faculty (2)	Fraction of Modules Outside Major Outside Faculty (3)
Female	0.001	0.000	0.001
	(0.002)	(0.002)	(0.002)
Indian	0.005**	0.008***	-0.002
	(0.002)	(0.003)	(0.003)
Malay	0.004	0.011***	-0.007**
	(0.002)	(0.003)	(0.003)
Others	-0.002	0.005	-0.007**
	(0.002)	(0.004)	(0.003)
Permanent Resident	0.002	-0.007**	0.009***
	(0.003)	(0.003)	(0.003)
International	0.000	-0.005**	0.005**
	(0.003)	(0.002)	(0.002)
Polytechnic	-0.069***	-0.026***	-0.043***
	(0.005)	(0.006)	(0.004)
International Baccalaureate	-0.008	0.001	-0.009
	(0.005)	(0.006)	(0.006)
Standardized UAS	-0.000	0.000	-0.000
	(0.001)	(0.001)	(0.001)
CAP	0.003	0.010***	-0.007***
	(0.002)	(0.003)	(0.002)
Have an Honors	-0.039***	-0.021***	-0.019***
	(0.008)	(0.006)	(0.004)
Number of Modules Taken	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)
Years of Study	-0.011***	-0.011***	-0.000
	(0.003)	(0.003)	(0.002)
Admission Year	Yes	Yes	Yes
Age	Yes	Yes	Yes
Major	Yes	Yes	Yes
Observations	23,503	23,503	23,503
R-Squared	0.564	0.738	0.757

Notes: Standard errors, clustered at the faculty-cohort-honors level, are shown in parentheses. Omitted base categories are Chinese (race), Singapore citizen (resident status), Junior College (entry route). Observations are undergraduates from the 2005 to 2010 admission cohorts. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.

Table 3: Does course taking diversity correlate with future labor market outcomes?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Dependent Variable: Log(Real Gross Earnings)								
Fraction of Modules Outside Major	-0.173***	-0.124***	-0.102**	-0.001	-	-	-	-
	(0.042)	(0.042)	(0.042)	(0.033)				
Fraction of Modules Outside Major Within Faculty	-	-	-	-	-0.125**	-0.077	-0.063	0.001
					(0.058)	(0.054)	(0.051)	(0.036)
Fraction of Modules Outside Major Outside Faculty	-	-	-	-	-0.225***	-0.176***	-0.148***	-0.002
					(0.045)	(0.046)	(0.047)	(0.043)
Observations	13,630	13,630	13,320	13,320	13,630	13,630	13,320	13,320
R-Squared	0.093	0.119	0.125	0.162	0.094	0.120	0.125	0.162
Panel B: Dependent Variable: Whether in Full-Time Permanent Employment								
Fraction of Modules Outside Major	-0.091	-0.088	-0.079	0.001	-	-	-	-
	(0.057)	(0.057)	(0.058)	(0.055)				
Fraction of Modules Outside Major Within Faculty	-	-	-	-	-0.099	-0.090	-0.089	-0.035
					(0.063)	(0.062)	(0.063)	(0.061)
Fraction of Modules Outside Major Outside Faculty	-	-	-	-	-0.081	-0.085	-0.065	0.049
					(0.071)	(0.070)	(0.070)	(0.067)
Observations	15,763	15,763	15,424	15,424	15,763	15,763	15,424	15,424
R-Squared	0.049	0.057	0.059	0.071	0.049	0.057	0.059	0.071
Panel C: Dependent Variable: Whether Unemployed								
Fraction of Modules Outside Major	0.050	0.065	0.077*	0.019	-	-	-	-
	(0.039)	(0.039)	(0.044)	(0.042)				
Fraction of Modules Outside Major Within Faculty	-	-	-	-	0.053	0.063	0.077	0.036

					(0.043)	(0.042)	(0.047)	(0.043)
Fraction of Modules Outside Major Outside Faculty	-	-	-	-	0.047	0.067	0.077	-0.003
					(0.048)	(0.048)	(0.052)	(0.051)
Observations	15,763	15,763	15,424	15,424	15,763	15,763	15,424	15,424
R-Squared	0.019	0.027	0.029	0.040	0.019	0.027	0.029	0.040
Socio-Demographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Pre-University Characteristics	No	No	Yes	Yes	No	No	Yes	Yes
University-Level Characteristics	No	No	No	Yes	No	No	No	Yes

Notes: Socio-demographic controls include student gender, race, age, and residency status. Pre-university characteristic controls include the route through which the student entered university and university admission score. University-level characteristic controls include university cumulative average point, whether the student received an honors degree, and the years of study in university. All regressions control for the number of modules read in university, GES year, major, and year admitted to the university. Standard errors, clustered at the faculty-cohort-honors level, are shown in parentheses. Observations are undergraduates from the 2005 to 2010 admission cohorts. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.

Table 4: Does course taking diversity affect future employments outcomes? IV and DID model results

Dependent Variable	Log(Real Gross Income) IV 2SLS	Whether Full-Time Employed IV 2SLS	Whether Unemployed IV 2SLS	Log(Real Gross Income) DID	Whether Full-Time Employed DID	Whether Unemployed DID
Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)
Fraction of Modules outside Major	0.167	0.146	-0.230	-	-	-
	(0.371)	(0.307)	(0.205)			
Treat*Post	-	-	-	-0.007	-0.006	0.009
				(0.014)	(0.012)	(0.008)
Female	-0.057***	0.046***	-0.041***	-0.054***	0.048***	-0.045***
	(0.010)	(0.012)	(0.009)	(0.007)	(0.010)	(0.008)
Indian	0.025**	-0.071***	0.036***	0.027**	-0.069***	0.033**
	(0.012)	(0.015)	(0.013)	(0.011)	(0.014)	(0.013)
Malay	-0.039***	-0.100***	0.052***	-0.036**	-0.098***	0.048***
	(0.014)	(0.017)	(0.014)	(0.014)	(0.017)	(0.014)
Others	0.004	-0.053***	0.033***	0.004	-0.052***	0.032**
	(0.012)	(0.018)	(0.012)	(0.012)	(0.018)	(0.013)
Permanent Resident	-0.001	-0.006	-0.007	-0.002	-0.007	-0.006
	(0.010)	(0.013)	(0.009)	(0.010)	(0.013)	(0.009)
International	0.016**	0.000	0.024**	0.018**	0.001	0.022*
	(0.008)	(0.017)	(0.012)	(0.008)	(0.017)	(0.012)
Polytechnic	0.010	0.008	0.005	-0.002	-0.003	0.021*
	(0.029)	(0.028)	(0.019)	(0.011)	(0.014)	(0.011)
International Baccalaureate	-0.053	-0.004	0.021	-0.053	-0.004	0.021
	(0.036)	(0.035)	(0.026)	(0.036)	(0.035)	(0.026)
Standardised UAS	-0.007**	0.000	0.002	-0.006**	0.000	0.001
	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)
CAP	0.103***	0.079***	-0.048***	0.104***	0.081***	-0.051***
	(0.010)	(0.009)	(0.006)	(0.010)	(0.008)	(0.006)
Have an Honors	0.024	0.035**	-0.034***	0.018	0.029***	-0.025***
	(0.017)	(0.015)	(0.012)	(0.012)	(0.010)	(0.008)
Number of Modules	-0.001	-0.003**	0.002***	-0.001	-0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Years of Study	-0.063***	-0.133***	0.070***	-0.062***	-0.133***	0.069***
	(0.021)	(0.022)	(0.014)	(0.021)	(0.022)	(0.014)
Admission Year	Yes	Yes	Yes	Yes	Yes	Yes
Faculty	Yes	Yes	Yes	Yes	Yes	Yes
GES Year	Yes	Yes	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes	Yes	Yes
Cragg-Donald Wald F statistic	167.148	184.718	184.718			
Weak Instrument	No	No	No			
Observations	15,023	17,475	17,475	15,023	17,475	17,475

Notes: Standard errors, clustered at the faculty-cohort-honors level, are shown in parentheses. Observations are undergraduates from the 2003 to 2010 admission cohorts. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.

Appendix 1

As discussed in Section 2, graduation requirements at NUS are broadly divided into three categories: University-level requirements, Program requirements, and Unrestricted Electives (UE). Here, we provide details on what the various requirements entail and how they changed after 2007.

University-level requirements consist of General Education Modules (GEM), Singapore Studies (SS) and Breadth modules. GEMs are concerned with critical and creative thinking that facilitate the application of knowledge to experience, and the formation of knowledge from experience. SS modules expose students to various issues confronting Singapore. A Breadth module is any module which is not from a student's home faculty. In 2007, there was a systematic change in University-level requirements, where the Breadth requirement for the honors degree decreased from 16 MC to 8 MC, as shown in Table A1.

Table A1: University-wide guidelines for basic degree requirements

For students admitted *before* 2007

	Bachelor's Degree (MC)	Bachelor with Honors Degree (MC)
University-level Requirements		
General Education	8	8
Singapore Studies	4	4
Breadth	8	16
Sub-total	**20**	**28**
Progam Requirements		
Faculty	12-16	16
Major	56-66	88-104
Sub-total	**68-82**	**104-120**
Unrestricted Elective Module Requirements	**18-32**	**12-28**
Minimum MCs required for graduation	**120**	**160**

(continued)

For students admitted *from* 2007

	Bachelor's Degree (MC)	Bachelor with Honors Degree (MC)
University-level Requirements		
General Education	8	8
Singapore Studies	4	4
Breadth	8	8
Sub-total	**20**	**20**
Progam Requirements		
Faculty	12-16	12-16
Major	60-72	88-110
Sub-total	**72-88**	**100-126**
Unrestricted Elective Module Requirements	**12-28**	**14-40**
Minimum MCs required for graduation	**120**	**160**

Program requirements consist of Faculty requirements and Major requirements. Faculty requirements introduce students to different disciplines in a faculty. A faculty consists of several departments, which focus on specific disciplines under the faculty's scope. Major requirements are specialized modules which aim to inculcate the core knowledge and skills expected of a graduate majoring in a particular discipline.

UE modules can be taken from any department. As its name suggests, these modules are "unrestricted", meaning that students can read any subject, at any level, to fulfill this requirement.

The university requires students to fulfill the three categories of requirements: University-level, Program, and UE, before they can graduate.

It should be noted that although Table A1 describes the university-wide guidelines, each faculty has some liberty in deciding how MC's are allocated across the Faculty, Major, and UE requirements. This explains why the Faculty requirements, Major requirements, and

UE requirements are specified as ranges rather than as a single value. The ranges do not indicate that Faculty, Major, and UE requirements vary from year to year within a faculty. The distribution of these requirements are actually quite stable from year to year within each faculty (apart from 2006 to 2007, when a systematic change in university-level requirements occurred). Rather, what the ranges do indicate, is that each faculty has some liberty in deciding how MC's are allocated across the Faculty, Major, and UE requirements.

In 2007, the university revised its University-level requirement for the honors degree so that students need only read 8 MC instead of 16 MC of modules to fulfill the Breadth requirement. This revision occurred because the university wanted to align the University-level requirements for its honors (4 year) and non-honors (3 year) programs so that they would be identical. In response to this, there was some heterogeneity in how faculties allocated the additional 8 MC. While the Faculty of Arts and Social Sciences (FASS) increased their Major requirement (thereby compelling students to read a greater share of modules in their major discipline), other faculties increased their UE requirement instead (so students were effectively allowed to choose whatever modules they wished to read to fulfill the additional 8 MC). In addition, FASS also decreased its Faculty requirement from 16 MC to 12 MC, with the 4 MC difference transferred towards its Major requirement. Hence, Major requirement increased by a total of 12 MC for FASS. We exploit this exogenous increase in Major requirement for FASS to investigate the impact of curriculum breadth on students' subsequent labor market outcomes.

By and large, departments within the same faculty share similar graduation requirements and structure. That is, the requirements under the University-level, Program, and UE components are standardized so that they are similar across all departments in a faculty. There are a few exceptions, however. Specifically, departments within FoS, FoE, and SoC have some discretion over the number of major-specific MC's that students need to complete to graduate. Regardless, the Major requirements do not vary much across departments in these faculties. In the case of FASS and BIZ, all departments within a faculty share the same graduation requirements and structure. Hence, ordinarily, and in the absence of the 2007 reforms, much of the variation in curriculum breadth within faculties arise due to the individual choices made by students. This makes the 2007 reform particularly useful for generating the exogenous variation in curriculum breadth required for causal identification.

Figure A1: Proportion of FASS students by major, 2005-2010

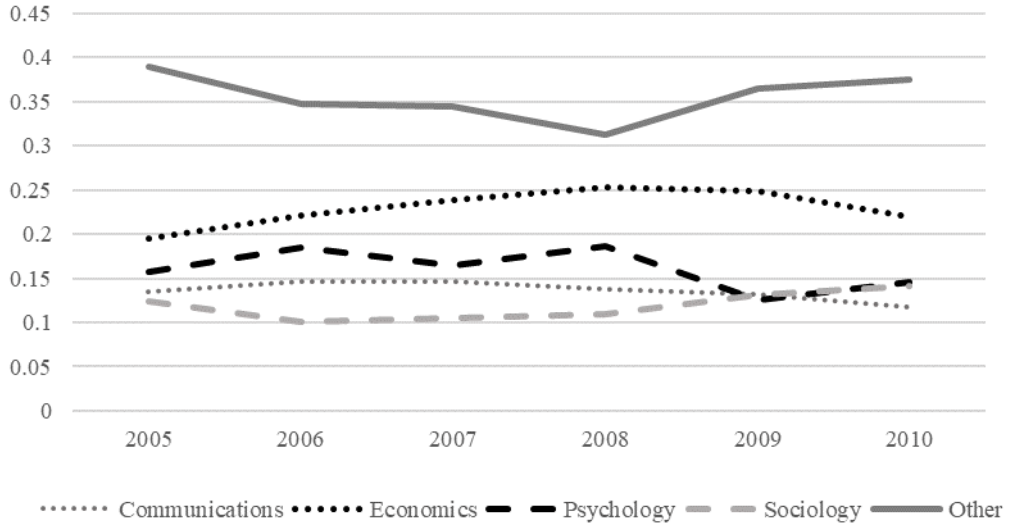
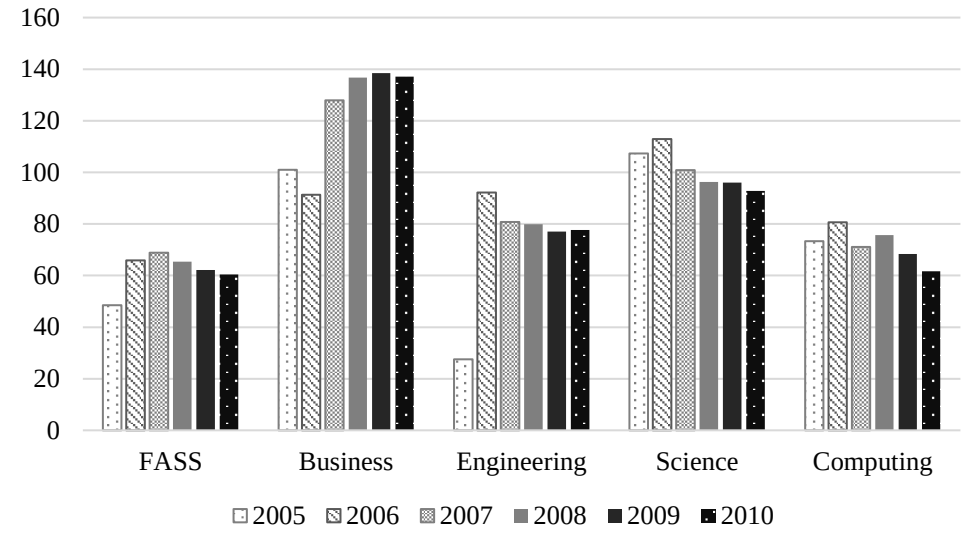


Figure A2: Average module class sizes and graduating cohort sizes by faculty, 2005-2010

Panel A: Average module class size



Panel B: Average graduating cohort size

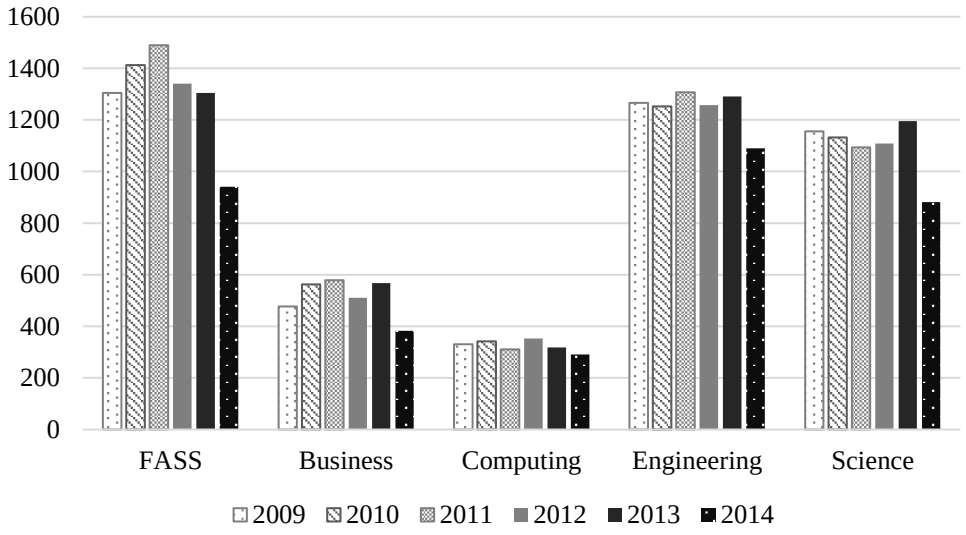


Table A2: List of majors belonging to each faculty

FASS	**BIZ**	**SoC**	**FoE**	**FoS**
Chinese studies	Business administration (accountancy)	Business analytics	Bioengineering	Applied chemistry
Chinese language	Business administration	Computational biology	Civil engineering	Applied mathematics
Economics		Computer engineering	Chemical engineering	Chemistry
English language		Communications and media	Computer engineering	Computational biology
English literature		Computer science	Electrical engineering	Food science and technology
European studies/history		Electronic commerce	Environmental engineering	Life sciences
Geography		Information systems	Engineering science	Mathematics
Japanese studies			Industrial and system engineering	Physics
Malay studies			Mechanical engineering	Pharmacy
Communications and new media			Materials science and engineering	Quantitative finance
Philosophy				Statistics
Psychology				
Political science				
Sociology				
Southeast Asian studies/South Asian studies				
Social work				
Theatre studies				

Table A3: Means of key variables for students who responded and who did not respond to labor market questions (2005-2010 cohorts)

	Sample (2005-2010 cohorts)					
Variable	Did not respond to earnings question (N=3,653)	Responded to earnings question (N=13,777)	Difference	Did not respond to labor force status question (N=7,378)	Responded to labor force status question (N=17,430)	Difference
Demographics:						
Female	0.528	0.534	-0.006	0.559	0.533	0.027***
Chinese	0.861	0.903	-0.043***	0.886	0.894	-0.008*
Indian	0.061	0.039	0.022***	0.052	0.044	0.008***
Malay	0.039	0.030	0.010***	0.028	0.032	-0.004
Others	0.039	0.028	0.011***	0.034	0.030	0.004
Age Admitted to University (years)	20.126	20.205	-0.079***	20.121	20.189	-0.067***
Residency:						
Singapore Citizen	0.875	0.897	-0.022***	0.783	0.892	-0.109***
Permanent Resident	0.053	0.055	-0.002	0.121	0.055	0.066***
International	0.072	0.048	0.024***	0.096	0.053	0.043***
Entry Route:						
Junior College	0.873	0.839	0.034***	0.836	0.846	-0.010*
Polytechnic	0.120	0.155	-0.035***	0.157	0.148	0.009*
International Baccalaureate	0.007	0.006	0.001	0.007	0.006	0.001
Pre-university Academic Achievement:						
Standardized UAS	0.031	0.008	0.023	-0.033	0.013	-0.046***
University-Level Characteristics:						
CAP	3.672	3.667	0.006	3.642	3.668	-0.026***

Have an Honors	0.615	0.629	-0.014	0.588	0.626	-0.038***
Years of Study	3.772	3.731	0.041***	3.677	3.740	-0.063***
Number of Modules Taken	36.064	35.468	0.597***	35.492	35.593	-0.101
Fraction of Modules Outside Major	0.470	0.468	0.003*	0.472	0.468	0.004***
Fraction of Modules Outside Major Within Faculty	0.219	0.203	0.016***	0.207	0.206	0.001
Fraction of Modules Outside Major Outside Faculty	0.251	0.265	-0.013***	0.265	0.262	0.003*

Notes: *** Difference is statistically significant at the 1% level; ** Difference is statistically significant at the 5% level; * Difference is statistically significant at the 10% level. All graduates are asked the labor force status question while only graduates who are in full-time permanent employment are asked the gross monthly earnings question.

Table A4: Does course taking diversity affect future employments outcomes? First-stage model results

Dependent Variable	Fraction of Modules Outside Major IV First-Stage (Log(Real Gross Income))	Fraction of Modules Outside Major IV First-Stage (Whether Full-Time Employed)	Fraction of Modules Outside Major IV First-Stage (Whether Unemployed)
Independent Variable	(1)	(2)	(3)
Treat*Post	-0.418***	-0.041***	-0.041***
	(0.015)	(0.015)	(0.015)
Treat	0.013	0.012	0.012
	(0.011)	(0.011)	(0.011)
Post	0.026	0.035	0.035
	(0.041)	(0.040)	(0.040)
Female	0.018***	0.019***	0.019***
	(0.004)	(0.004)	(0.004)
Indian	0.011**	0.009**	0.009**
	(0.005)	(0.004)	(0.004)
Malay	0.020***	0.017***	0.017***
	(0.006)	(0.005)	(0.005)
Others	0.003	0.006*	0.006*
	(0.004)	(0.003)	(0.003)
Permanent Resident	-0.006	-0.007*	-0.007*
	(0.004)	(0.004)	(0.004)
International	0.009**	0.006*	0.006*
	(0.004)	(0.003)	(0.003)
Polytechnic	-0.071***	-0.071***	-0.071***
	(0.007)	(0.007)	(0.007)
International Baccalaureate	-0.007	-0.005	-0.005
	(0.005)	(0.004)	(0.004)
Standardised UAS	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
CAP	0.009***	0.010***	0.010***
	(0.003)	(0.003)	(0.003)
Have an Honors	-0.038***	-0.038***	-0.038***
	(0.008)	(0.008)	(0.008)
Number of Modules	-0.001***	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)
Years of Study	0.006	0.006	0.006
	(0.011)	(0.011)	(0.011)
Admission Year	Yes	Yes	Yes
Faculty	Yes	Yes	Yes
GES Year	Yes	Yes	Yes
Age	Yes	Yes	Yes
Cragg-Donald Wald F statistic	167.15	184.72	184.72
Weak Instrument	No	No	No
Observations	15,023	17,475	17,475

Notes: Standard errors, clustered at the faculty-cohort-honors level, are shown in parentheses. Observations are undergraduates from the 2003 to 2010 admission cohorts. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.

Table A5: Difference-in-differences in FASS student characteristics, relative to other faculties

Dependent Variable	(1) Female	(2) Chinese race	(3) Singaporean resident	(4) Junior college entry route	(5) Standardised UAS
Treat*Post	0.003	0.018	-0.001	-0.016	0.148***
	(0.019)	(0.013)	(0.018)	(0.029)	(0.050)
Treat	0.032**	-0.077***	0.082***	0.119***	-0.792***
	(0.015)	(0.013)	(0.017)	(0.020)	(0.031)
Post	-0.230**	0.022	-0.164**	0.600***	-0.966***
	(0.096)	(0.053)	(0.073)	(0.133)	(0.361)
CAP	-0.072***	0.069***	-0.034***	0.023**	0.521***
	(0.008)	(0.008)	(0.007)	(0.010)	(0.036)
Have an Honors	0.114***	0.012	0.043***	-0.105***	0.107**
	(0.015)	(0.010)	(0.013)	(0.017)	(0.048)
Number of Modules	-0.007***	-0.003***	-0.018***	0.002	-0.007**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)
Years of Study	-0.176***	-0.016	0.065***	0.311***	-0.121
	(0.024)	(0.013)	(0.022)	(0.034)	(0.085)
Admission year	Yes	Yes	Yes	Yes	Yes
Faculty	Yes	Yes	Yes	Yes	Yes
GES Year	Yes	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes	Yes
Observations	19,632	19,632	19,632	19,632	19,178

Notes: Standard errors, clustered at the faculty-cohort-honors level, are shown in parentheses. Observations are undergraduates from the 2003 to 2010 admission cohorts. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.

Table A6: Impact of course taking diversity on future employments outcomes, including and excluding student pre-college characteristics

Panel A: IV results						
Dependent variables	Log(Real Gross Income)		Whether Full-Time Employed		Whether Unemployed	
	(1) Including pre-college characteristics	(2) Excluding pre-college characteristics	(3) Including pre-college characteristics	(4) Excluding pre-college characteristics	(5) Including pre-college characteristics	(6) Excluding pre-college characteristics
Fraction of Modules outside Major	0.167	0.163	0.146	0.139	-0.230	-0.247
	(0.371)	(0.351)	(0.307)	(0.306)	(0.205)	(0.204)
Treat	0.002	0.003	0.014	0.012	-0.014**	-0.017***
	(0.010)	(0.010)	(0.011)	(0.010)	(0.007)	(0.006)
Post	-0.503***	-0.481***	-0.676***	-0.709***	0.329***	0.344***
	(0.087)	(0.087)	(0.085)	(0.085)	(0.054)	(0.051)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,023	15,333	17,475	17,814	17,475	17,814
Panel B: DID results						
Dependent variables	Log(Real Gross Income)		Whether Full-Time Employed		Whether Unemployed	
	(1) Including pre-college characteristics	(2) Excluding pre-college characteristics	(3) Including pre-college characteristics	(4) Excluding pre-college characteristics	(5) Including pre-college characteristics	(6) Excluding pre-college characteristics
Treat*Post	-0.007	-0.007	-0.006	-0.006	0.009	0.010
	(0.014)	(0.013)	(0.012)	(0.012)	(0.008)	(0.007)
Treat	0.004	0.005	0.016	0.014	-0.017*	-0.021**
	(0.013)	(0.012)	(0.013)	(0.013)	(0.009)	(0.008)
Post	-0.498***	-0.466***	-0.671***	-0.696***	0.321***	0.321***
	(0.084)	(0.080)	(0.086)	(0.084)	(0.053)	(0.050)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,023	15,333	17,475	17,814	17,475	17,814

Notes: Standard errors, clustered at the faculty-cohort-honors level, are shown in parentheses. Observations are undergraduates from the 2003 to 2010 admission cohorts. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.

Table A7: Impact of course taking diversity on future employments outcomes, including all industries and restricted to selected industries

Panel A: IV results				
Dependent variables	Log(Real Gross Income)		Whether Full-Time Employed	
	(1) All industries	(2) Selected industries	(3) All industries	(4) Selected industries
Fraction of Modules outside Major	0.167	-0.001	0.146	-0.373
	(0.371)	(0.287)	(0.307)	(0.251)
Treat	0.002	0.004	0.014	0.014
	(0.010)	(0.010)	(0.011)	(0.010)
Post	-0.503***	-0.330***	-0.676***	-0.291***
	(0.087)	(0.116)	(0.085)	(0.103)
Other controls	Yes	Yes	Yes	Yes
Observations	15,023	6,648	17,475	6,902
Panel B: DID results				
Dependent variables	Log(Real Gross Income)		Whether Full-Time Employed	
	(1) All industries	(2) Selected industries	(3) All industries	(4) Selected industries
Treat*Post	-0.007	0.000	-0.006	0.017
	(0.014)	(0.013)	(0.012)	(0.011)
Treat	0.004	0.004	0.016	0.007
	(0.013)	(0.012)	(0.013)	(0.012)
Post	-0.498***	-0.330***	-0.671***	-0.276***
	(0.084)	(0.114)	(0.086)	(0.100)
Other controls	Yes	Yes	Yes	Yes
Observations	15,023	6,648	17,475	6,902

Notes: Standard errors, clustered at the faculty-cohort-honors level, are shown in parentheses. Observations are undergraduates from the 2003 to 2010 admission cohorts. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.