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Abstract

We estimate the effects of discrete changes in student fees and government subsidies on student field of study preferences and enrolments at university. These estimates are constructed using both standard two-way fixed effects models and Conditional Multinomial Logit models using individual unit-record applications and enrolments data from the largest Australian state of New South Wales. Student preferences are negatively related to student fees but the elasticity estimates are not large. This is likely due to generous income-contingent loans with a zero real interest rate that cover all tuition fees. University enrolments by field of study respond to changes in fees and subsidies in a manner consistent with student preference responses rather than teaching revenue maximisation. This may be due to supply constraints, reputation concerns and other organisational priorities.

JEL classification: H52, I22, I24, I28

Keywords: student choice, university, field of study, fees, subsidies.

1 Introduction

University enrollment decisions are one of the most important choices individuals make. Educational qualifications are strongly related to lifetime earnings, job satisfaction and health outcomes. Choosing a specific field of study is also important for lifetime outcomes, with earnings differing considerably across fields (see Andrews et al. (2022) and references therein).

Educational outcomes, including field of study, are also of central importance for societies more generally. A workforce that possesses desirable levels and types of skills is crucial for many outcomes: economic growth, innovation, democracy and health to name but a few. Having a healthy supply of healthcare practitioners and educators while also nurturing the development of an innovative science and technology workforce are likely important objectives.

In this study, we investigate the effects of discrete and large changes in university student fees and government subsidy rates by field of study on student preferences and final enrolment outcomes. These fee changes were introduced by the Australian government in 2021 in an attempt to induce students into "high demand" fields such as health, education, information technology (IT) and engineering and away from what they considered "low demand" fields such as the humanities.[1] Subsidisation rates and tuition fee levels are two tools policy-makers may use to influence enrolment decisions.

In the Australian setting, domestic undergraduate university students are not required to pay tuition fees up-front (Chapman, 1997). Students can defer payment via an income-contingent loan (ICL) until when they are working and earning.[2] Australia's use of an ICL implies that any effects of tuition fee changes on field choices should not reflect borrowing constraints prior to study.

Beyond student choice, tertiary institutions also play a key role in determining final student enrolments by field of study in Australia. For the most part, universities choose the number of places by field of study to provide, with places rationed among applicants based on high school achievement. The government has a role in affecting these university

[1] This new policy was titled the 'Job-ready Graduates Package': https://www.education.gov.au/job-ready.

[2] This scheme was first introduced in 1989 and is currently referred to as the 'HECS-HELP' or Higher Education Contribution Scheme: https://www.studyassist.gov.au/help-loans/hecs-help. Several other countries have followed Australia's lead by implementing similar ICL schemes, including New Zealand and the United Kingdom.

decisions via their subsidisation choices and potentially via limiting places by field of study directly.

This paper addresses the dual questions of how price-sensitive students are in their study choices (preferences), and potentially how responsive university allocations are to fee and subsidy (total student revenue) changes. The policy change we study involved fee and subsidy rate changes across fields of study that were not consistently aligned with the stated objectives of the policy. That is, subsidy changes did not always fully offset fee changes, such that total university revenue per student fell in many fields subject to fee reductions and rose in fields subject to fee increases.

Our main data source is administrative unit-record data on undergraduate Bachelor degree student preferences and enrolments by university and field of study from 2014 to 2022. This information was provided by the Universities Admissions Centre (UAC), a centralized allocation or "clearing house" system for universities located in New South Wales (the largest state in Australia) and the Australian Capital Territory. This data precludes analysis of the decision of whether to apply to university. We focus solely on the field of study decision.

Studies of the effect of tuition fees on university / college enrolment more generally (not specifically on field of study) are plentiful, particularly in the US setting. Earlier reviews of this extensive literature include Leslie and Brinkman (1987) and Heller (1997), while Havranek et al. (2018) provide a recent meta-analysis.[3] Estimates from these studies are often interpreted as effects of fees on student demand, rather than reflecting both student demand and university enrolment decisions. The overarching finding from these studies are that there is a weak negative relationship between fees and enrolment, with a stronger relationship for individuals from less-advantaged backgrounds.[4]

Estimates of the effects of student fees on field of study choices and outcomes are much less prevalent, as many universities and jurisdictions do not differentiate fees by field of study at the undergraduate level (Kalamova et al., 2020). However, OECD (2020) lists five countries (in addition to Australia) with notable variation in fees by field of study

[3]Studies of tuition fee effects for Canada include Christofides et al. (2001), Coelli (2009) and Neill (2009).

[4]Previous Australian research on the introduction of and subsequent increases in tuition fees payable via an ICL include Andrews (1999) and Aungles et al. (2002). These studies, using aggregated enrolment data, generally report enrolments were not negatively affected by the introduction or subsequent increases in fees. Murphy et al. (2019) reports a similar finding in the UK setting.

at the undergraduate level (Canada, Chile, Ireland, Israel and New Zealand) and two countries with some variation (Spain and Germany). There is also growing variation in fees by college major in the US, where individual universities often have more control over fee-setting (Ehrenberg, 2012).

A handful of studies investigate the effects of fee differentiation by college major on major completions in the US setting: Stange (2015), Andrews and Stange (2019) and Patnaik (2021). The fee variation in these studies comes from some universities introducing surcharges for business, engineering and nursing majors based on higher expected earnings / costs of provision. Major completions do appear to respond to differential fees, with heterogeneous effects among low-income students across studies. Other related US studies estimate the effects of specific financial aid programs aimed at raising low-income student enrolments in science, technology, engineering and mathematics (STEM) majors: Denning and Turley (2017), Evans (2017) and Castleman et al. (2018). While two studies find positive effects, one does not.

We add to this literature along several dimensions. First, the size of fee changes by field of study we employ in identification are considerably larger than the variation available in prior research. Fee changes range from a reduction of 59% to an increase of 117%. Second, we are able to analyze both student preference responses and final enrolment outcomes, where final enrolments are influenced by both student preferences or 'demand' and university allocations or 'supply'.[5] Third, our study setting allows students to defray the up-front costs of tuition via an ICL. We thus focus more closely on a 'price' response as up-front borrowing constraints do not constrain individual field of study choices.

Apart from using the standard two-way fixed effects strategies to estimate effects on enrolment, we estimate Conditional Multinomial Logit models of student preferences to control for the influence of detailed individual student characteristics on study choices. We find student field of study preferences responded negatively to fee increases, but the response elasticity is not particularly large: increasing the fee for a specific field of study by 1% reduces the demand for said field by approximately 0.1%. Overall, we estimate that the studied policy change led 1.52% of students to demand courses they wouldn't have demanded under the old fee structure. We also find that final enrolments by field of study responded similarly to student preferences, implying universities did not respond

[5]Related US studies of university / college enrolment or 'supply' responses include Epple et al. (2006), Gansemer-Topf et al. (2021), Cameron (1983) and Rolfe (2003).

in a manner consistent with revenue maximisation.

The remainder of the paper is organized as follows. Section 2 provides details of the Australian setting and of the policy changing fees and subsidy rates. Section 3 describes the data we employ and presents descriptive statistics. Simple frameworks for student choices and university allocation decisions are described in Section 4 to aid interpretation of our estimates. Following a description of the estimation strategies we employ in Section 5, our main results are presented in Section 6. Section 7 provides some concluding comments.

2 Background and Setting

2.1 Higher Education in Australia

Post-school education in Australia comprises two main sectors: university and vocational education and training (VET). Universities focus on Bachelor and post-graduate qualifications, while VET providers focus on certificate and diploma qualifications of various lengths. We focus on university education in this study.

Australia had 43 universities during the study period: 37 larger public universities and 6 smaller private institutions (including 2 international). Public universities are primarily funded by the Federal Government. The Government subsidises public universities to educate domestic students and also sets the maximum fees that public universities can charge domestic students. While Australian universities expanded enrolment of unsubsidised fee-paying international students rapidly over the past two decades to raise revenue,[6] we focus on domestic students, as domestic students were subject to the policy change we study.

Domestic student entry at the undergraduate level mostly occurs via one of five main state-based Tertiary Admissions Centres (TACs).[7] University applicants submit a list of ordered preferences over specific fields of study at specific universities. Universities then make offers to applicants based on their ordered preferences, with high school achievement being the main factor in university offer decisions. High school students sit state-based

[6]Universities can set their own international student fee levels, with international students paying significantly higher fees than domestic students.

[7]Australia has six states and two territories. One state - Tasmania - only has one university so local applicants apply directly to it. Universities in the two territories are included in state-based TACs.

tests at the end of high school, with each graduating student receiving an achievement rank referred to as the Australian Tertiary Admission Rank (ATAR).

2.2 Domestic Student Fees and Income Contingent Loans

Australia first introduced university student fees payable by an income-contingent loan (ICL) in 1989 (Chapman, 1997). The introduction of the Higher Education Contribution Scheme (HECS) followed 15 years of essentially fee-free university study.[8] The HECS was introduced with the objectives of raising funding for universities enabling expansion of enrolment while not deterring low-income students from attending. The loan scheme was expanded and re-named as the Higher Education Loan Program (HELP) in 2005, with the specific program for undergraduate university study now referred to as HECS-HELP.

Under HECS, students can pay their fees or 'student contributions' up-front at a discounted rate (15% originally, 10% in 2022),[9] but they are not required to. Students can delay repayment until their income exceeds a specific threshold (originally set at average taxable income of workers), with repayments collected automatically by the Australian Taxation Office at an increasing percentage of total income. These repayment rates were originally set at 1%, 2% or 3%, with both the rates and income thresholds changing over time. Repayment thresholds and rates for 2020/21 (the year of the policy change) are provided in Appendix Table A1. No repayments were required if income was below \$46,320 (around the 31st percentile of incomes in 2020/21). Repayment rates now range from 1% all the way up to 10% if income exceeded \$136,740 (90th percentile) in 2020/21. Outstanding (unpaid) HECS balances are increased annually in line with changes in the Consumer Price Index (CPI), thus these ICLs have a real interest rate of zero. The majority of undergraduate university students (more than 90%) opted to take out a HECS-HELP loan to finance their studies in 2021.[10]

When first introduced in 1989, fees or 'student contributions' were set at \$1,800 per year irrespective of field of study. Student contributions were first differentiated by field of study in 1997, with three different levels or "bands" set according to expected earnings after graduation. Degrees associated with high expected earnings (such as law and

[8] A \$250 Higher Education Administration Charge (HEAC) was introduced in 1987 and increased to \$263 in 1988.

[9] The discount was even higher in some years but is being removed for 2023 onward, but this is beyond our estimation period.

[10] See HELP Statistics on Parliament of Australia website. Updated 1 March, 2023.

economics) had higher $5,500 annual contributions, whereas degrees with low expected earnings (humanities and arts) had lower $3,300 annual contributions (the middle band had fees of $4,700). Apart from the addition of a fourth lower 'national priorities' band from 2005 to 2012,[11] this fee structure remained in place until the introduction of the Job-ready Graduates package described below. While contribution levels varied over time (often with inflation), the general structure that aligned fees with expected future income was maintained until 2021.[12]

2.3 University Revenues

Australian public universities have a number of revenue sources. These include government funding for research and for teaching domestic students, domestic student contributions (fees) under HECS, international student fees, investment income on endowments and retained earnings, consultancies and contracts plus other income, fees and charges. For each domestic undergraduate student that is offered a Commonwealth Supported Place (CSP), the university receives a per-student government contribution plus the equivalent of the student contribution under HECS up-front[13]:

$$\text{Total revenue (per student)} = \underbrace{\text{Government contribution}}_{\text{CSP Subsidy}} + \underbrace{\text{student contribution}}_{\text{HECS-HELP Loan}}$$

Both contribution amounts vary by field of study. These per-student government contributions are higher for degrees that are more costly to provide (such as medicine) and lower for less-costly degrees (such as law and economics). Total revenue per student amounts by field of study are arguably set to cover the full costs of provision. Contribution amounts by field of study 'cluster' in 2020 and 2021– the years immediately before and after the reform – are provided in Appendix Table A2.

Apart from medicine, individual universities have been able to choose how many students to enrol by field of study since the introduction of the 'Demand-driven System' in 2012. Enrolments grew strongly after 2012, putting pressure on government budgets. In

[11] These priority fields were nursing and education from 2005 to 2009, then science and mathematics from 2009 to 2012.

[12] A comprehensive history of HECS is provided on The Australian Parliament website, titled "The Higher Education Loan Program (HELP) and related loans: a chronology". Updated on 23rd of March, 2021.

[13] The Government provides the loan under the HECS, not individual universities.

response, total Government contributions were capped for each university in 2018 and 2019 at 2017 levels, with these caps being increased slowly since then. These caps covered Government contributions only, not student contributions. If universities choose to increase student enrolments beyond these caps, they still receive the student contribution amounts, but no additional Government contributions are received.

2.4 The Policy Change

Then Australian Education Minister Dan Tehan announced the *Job-ready Graduates Package* (JRG) on 19 June 2020, with the associated legislation passed by Parliament on 19 October 2020. This new funding model for government-subsidised domestic undergraduate places took effect from 1 January 2021. The stated objective of the reform was to divert university applicants into fields of study that would arguably support the needs of the future labour market.[14] Areas of 'national priority' including nursing, agriculture and teaching were targeted with reduced fees.[15] In contrast, supposedly 'low need' areas including arts, communications and law were targeted with fee increases.

The reform affected both student and government contribution levels by field of study (see Appendix Table A2). These contribution rates affected new undergraduate enrolments only. Existing students had their fees 'grandfathered' with no changes for the remainder of their degree if rates increased in their field of study. If rates declined in their field of study, their contributions were also reduced to the new levels. Apart from this discrete policy change in 2021, contribution rates by field of study generally moved with CPI inflation over our estimation period of 2014 to 2022.

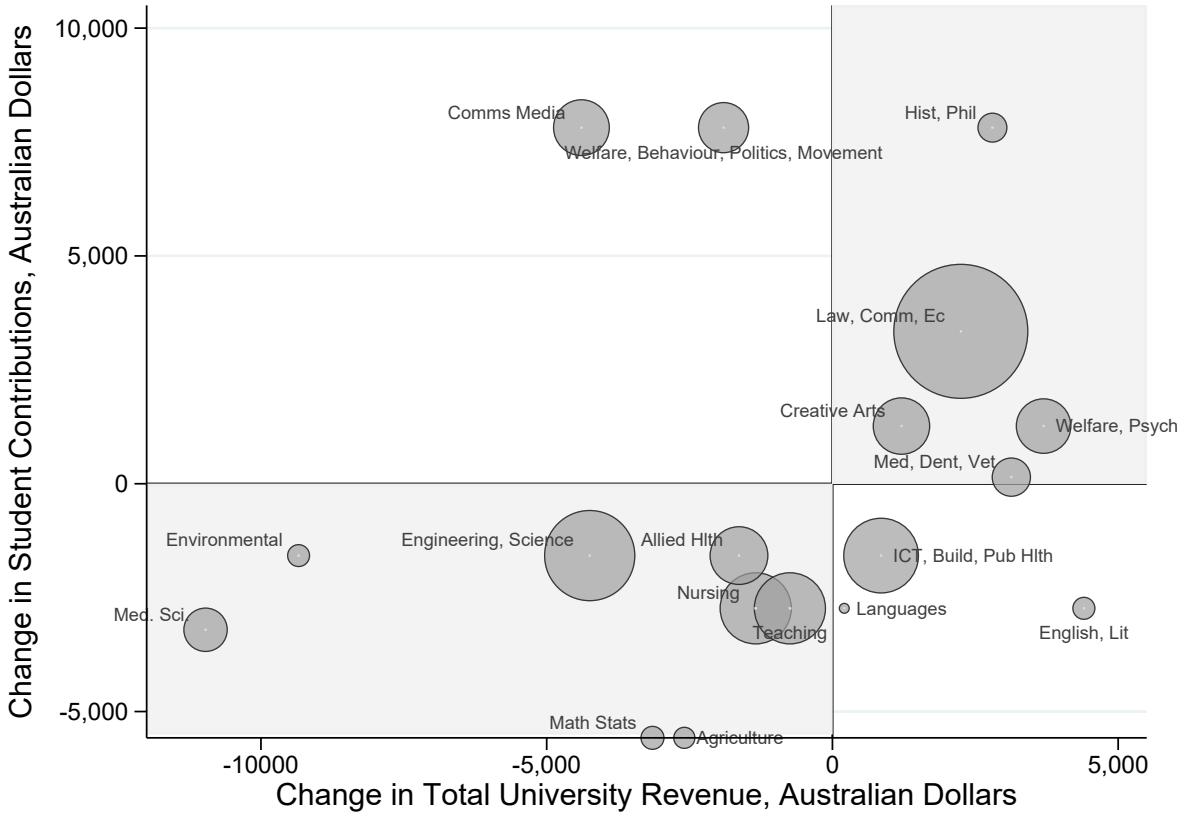
Figure 1 illustrates the changes in student contributions and total university per-student revenues (student plus government contributions) by aggregated fields of study due to the JRG reform. This highlights one of the main criticisms levelled at the reform (Daly and Lewis, 2020; Koshy et al., 2020; Grant-Smith et al., 2020). The changes in incentives for students and universities are mostly not aligned (shaded areas in the figure). For example, the policy increased student contributions in history studies by 117% (from $6,684 to $14,500) to discourage enrolments. However, the total per-student

[14]The Minister claimed "We are sending a price signal to encourage people to study in areas of expected employment growth". See the Ministerial Media Release posted on 19th of June, 2020.

[15]For more detailed information, see "Job-ready Graduates Package" on the Department of Education website.

revenue that universities receive for history students rose by 22% ($12,800 to $15,600), which may encourage universities to enrol more history students. As universities set their own minimum achievement score (ATAR) for each field of study when making offers, they potentially could increase enrolments by lowering the minimum. On the other hand, the policy reduced student contributions in mathematics by 59% ($9,527 to $3,950) to encourage more enrolments. However, total per-student university revenue fell by 15% ($20,348 to $17,200) in mathematics, which may affect the ability of universities to increase enrolments in this field.

Figure 1: Changes in Student Contributions and Per Student University Revenues, 2020 to 2021



Notes: Circle sizes represent Bachelor Degree graduates aged 20 to 29 by aggregated field of study from the 2021 Australian Census (via ABS TableBuilder).

Based on recent completions by field of study,[16] the policy change raised average student contributions by around $925 (9%), lowered average Government contributions by around $1,250 (12.5%), thus lowering total university per-student revenue by around

[16]Measured by field of study responses of Bachelor Degree graduates aged 20 to 29 from the 2021 Australian Census (via ABS TableBuilder).

$325 (1.6%).

By analysing the field of study responses of both student preferences and university enrolments to the policy change, we are able to provide a more complete understanding of the effects of these student and Government contribution changes.

3 Data and Descriptive Statistics

3.1 Data

Our main data source is unit-record administrative data on domestic student undergraduate preferences and enrolments from 2014 to 2022 provided by the Universities Admissions Centre (UAC). UAC is the sole clearinghouse tasked with matching applicants based in New South Wales (NSW) and the Australian Capital Territory (ACT) with 28 higher education institutions including but not limited to the 12 main public universities located in NSW and the ACT. The UAC is one of five Tertiary Admission Centres (TACs) in Australia. As the policy change was effective from the beginning of 2021, we have seven years of data pre-reform and two years in the post-reform period. We focus on domestic applicants eligible for a government-subsidised place applying to Bachelor degree courses.

A simplified representation of the de-identified unit-record data provided by the UAC is presented in Table 1. For each applicant, we have information on gender, year of birth, First Nations[17] status, parental education attainment, language spoken at home, postcode of residence at the time of application, ATAR (high school achievement ranking) in categories, plus the year and type of school attended when the ATAR was attained. We define school leavers as individuals attaining their ATAR in the year immediately prior to application (when undergraduate studies are due to commence). We use the highest educational attainment of either parent as the primary indicator of socio-economic status (SES). We also use the applicant's postcode to measure the SES of the applicant's local community, as location is highly correlated with university attendance in Australia.[18]

[17] Applicants can self-report if they are from an Aboriginal or Torres Strait Islander background.

[18] We link each applicant's postcode with the Australian Bureau of Statistics' Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) to construct this measure.

Table 1: Representative (fictitious) Applicant Data

Year	Age	Gender	Leaver	Indigenous	SES	Postcode	Language	School	ATAR
2016	18	F	Yes	No	High	2043	English	Private	95-95.95

Preference	Course ID	Field of study	Course Start	Uni group	Level	Enrol?
1	5492	010101	Feb-16	Top-ranked*	Bachelor	No
2	5978	020101	Feb-16	Top-ranked*	Bachelor	Yes
3	122	020300	Mar-16	Metropolitan	Bachelor	No
4	1679	060100	Feb-16	Metropolitan	Bachelor	No
5	4189	010101	Feb-16	Regional	Bachelor	No

Notes: Leaver = high school applicant; Language = the applicant's primary language spoken at home; School = whether the applicant attended a private or public high school; ATAR is provided in ranges, with finer detail at higher ATARs; Age is calculated from year of birth and enrolment year data; SES is constructed from self-reported parental educational attainment information.
* Top-ranked in terms of international rankings, based mostly on research outputs.

3.2 Descriptive statistics

Summary statistics on the characteristics of the applicants in the data are presented in Table 2. While approximately 60% of applicants are recent high school graduates and aged 19 or under, mature-age applicants are also prevalent even at the Bachelor degree level. Applicants also tend to have more educated parents and reside in more affluent neighbourhoods than the general population.

Applicants can submit an ordered list of up to five courses when submitting their preferences.[19] These courses can differ in both field of study and institutional provider. Applicants may revise their preferences at any time prior to the closure of the application round by submitting a new list. We use the six digit field-of-study code and course start date to determine the relevant student and Government contribution amounts.

We observe 236 distinct six digit field-of-study codes in the UAC data. In the main estimation of student preferences, we place individual fields into 27 groups ensuring the fields within these groups have the same levels of student and Government contributions over the period and are within the same broad field of study. Due to privacy concerns, the UAC grouped higher education providers into four categories rather than providing individual institution identifiers. These four groups are: (a) three top-ranked

[19]Prior to 2018, students could submit a list with up to nine preferences.

Table 2: Summary Statistics – Domestic Bachelor Degree Applicants

Characteristics	Applicants	Enrolled
Female[a]	0.564	0.551
First Nations (Aboriginal or Torres Strait Islander)	0.0180	0.0154
English spoken at home	0.715	0.710
School leaver	0.591	0.596
Age		
19 or less	0.631	0.636
20 to 24	0.238	0.247
25 and over	0.130	0.117
Highest parental education		
Bachelor degree or higher	0.550	0.556
Diploma or certificate	0.163	0.169
High school graduate	0.116	0.112
Less than high school[b]	0.171	0.163
SES of home postcode		
Top 30%	0.535	0.559
Middle 40%	0.285	0.274
Bottom 30%[c]	0.180	0.167
Observations	728,496	369,868

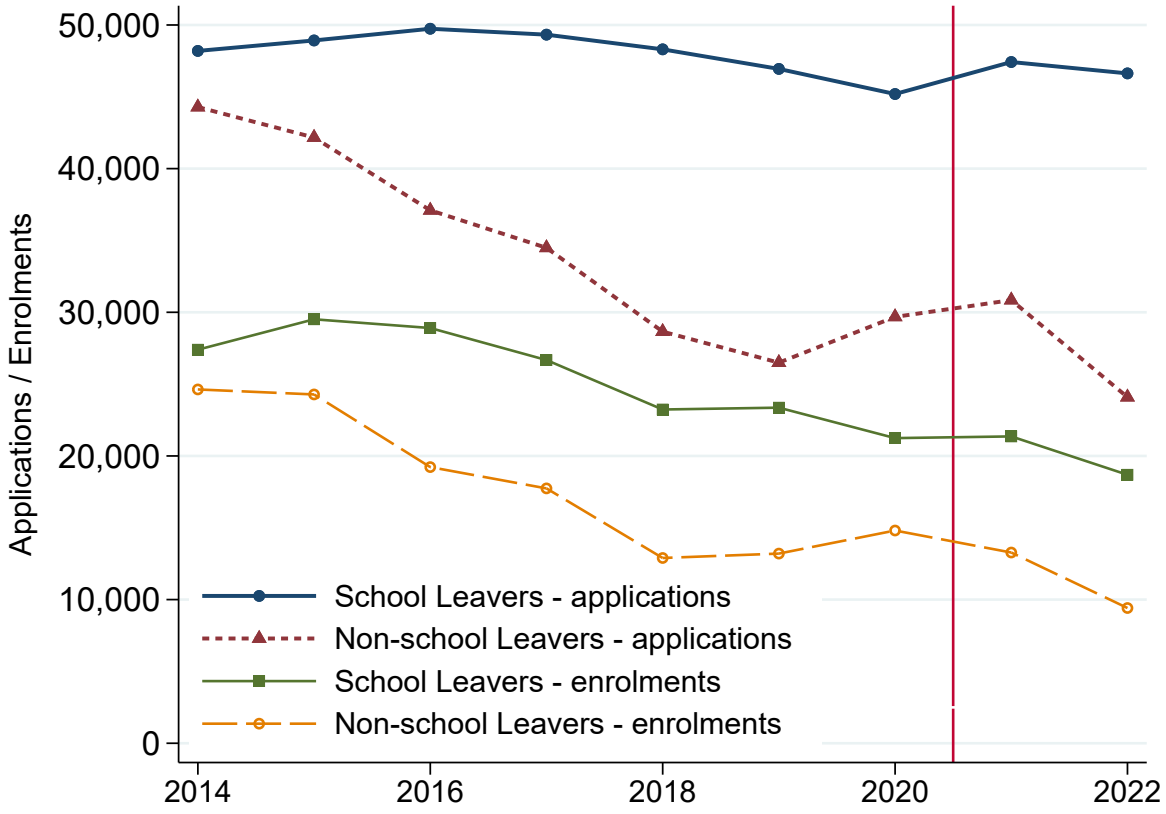
Notes: Data provided by the UAC covering applicants from 2014 to 2022. [a] 0.09% also reported non-binary gender. [b] includes 7.73% with no report of parental education. [c] includes 1.53% with no report of postcode.

research universities (which account for 31.2% of enrolments), (b) five other metropolitan-located universities (44.3%), (c) eight regionally-located universities (22.9%), and (d) twelve 'Other' higher education institutions (1.6%). A list of institutions by group is available in Appendix Table A3.

While the UAC is the only centralised matching centre in NSW and the ACT, students can choose to apply directly to universities. We are unaware of any data on the percentage of applicants who apply through UAC, but it is likely quite high, particularly among recent school leavers. Figure 2 presents trends for applications and enrolments separately for school leavers and non-school leavers. While applications fell over time leading up to the end of the 'demand-driven system' in 2017 among non-school leavers, application

levels remained quite stable among school leavers.

Figure 2: Applications and Enrolments by Commencement Year, UAC Data



Notes: Domestic undergraduate applications for Bachelor degree level places via the UAC. Vertical line denotes policy change between 2020 and 2021.

The UAC employs an applicant matching process that resembles a serial dictatorship (SD) algorithm, where the serial order is determined by the applicant's ATAR (Artemov et al., 2017). The SD matching process works as follows (Abdulkadiroglu and Sonmez, 1998). The applicant with the highest ATAR is offered their first preference course. The applicant with the next highest ATAR is then offered their first preference, with this process continuing until a course reaches its enrolment limit (as set by the university). If a student's first preference course is full, they are offered a place in their next highest-preference course that is not full.[20]

Our analysis focuses on the first preferences of applicants. We interpret these submitted preferences as reflecting the true preferences or choices of applicants. We note, however, that due to the limit (5 or 9) on the number of preferences applicants can list,

[20]Universities may choose to set a minimum ATAR entry threshold for courses rather than a strict enrolment limit. In such instances, students will receive an offer for their highest preference course where their ATAR meets or exceeds the entry threshold.

this algorithm is no longer strategy-proof (Haeringer and Klijn, 2009; Nisan et al., 2007). In addition, Artemov et al. (2017) finds evidence in the Australian context that some applicants "adopt [preference] strategies that are unambiguously dominated". The authors suggest that this may be due to lack of knowledge of the UAC matching process in addition to the non-strategy-proof nature of the algorithm with limited preference lists. Due to list limits, students may place a 'safe' course among their preferences with the objective of ensuring they receive at least one offer and thus do not miss out on attending university.

3.3 Preferences, Enrolments and the Policy Change

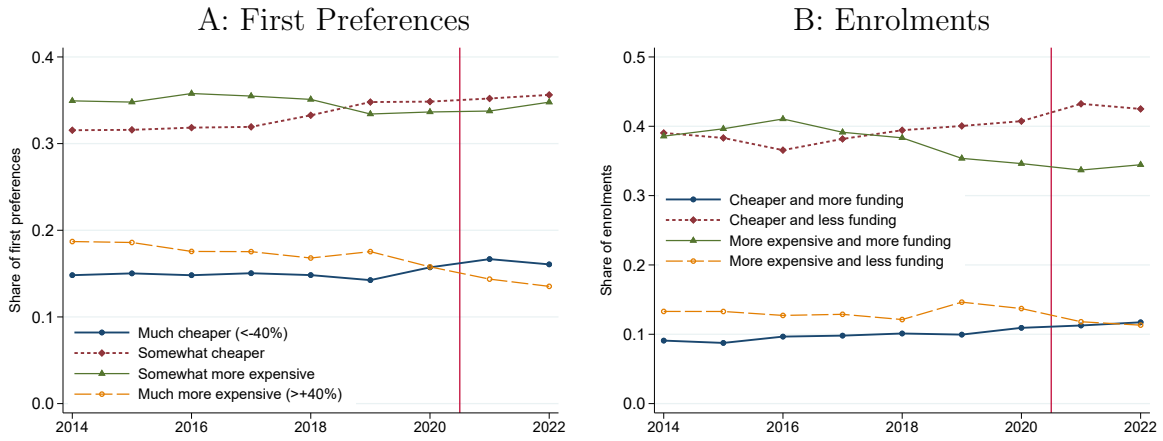
Panel A of Figure 3 presents movements over time in the shares of first preferences grouped by the size of the change in student contributions (fees) due to the JRG reform in 2021. If applicants respond to higher fees in the expected direction, preferences should fall if student contributions rise, and fall more if the increase is larger. It is difficult to observe clear responses in Panel A. The share of first preferences for fields that became much more expensive (>40% price increase) decline from 2020 to 2022. However, this may simply be a continuation of an overall trend decline in communications, arts (broad), criminology, and creative arts (broad).[21] The share of first preferences in fields that became somewhat more expensive (<40% price increase) rose post-reform, led by psychology, law and economics. While courses that became cheaper due to the policy change experienced an increase in first preference shares, it is difficult to determine whether there has been any significant deviation from pre-existing trends. Fields that became much cheaper (>40% price decrease) saw a large increase in first preference shares beginning in 2019 (prior to the policy change), mostly in teaching and nursing.[22]

Panel B of Figure 3 shows enrolment shares over time in fields grouped by the direction of both the change in student contributions and the change in total university revenue due to the policy change (the four segments of Figure 1). Enrolments are co-determined by applicant preferences and university offer decisions. As noted above, the policy change

[21] In some instances, these broad fields of study may involve students taking subjects belonging to more than one funding cluster. We employ enrolment-weighted averages across subject fields to calculate student and Government contributions for these broad courses.

[22] The COVID-19 pandemic may have increased interest in studying nursing (Pfeifer, 2022; Bai et al., 2021), so this increase may be due to an underlying change in course preferences rather than due to any fee change.

Figure 3: First Preferences and Enrolments by Price / Revenue Changes



Notes: Shares of first preferences and enrolments for domestic Bachelor degree places via the UAC. Groups in panel A determined by size and direction of the change in student contributions. Groups in panel B determined by direction of changes in student contributions and changes in overall university funding per student (student and government contributions combined). Vertical lines mark policy change between 2020 and 2021.

provided potentially inconsistent incentives for students and universities in the second and third categories (top two lines). The first category of 'cheaper and more funding' provides consistent incentives, potentially driving higher enrolments via both increased student preferences and university offers. Although the enrolment share of this category rises in 2021 and 2022 driven by architecture, IT, and public & other health, it may simply reflect an upward trend beginning in 2019, prior to the policy change. The fourth category also has aligned incentives of higher student contributions and lower university revenues, potentially pushing enrolments lower. While there is a decline in enrolments post-policy (driven by politics, history and human movement), it may reflect a continuation of a declining trend beginning in 2019.

Given the heterogeneous trends in both preference and enrolment shares across fields pre-policy change, we condition on linear field-of-study group trends in our analysis.

4 Decision Frameworks

In this section, we describe simple frameworks for thinking about the decisions of student applicants and universities when determining field-of-study preferences / allocations.

4.1 Student Preferences

We describe here a simplified net-present value framework to fix ideas around the decision problem facing students when choosing their field of study in a setting with an ICL. The framework builds on Chapman and Khemka (2022) by also allowing for the possibility of non-financial factors influencing student choice.

For a representative 18-year-old university applicant, the net present value of utility until expected retirement at age 65 can be expressed as:

$$U_i(f_v) = \underbrace{\sum_{t=19}^{65} \frac{y_{it}(f_v)}{(1+r_i)^{t-19}}}_{\text{PV Income}} - \underbrace{\sum_{t=19}^{65} \frac{h_{it}[f_v, y_{it}(f_v)]}{(1+r_i)^{t-19}}}_{\text{PV Costs}} + \underbrace{\gamma_i(f_v)}_{\text{Non-financial factors}} \tag{1}$$

where individual i discounts future expected incomes y_{it} and HECS-HELP loan repayments h_{it} at their individual-specific rate r_i, and γ_i represents the present value of non-financial factors affecting utility. Future expected incomes, HECS-HELP loan repayments and non-financial factors are all functions of f_v, the chosen field of study f at university v.[23] This framework allows for potential heterogeneity across fields of study (and universities) in expected incomes (medicine at a top-ranked university versus communications at a lower-ranked university). It allows for repayments h to vary by field of study as student contributions vary by f. Finally, repayments h are a function of incomes y under the Australian HECS-HELP system. Repayment rates are an increasing percentage of income (see Table A1). Higher earners also pay off more of their HECS-HELP debt each year, so repayments end sooner. Individuals who do not earn above repayment thresholds may never pay.[24]

Our representative 18-year-old maximises the present value of utility by choosing f_v subject to having an ATAR (high school achievement level) that exceeds the course's minimum requirement for entry:

$$\max_{f_v} U_i(f_v) \quad \text{subject to} \quad ATAR_i \geq \underline{ATAR}_{f_v} \tag{2}$$

Given a positive real rate of discount r_i, the present value of university costs under the Australian ICL is lower than the original student contribution amounts (recalling

[23] Expected incomes y_{it} include probabilities of unemployment and of withdrawal from the labour force.
[24] HECS-HELP debts are set to zero upon death.

that unpaid HECS-HELP debts are increased over time in line with headline CPI inflation only). Using this type of framework, Chapman and Khemka (2022) calculate the potential effects of the policy change we consider on changes in the present value of ICL repayments under Australia's HECS-HELP system. They illustrate the point that under this system, the present value of changes in ICL repayments given discounting are considerably lower than changes in student contribution rates. For example, using a conservative 5% discount rate, the authors calculate that for the average female studying communications, an increase of 113% in student contributions (what happened under the JRG reform) increases the present value of ICL repayments by only 83%.

Young adults may also have higher-than-average discount rates (Green et al., 1994; Read and Read, 2004), suggesting that sensitivity to changes in student contribution amounts may be lower among younger applicants. Prospective students may also find it difficult to calculate these present values given uncertainty about future incomes. Moreover, Soutar and Turner (2002) reports that students are concerned about more than cost when selecting university degrees, taking into account course suitability, academic reputation, teaching quality, campus atmosphere and job prospects. If the non-financial factors subsumed in $\gamma_i(f_v)$ are sufficiently important, sensitivity to changes in course costs may be low.

4.2 University Enrolments

Here we describe a simple framework for thinking about university decisions regarding the enrolment of students by field of study. To fix ideas around the likely effect of the policy change on university incentives, we focus on one specific objective: maximising net teaching revenue. Universities likely have multiple objectives when determining their optimal allocation of resources: maximising net revenue, increasing research impact, improving reputation, plus others. Lindsay (1982) argues that universities are different from other institutions due to their "lack of profit motive, goal diversity and uncertainty, diffuse decisionmaking, and poorly understood production technology". We focus on the maximisation of net teaching revenue to aid the interpretation of our estimates, but acknowledge that this is very much a simplification.

University v's net teaching revenue (NTR) in year t may be defined as:

$$NTR_{vt} = \underbrace{\sum_{f=1}^{F}[G_{ft} + S_{ft}] \cdot E_{fvt}}_{\text{Revenue}} - \underbrace{\sum_{f=1}^{F} C_{fvt}(E_{fvt})}_{\text{Costs}} \tag{3}$$

where G_{ft} and S_{ft} are per-student government and student contributions in field f and year t respectively, E_{fvt} are university v's enrolments by field and year, while C_{fvt} are university teaching costs in field f, which are (for simplicity) assumed to be increasing and convex functions of enrolments, separable across fields.

As noted above, universities could choose how many students to enrol by field of study over our period of analysis.[25] However, at the time of the JRG reform (starting in 2018), each university had an overall cap on the aggregate amount of Government contributions ($G_{ft} \cdot E_{fvt}$) it received each year. These Maximum Basic Grant Amounts (MBGAs) are set in individual university-Government agreements formalised each year.[26] Designed to contain costs, these MBGAs act as a disincentive to university over-enrolment of students. If universities enrol students beyond their MBGA cap, they only receive the student contribution S_{ft} for each enrolment, not also the Government contribution G_{ft}. Universities have consistently breached their caps (Norton, 2020), which may be optimal if revenues from S_{ft} exceed marginal per-student costs in some fields. Other potential explanations for university over-enrolment may include administrative errors, pursuit of non-financial strategic goals, and attempting to encourage the Government to maintain or even increase their MBGA in future years.

Over the period since 2018, universities maximising NTR are potentially subject to $F + 1$ constraints:

$$\begin{aligned} \max_{E_{fvt}} NTR_{vt} \quad \text{subject to} \quad & \underbrace{\sum_{f=1}^{F} G_{ft} \cdot E_{fvt} \leq \overline{MBGA}_{vt}}_{\text{MBGA limit}} \\ \text{and} \quad & \underbrace{E_{fvt} \leq \min[(A_{fvt}(S_{ft}),\ \overline{E}^{S}_{fvt}]}_{\text{Enrolment constraints}} \quad \forall\ f = 1, ..., F \end{aligned} \tag{4}$$

where the first constraint reflects the MBGA limit and the remaining F constraints

[25] One exception is Medicine: see Higher Education Support Act (2003).

[26] MBGA's are legislated under the Higher Education Support Act (2003). Each university's MBGA can be found on the Department of Education website.

acknowledge that enrolments cannot exceed either the number of student applicants A_{fvt} or potentially other constraints on the number of places $\overline{E}^S_{fvt}$ universities are able to offer. Due to the MBGA, universities may respond less to changes in G_{ft} than to changes in S_{ft} when making offers to students. While changes in S_{ft} flow directly into university NTR, changes in G_{ft} may not if universities already are at or in excess of their MBGA.

The number of student applicants A_{fvt} by field are potentially a function of student contributions S_{ft} if applicants respond to costs. While increases in S_{ft} under the policy change may induce universities to offer more places in those fields, fewer students may apply, constraining enrolment growth. Concerns around reputation might also discourage universities from increasing enrolments via lowering entry thresholds (minimum ATARs), as it may reduce student quality.[27]

Universities may be unable to expand offers in response to the policy change if there are internal or external limits $\overline{E}^S_{fvt}$ on enrolments in some fields. For example, the policy change lowered S_{ft} in nursing to induce higher enrolments, but universities may be unable to offer more places due to difficulties in finding additional hospital placements for required nurse training.

While this framework is very much a simplification, it highlights several potential mechanisms at play when considering the likely offsetting and constrained impacts of the policy change on university enrolments.

5 Econometric Models

In what follows, we introduce two models that are used in our empirical analyses. The first model is a multinomial choice model that is used for analysing the stated preferences of university applicants. The aim of this model is to focus solely on the demand factors, and ascertain to what extent is the desirability of available fields of study influenced by their costs. The second model is a two-way fixed effects model that is used for analysing the eventual university enrolments. We use a different model to analyze enrolments, because the multinomial choice framework is less suited for the study of equilibrium outcomes that reflect both students' demand and universities' supply of education.

[27] See for example ABC Article titled "Students with lowest ATAR scores being offered places in teaching degrees: secret report". Posted 18 September 2018.

5.1 Student Preferences: Conditional Multinomial Logit

To assess whether the JRG reform managed to steer applicants' preferences towards the prioritized fields, we employ a conditional multinomial logit (CML) model. The multinomial structure of the model conforms well with our case where applicants choose from a broad set of fields, and that their stated preferences are mutually exclusive.

Applicant i chooses field f if the expected utility derived from this field (U_{if}) outweighs the expected utilities of all other fields. We assume that U_{if} is a function of applicants' individual characteristics $\mathbf{W}_i$, field-of-study attributes $\mathbf{X}_f$, and unobservable errors ϵ_{if}. The functional form of U_{if} is as follows:

$$U_{if} = \mathbf{W}_i'\boldsymbol{\beta}_f + \mathbf{X}_f'\boldsymbol{\gamma} + \epsilon_{if} \tag{5}$$

The individual characteristics $\mathbf{W}_i$ include age, gender, highest parental education level, ATAR (quadratic), First Nations status, school leaver status, language spoken at home, high school type, SES decile, and application year. Similar to covariates in the standard multinomial logit model, they are assumed to wield distinct influences on the utilities corresponding to each field of study (denoted by the subscript of $\boldsymbol{\beta}_f$).[28] Within the context of our model, $\mathbf{W}_i$ serve as control variables that account for year-to-year changes in the demographic characteristics of university applicants, and also for any overarching trends that characterize the rise or fall of applicants' interest in specific fields over time.

Our primary covariates of interest are the field-of-study attributes $\mathbf{X}_f$, which capture the payments associated with studying the given field. Specifically, we use the logarithm of student contributions S_{ft}, and the logarithm of total revenues ($S_{ft} + G_{ft}$). The subscript t denotes the application year, reflecting the fact that payment amounts changed in response to the policy change. We anticipate that applicants will be more responsive to the changes in student contributions, as these are the 'sticker prices' of their degrees. However, they could also respond to the changes in total revenues. For example, universities could engage in more aggressive marketing of courses with higher total revenues, thereby influencing applicants' stated preferences.

It is worth noting that the field-of-study attributes, unlike the individual character-

[28] An example of this is that applicants whose language spoken at home is English may derive different utility from studying English than applicants from other linguistic backgrounds.

istics, vary across choices. This has consequences for our estimation framework, because the standard multinomial logit model does not allow for this type of variation. Instead, we employ the CML model, which allows both choice-specific and choice-invariant covariates. Within the CML model, the choice-specific covariates are assumed to wield the same influence on each of the choice-specific utilities, which means that the applicants' price responses are homogeneous across fields of study.

Assuming errors ϵ_{fi} are i.i.d. type I extreme value, the probability that individual i chooses field f is:

$$P(f^* = f|X, W_i) = \frac{\exp(X_f'\gamma + W_i'\beta_f)}{\sum_{j=1}^{F} \exp(X_j'\gamma + W_i'\beta_j)} \tag{6}$$

Our CML model distinguishes between 27 broad fields of study ($F = 27$). These fields contain programs that are: 1) thematically close to each other, and 2) subject to the same student and government contribution amounts.[29] Allocations of individual programs to the 27 fields are listed in Appendix Table A4.

Coefficients for the CML model are estimated via Maximum Likelihood. We use these estimates to calculate response elasticities to changes in student contributions S_{ft}.

$$e_{S_f} = \frac{\%\Delta P(f^* = f)}{\%\Delta S_f} \tag{7}$$

The inclusion of total revenues in the model has the added benefit that the response elasticities correspond to a hypothetical scenario in which increases in student contributions are fully compensated by reductions in government contributions (so that the total revenues remain constant). The advantage of these elasticities is that they isolate applicants' responses to the sticker price of their degrees, whilst ensuring their preferences are not influenced by any potential supply effects stemming from increasing total revenues.

[29] We make two exemptions to this rule to avoid specifying fields with very small numbers of enrolments: (1) Foreign Languages are grouped with English and Literature Studies, and (2) Pathology is grouped with Pharmacy, Optometry and Allied Health. While student contributions are the same within these groups, Government contributions are higher for foreign languages and for pathology. We also excluded individuals choosing general education or "mixed field" programs, because we cannot establish what are the expected costs of these degrees.

5.2 University Enrolments: Poisson

We estimate the effects of changes in student and government contributions on university enrolments by field of study using a two-way fixed effects (TWFE) framework:

$$E_{ft} = \beta_0 + \beta_1 \ln(S_{ft}) + \beta_2 \ln(G_{ft}) + \eta_f + \gamma_t + \delta_f \cdot Y_t + \varepsilon_{ft} \tag{8}$$

where E_{ft} are enrolments in field f in year t, η_f are field of study fixed effects and γ_t are commencement year fixed effects. In some models, we also include separate linear time trends by field of study ($\delta_f \cdot Y_t$) to allow for differential trends in enrolments by field of study.

As E_{ft} is count data and there are zero enrolments in some fields in specific years in our data, we estimate this model using the Poisson Psuedo-Maximum Likelihood (PPML) estimator. Coefficient estimates on logged covariates from this model can be interpreted as elasticities.

6 Results

6.1 Preferences of university applicants

The key estimates from the CML model of applicants' field-of-study preferences are presented in Table 3. For the sake of parsimony, we restrict our attention to the coefficient estimates corresponding to field-specific attributes, and the estimates of applicants' price elasticities.

6.1.1 Baseline results

Baseline results for all UAC applicants are presented in Column 1. As expected, the coefficient estimate on student contributions is negative and highly statistically significant ($p < 0.001$). However, since it does not have a clear economic interpretation, we turn to the corresponding price elasticity. The elasticity is -0.104, which means that a 1% increase in field-specific student contributions lowers applicants' preference for that field by 0.104%. Applicants are thus responsive to the prices of their degrees, however it needs to be emphasized that meaningful changes of their preferences require very large price changes. The coefficient estimate on total revenues is positive, but is not statistically

significant. The positive sign is in line with the prediction that universities may engage in more aggressive marketing of courses that generate more revenue per student, but the applicants' preferences do not seem to be substantively influenced by these supply-side effects.

Table 3: Student Preferences, Conditional Multinomial Logit Results

	All	Men	Women	School Leaver	Non-leaver
	(1)	(2)	(3)	(4)	(5)
Log student contributions	-0.115***	-0.072***	-0.138***	-0.062***	-0.206***
	(0.011)	(0.019)	(0.014)	(0.014)	(0.019)
Log university revenues	0.052	-0.027	0.111**	0.043	0.020
	(0.032)	(0.049)	(0.043)	(0.039)	(0.055)
Field demand elasticity	-0.104***	-0.065***	-0.125***	-0.057***	-0.185***
w.r.t. student contributions	(0.011)	(0.016)	(0.012)	(0.015)	(0.015)
Applicants	719,588	314,314	405,274	427,689	291,899

	English	Non-English	Low SES	Medium SES	High SES
	(6)	(7)	(8)	(9)	(10)
Log student contributions	-0.112***	-0.133***	-0.096***	-0.095***	-0.134***
	(0.013)	(0.024)	(0.029)	(0.021)	(0.015)
Log university revenues	-0.029	0.263***	0.043	-0.019	0.082*
	(0.037)	(0.063)	(0.084)	(0.063)	(0.042)
Field demand elasticity	-0.102***	-0.118***	-0.086***	-0.086***	-0.121***
w.r.t. student contributions	(0.011)	(0.021)	(0.027)	(0.018)	(0.015)
Applicants	513,915	205,673	123,326	200,844	395,418

Notes: 'English' and 'Non-English' refers to whether the applicant's primary language at home is English or not. 'Leaver' and 'Non-leaver' refers to whether the applicant is applying straight out of high school or not. Low, medium and high SES is based on the highest level of parental education. Field demand elasticities denote weighted averages of field-specific elasticities e_{S_f}, with the weights being the applicant shares observed in year 2020. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

The framework described in Section 4.1 suggests why price is unlikely to be the primary factor driving applicants' preferences. Firstly, the net present value of university fees is considerably lower than the quoted nominal amount (since graduates pay off their HECS-HELP debt over an average of 9.4 years).[30] When an (average) applicant is deciding which field to study, they are discounting fee repayments over 12.4 years (including

[30]Based on 2020-21 data in an Australian Parliament HECS-HELP Loan Report.

three years of study). Depending on their personal discount rate – which could be quite high for young people focused on their present finances – their present value of university fees can be much lower than the 'sticker price'. In 2022, the price difference between the cheapest and most expensive course was $10,645 per year. For an applicant choosing a 3-year degree with a 5% discount rate and an expectation to earn the median Australian income after graduation, the present value difference becomes $4,186 per year, or 61% less (Chapman and Khemka, 2022). Even a large price increase may thus have little effect on applicants who expect to be in a low income percentile permanently, since they will never have to repay their debt.

Secondly, the present value of student contributions is small in comparison to expected lifetime income. Daly et al. (2015) estimates that Australian Bachelor degrees have private rates of return between 8% and 58% (humanities and economics, respectively). Applicants wishing to maximise lifetime income are thus likely to focus more on expected incomes than costs.

Thirdly, students consider non-financial factors when deciding what degree to study (Soutar and Turner, 2002). Students also consider non-financial factors when choosing the specific tertiary institution they wish to attend (Johnston, 2010; Price et al., 2003).

Moreover, the timing of this research only allows us to estimate effects for two post-reform periods. de Gendre and Kabátek (2021) find that the effects of fee changes on student decisions are often lagged, with larger effects each year post-reform until a new equilibrium is reached.[31] It is possible that Australian applicants may become more price sensitive in future years.

6.1.2 Heterogeneity among demographic groups

In this section we investigate whether various demographic groups are more or less responsive to the changes in prices and revenues.

Columns 2 and 3 of Table 3 show results split by applicant gender. We see that women are almost twice as responsive to the changes in student contributions than men. This is in line with the findings of de Gendre and Kabátek (2021), who found that Dutch women are much more responsive to the changes in national student finance system than

[31] This is potentially due to university courses often having high school subject prerequisites, making it difficult to change university plans in the final years of high school.

Dutch men.[32] Interestingly, women are also responsive to the changes in total revenues, which suggests that their preferences may be more sensitive to the universities' marketing campaigns.

Next, we look at the results for applicants who are transitioning to university study straight from high school (Column 4), and individuals applying later in life (Column 5). We see that the latter group is much more responsive to changes in student contributions. Such individuals are likely to face a higher present value of repayments, since their present income may already exceed loan repayment thresholds. We do not find large differences in the price responsiveness of applicants with English and non-English family backgrounds (Columns 6 and 7), although applicants with non-English backgrounds appear responsive to changes in total revenues.

We also do not find large differences in price responsiveness across low-, medium- and high-SES applicants (Columns 8, 9 and 10). While this may seem counter-intuitive and at odds with previous research, the income-contingent nature of HECS-HELP loan repayments implies that the relative responsiveness of the three SES groups is ex-ante ambiguous.[33]

6.1.3 JRG Reform Effects

We now consider the overall effect of the JRG reform. Figure 4 presents the percent changes in demand for the 27 fields of study, as predicted by our model. These predicted changes are presented together with the percent changes in student and Government contributions due to the reform (the graph of nominal changes in demand and contributions can be found in Appendix Figure A1). To further contextualize the overall importance of the presented demand changes, the secondary vertical axis of Figure 4 lists the overall field demand (proxied by the share of 2020 applicants whose first preference was to study the respective fields).

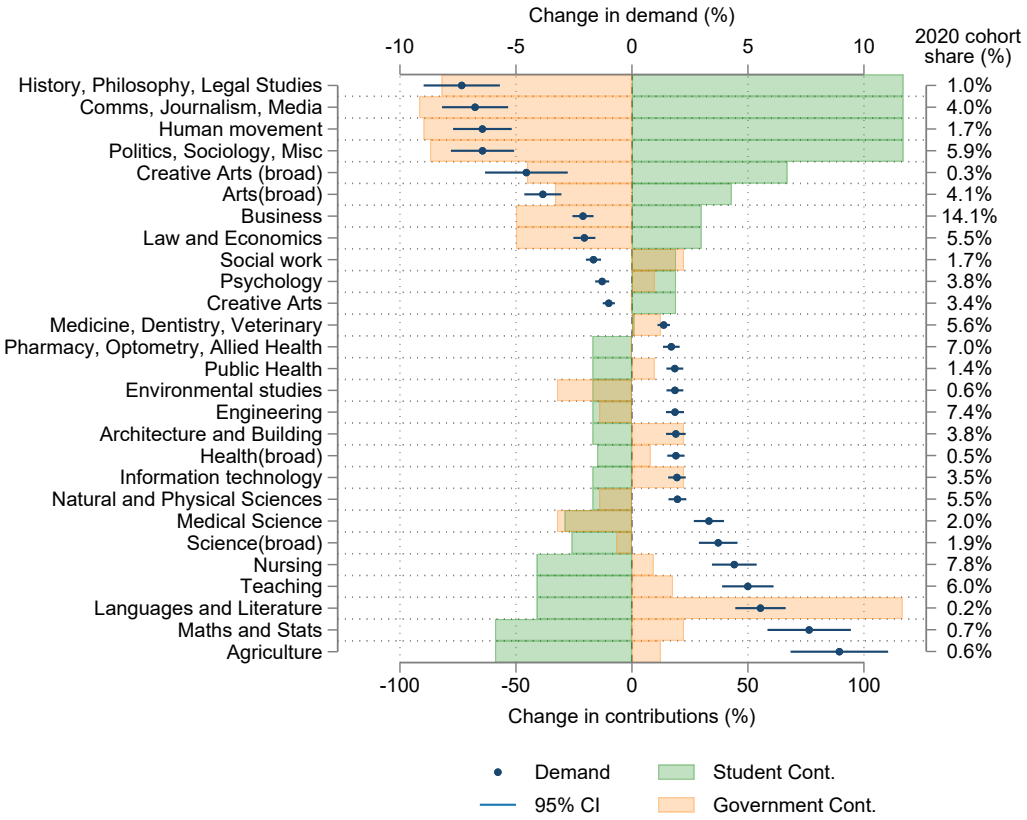
In line with the coefficient estimates presented in Table 3, we see that changes in

[32] One of the possible mechanisms underlying these results is that of Breda and Napp (2019), who showed that women tend to be less constrained in terms of their field-of-study choices than men. If it is indeed the case that men (given their interests and test scores) do not have as many fields to choose from, they are likely to prove less price elastic than women.

[33] Andrews (1999) concludes that it is unclear whether university fee increases under HECS deter low SES students and posits that if low SES applicants are more debt-averse, they may be more price sensitive. Our findings suggest that there is no difference for low SES applicants, which concurs with Christofides et al. (2001).

demand are inversely related to changes in student contributions. Changes in Government contributions wield a much smaller (positive) influence on preferences.

Figure 4: Estimated Effects of the JRG Reform on Applicant Preferences



Notes: Changes in demand for individual fields are estimated by applying the 2021 contribution rates to the 2020 cohort of applicants, and comparing their predicted preferences to the ones predicted under the 2020 contribution rates. Bootstrapped 95% confidence intervals are based on 100 draws from the underlying parameter distribution. 2020 Cohort shares represent the shares of applicants in the year 2020 whose first-preference course belonged to the respective field group.

The largest relative drop in preferences is 7.3%, for history, philosophy and legal studies (HPLS). These fields were subject to a \$7,816 (117%) increase in student contributions, and a \$5,016 (82%) decrease in government contributions.[34] The largest relative gain in preferences is 8.9% in agriculture. This field experienced a \$5,577 (59%) decrease in student contributions, and a \$2,986 (12.4%) increase in Government contributions. Most of the preference responses are, however, much more subdued: out of 27 fields, 20 experienced changes of less than 5% with 14 of those experiencing changes of less than 3%.

[34]The second largest negative effect pertains to communications, journalism, and media. Figure 4 shows that these fields were subject to a larger drop in government contributions than HPLS, which may lead us to expect a more pronounced demand effect. The reason why this expectation is not met is that HPLS is estimated to have a relatively low intrinsic value, which makes it more price-sensitive.

We note that both HPLS and agriculture are niche fields that attract only a small numbers of applicants (as evidenced by the respective 2020 cohort shares). This means that their large relative changes in preferences translate into quite small absolute changes: -0.07 and +0.05 percentage points (p.p.) of total student applications, respectively. In contrast, the largest absolute changes are in fields with sizable intakes: the largest absolute drop is in politics, sociology, sports and recreation (-0.38 p.p.), whereas the largest absolute increase is in nursing (+0.35 p.p.).

Finally, we approximate the total share of students whose stated preferences were altered by the reform. This is done using a dissimilarity index (DI) akin to Duncan and Duncan (1955). The functional form of the index is as follows,

$$DI = \sum_{f=1}^{F} \left| \frac{\Delta P(f^* = f)}{2} \right|. \tag{9}$$

The estimated dissimilarity index equals to 1.52, which means that the JRG reform made 1.52% of university applicants choose fields that they would have not chosen in the absence of the reform. Once again, this metric indicates that the reform-induced changes of students' preferences were relatively minor.[35]

6.2 University Enrolments

We now focus on the effect of changes in student and Government contributions on enrolments by field of study. Final enrolments are determined both by student preferences (demand) and university allocation decisions (supply). While increases in student contributions may lower student preferences for certain fields, they may allow universities to allocate more places to such fields as per-student revenues are now higher. For enrolments to rise as preferences fall, there must exist excess demand, where the number of applications exceeds places offered by universities.

Estimates of the effects of student and Government contributions on university enrolments by field of study using PPML estimation and two-way fixed effects (year and field) are presented in Table 4. These coefficient estimates can be interpreted as approximate elasticities.

[35] We note that the dissimilarity index cannot capture preference shifts *within* each of the 27 field groups. More broadly, it cannot capture preference shifts that leave the composition of field shares unchanged. The index should be therefore considered a lower bound of the overall reform effect

Table 4: Student Enrolments, Poisson PML Estimation Results

	All years (2014-22)		Cap years (2018-22)		Final years (2019-22)	
	(1)	(2)	(3)	(4)	(5)	(6)
Log student contributions	-0.247	-0.143*	-0.152	-0.0471	-0.108	-0.0934
	(0.196)	(0.0773)	(0.120)	(0.101)	(0.100)	(0.111)
Log government contributions	0.0274	0.0149	0.0340	0.0961	0.0637	0.0182
	(0.0984)	(0.0466)	(0.0555)	(0.0936)	(0.0556)	(0.0527)
Log university revenue	-0.388	-0.115	-0.166	0.0598	-0.0366	-0.126
	(0.322)	(0.171)	(0.210)	(0.267)	(0.218)	(0.204)
Log student contributions	-0.271***	-0.166***	-0.204***	-0.218*	-0.219***	-0.119***
	(0.0684)	(0.0591)	(0.0364)	(0.126)	(0.0580)	(0.0460)
Log university revenue	-0.220	-0.0166	-0.0399	0.188	0.0945	-0.0553
	(0.255)	(0.174)	(0.162)	(0.301)	(0.183)	(0.190)
Year indicators	✓	✓	✓	✓	✓	✓
Field indicators	✓	✓	✓	✓	✓	✓
Year (linear) by broad field		✓		✓		✓
Observations	2,104	2,104	1,180	1,180	944	944

Notes: Models estimated using Poisson Psuedo-Maximum Likelihood (PPML). University revenue is the sum of student and government contributions per student. Standard errors clustered at the broad 27-group field of study level are provided in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Using enrolment data by individual field of study[36] over all years from 2014 to 2022 yields a negative but imprecisely estimated coefficient on student contributions (column 1, top panel). The coefficient on government contributions is near zero. If we combine government and student contributions into a measure of total university per-student revenue (second panel in Table 4), the coefficient is also negative but again imprecisely estimated. If we instead include both student contributions and total university per-student revenue in the model (third panel), the coefficient on student contributions is negative and statistically significant at standard levels. This third model is closest in spirit to our CML estimates for student preferences. There is thus no evidence of universities responding to the JRG reform in a manner consistent with maximising net teaching revenue. Rather, enrolments generally moved in the same direction as student preferences.

In column 2 of Table 4, linear time trends by broad field of study (the 27 broad fields

[36]There are 236 individual fields of study in recent years. A small number of these were not offered in early years.

used in the CML estimation of student preferences above) are included in the estimating equations. The estimated coefficients on student contributions and university revenue both fall in absolute value, with some improvement in estimation precision. Restricting our attention to the years when the government capped Government contributions (columns 3 and 4) resulted in further reductions in the absolute values of the main coefficients. Restricting the time period of analysis even further to just the last four years (2 years pre and post reform) again resulted in imprecise negative coefficients. Overall, there is little evidence in Table 4 for these very large changes in student contributions having any large significant effect on enrolments by field of study. In addition, there is little evidence that universities were increasing enrolments in fields where they received more funding.

One possible explanation for these insignificant enrolment responses by universities are difficulties in altering a specialised workforce in the short run. Although Australian universities employ a significant number of staff on casual (non-permanent) bases, the majority of lecturers and course coordinators running degree programs are generally on a mix of medium-term contracts and permanent positions (NTEU Policy and Research Unit, 2018). Such staff are highly trained in their specific fields (for example, medicine or mathematics), and would not be in any position to simply switch fields to teach into other programs. Universities may take time to adjust their workforce in response to any changed incentives.

In addition, this policy change came into effect when the effects of the COVID-19 pandemic were still being felt. There was considerable uncertainty surrounding international student enrolments at this time.[37] Universities may have been focused on responding to this uncertainty rather than on this policy change affecting domestic student enrolments when making staffing decisions.

Enrolment responses to the policy change broken down by university group are provided in Table 5. The precision of the estimates here is, however, quite low.

There is some indicative evidence, however, that enrolments in Metropolitan universities fell with student contributions while they increased in Regional universities with Government contributions. There is little evidence that the Top-ranked Research and Metropolitan universities exhibited behaviour consistent with maximisation of net teach-

[37] See The Conversation article titled "COVID-19: what Australian universities can do to recover from the loss of international student fees". Posted on 3rd of June, 2020.

Table 5: Enrolment Responses by University Group

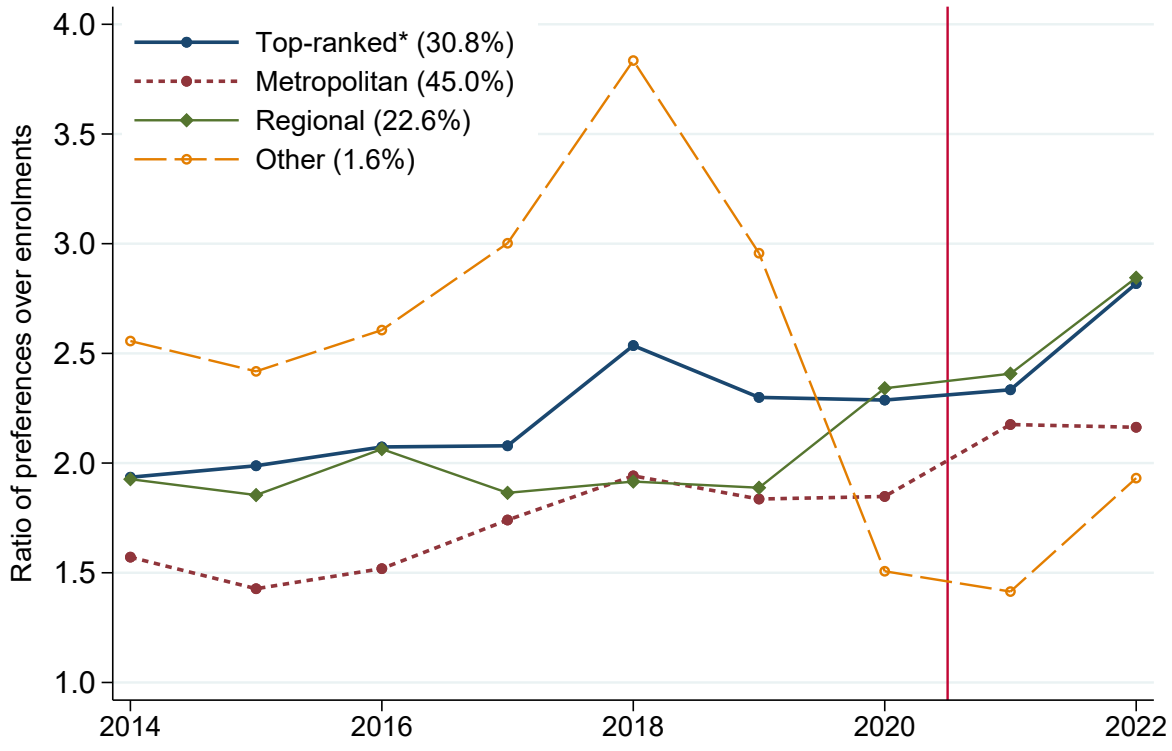
	All years (2014-22)			Cap years (2018-22)		2019-22
	(1)	(2)	(3)	(4)	(5)	(6)
Log student contributions by						
Top-ranked Research	-0.263	-0.128	-0.0825	-0.211	-0.179	-0.153
	(0.273)	(0.187)	(0.295)	(0.220)	(0.159)	(0.198)
Metropolitan	-0.515*	-0.359*	-0.250	-0.351**	-0.158	-0.269
	(0.271)	(0.216)	(0.206)	(0.176)	(0.180)	(0.172)
Regional	0.112	0.108	-0.0612	0.126	0.260	0.106
	(0.319)	(0.288)	(0.253)	(0.244)	(0.269)	(0.245)
Other	-0.0657	-0.152	0.239	0.183	0.219	0.231
	(0.313)	(0.360)	(0.268)	(0.279)	(0.316)	(0.263)
Log government contributions by						
Top-ranked Research	0.0163	0.0583	-0.0407	-0.0233	0.0127	0.00846
	(0.106)	(0.0938)	(0.125)	(0.0937)	(0.0960)	(0.0836)
Metropolitan	-0.0912	-0.106	0.0222	-0.0227	0.0469	0.0339
	(0.130)	(0.0993)	(0.158)	(0.101)	(0.155)	(0.126)
Regional	0.291	0.195	0.0955	0.234	0.266**	0.192
	(0.194)	(0.136)	(0.126)	(0.147)	(0.134)	(0.136)
Other	-0.00902	-0.0834	0.0444	0.0266	0.0321	0.0503
	(0.178)	(0.182)	(0.136)	(0.139)	(0.165)	(0.129)
Log university revenue by						
Top-ranked Research	-0.183	0.0844	-0.0963	-0.131	0.0119	-0.0354
	(0.275)	(0.341)	(0.292)	(0.248)	(0.303)	(0.267)
Metropolitan	-0.561	-0.240	0.0398	-0.140	0.211	0.0470
	(0.450)	(0.340)	(0.380)	(0.345)	(0.401)	(0.397)
Regional	-0.0378	-0.0237	-0.349	-0.130	0.0846	-0.0776
	(0.660)	(0.438)	(0.419)	(0.529)	(0.488)	(0.444)
Other	-0.170	-0.119	0.305	0.174	0.309	0.220
	(0.547)	(0.523)	(0.371)	(0.436)	(0.461)	(0.453)
Year by university group	✓	✓	✓	✓	✓	✓
Field by university group	✓	✓	✓	✓	✓	✓
Year (linear) by broad field		✓			✓	
Year (linear) by broad field by university group			✓			
Observations	8,416	8,416	8,416	4,720	4,720	3,776

Notes: Models estimated using PPML. University revenue is the sum of student and government contributions per student. Standard errors clustered at the broad 27-group field of study level are provided in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

ing revenue. There is some weak evidence of enrolments at 'other' higher education institutions responding positively to increased revenue but only if estimation is confined to more recent years.[38]

As noted in Section 4.2, the ability of universities to respond to increased tuition revenue by raising enrolments is constrained by student applications (demand). Applications must exceed the number of places previously being offered for universities to enrol more students. They may not choose to do this if it requires lowering the student achievement entry threshold too much. Figure 5 provides details on the ratio of student applications to university enrolments in the UAC data over time. First preferences exceed enrolments for all four university groups. These ratios also increased in 2018 when government contributions were first capped, constraining enrolment growth. These ratios show that at the time of the policy change, the Top-ranked Research and Regional universities enjoyed the highest rates of 'excess demand', suggesting that they may have more room to increase enrolments in response to rising tuition.

Figure 5: Ratio of applications to enrolments by university group, 2014-2022



Notes: Ratio of first preferences to enrolments by university group and year in UAC data. Figures in parentheses are university group shares of enrolments averaged over the 2014 to 2022 period. * Top-ranked according to international rankings of universities, primarily based on research.

[38]These 'other' higher education institutions account for only 1.6% of enrolments in the UAC data.

7 Conclusions

Using large discrete policy-induced changes in university fees by field of study in Australia, we find that student applications are not particularly price sensitive in a system where income-contingent loans (ICLs) are available. We also find that universities did not respond to these large changes in both student and government contributions in a manner consistent with maximisation of net teaching revenue. We contribute to the related literature by analysing rich preference and enrolment data, allowing us to isolate the effects of fee changes on student choices. The majority of prior research observed enrolments or completions only, with these being affected both by student choices and university allocation decisions.

While these large policy-induced changes in student contributions have had little effect on individual field of study decisions, they will have lasting effects on the student debt levels of individuals. For example, students pursuing studies in communications will accumulate debts of $43,500 after three years of study, while those pursuing literature will have debts of only $11,850. While Australian domestic students can delay repayment until they are earning a reasonable wage post-study via an ICL with a zero real interest rate, larger debts mean repayments will stretch over many more years. This may affect decisions regarding purchasing a home, getting married and having children. The underlying inequities in this policy change are quite stark.

Having an appropriately trained workforce is important for the overall economy and general well-being. Policy interventions to influence student field of study decisions towards "in demand" areas such as nursing and teaching may more usefully include raising wages or targeted educational campaigns during high school.

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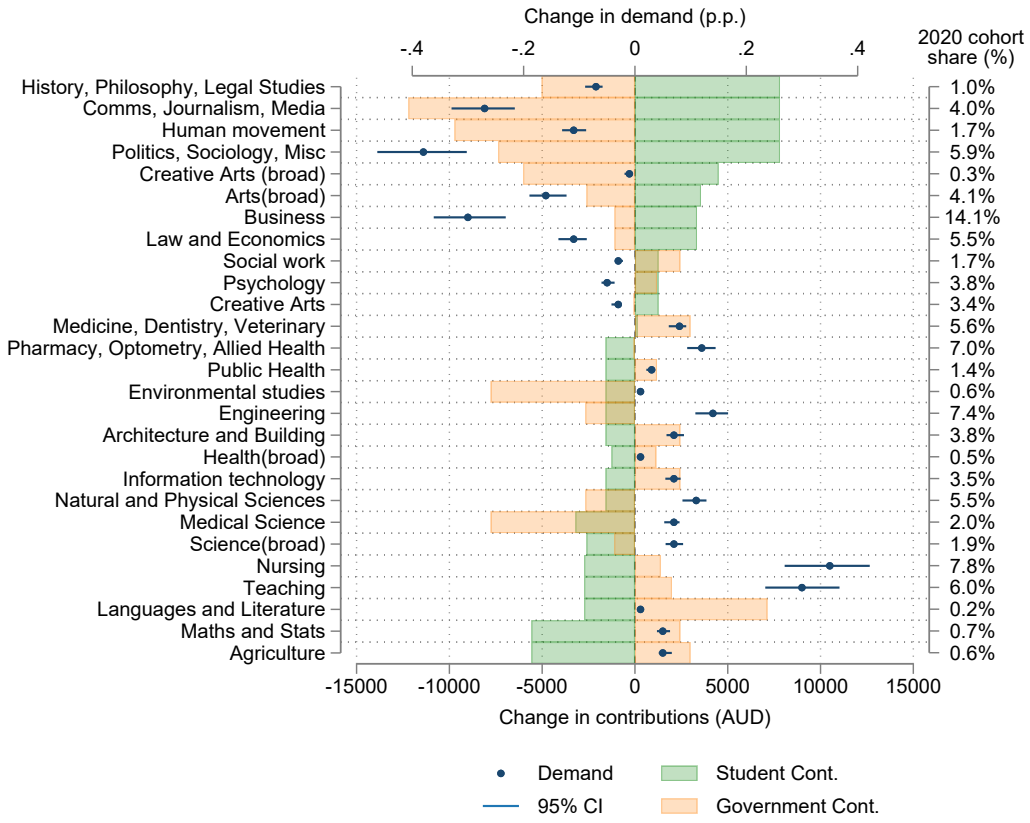
Appendix – Additional Information

Figure A1: Estimated Nominal Effects of the JRG Reform on Applicant Preferences



Notes: Changes in demand for individual fields are estimated by applying the 2021 contribution rates to the 2020 cohort of applicants, and comparing their predicted preferences to the ones predicted under the 2020 contribution rates. Bootstrapped 95% confidence intervals are based on 100 draws from the underlying parameter distribution. The ordering of fields is aligned with Figure 4.

Table A1: HECS Repayment Income Thresholds and Rates, 2020/21

Taxable Income Range	Repayment Rate	Percentiles of Taxable Income
Below $46,620	Nil	Below 31
$46,620 to $53,826	1%	31 to 40
$53,827 to $57,055	2%	40 to 44
$57,056 to $60,479	2.5%	44 to 48
$60,480 to $64,108	3%	48 to 51
$64,109 to $67,954	3.5%	51 to 55
$67,955 to $72,031	4%	55 to 59
$72,032 to $76,354	4.5%	59 to 62
$76,355 to $80,935	5%	62 to 66
$80,936 to $85,792	5.5%	66 to 69
$85,793 to $90,939	6%	69 to 72
$90,940 to $96,396	6.5%	72 to 75
$96,397 to $102,179	7%	75 to 78
$102,180 to $108,309	7.5%	78 to 81
$108,310 to $114,707	8%	81 to 83
$114,708 to $121,698	8.5%	83 to 86
$121,699 to $128,999	9%	86 to 88
$129,000 to $136,739	9.5%	88 to 90
$136,740 and above	10%	Above 90

Notes: HECS-HELP debt repayment thresholds and rates for 2020/21 from the Australian Taxation Office: https://atotaxcalculator.com.au/help-debt#hecs2020, Percentiles of taxable income distribution for 2020/21 from Australian Government Database: https://data.gov.au/data/dataset/taxation-statistics-2020-21/resource/d902104e-a9c1-4d14-8d21-f4538bda037a.

Table A2: Student / Government Contributions Pre and Post Policy Change

	Group	Student Contributions		Government Contributions	
		2020	2021	2020	2021
1	Mathematics and Statistics	9527	3950	10821	13250
2	Natural and physical sciences	9527	7950	18920	16250
3	Medical science	11155	7950	24014	16250
4	Information technology	9527	7950	10821	13250
5	Engineering	9527	7950	18920	16250
6	Architecture and Building	9527	7950	10821	13250
7	Agriculture	9527	3950	24014	27000
8	Environmental studies	9527	7950	24014	16250
9	Medicine, Dentistry, Veterinary	11155	11300	24014	27000
10	Nursing	6684	3950	14858	16250
11	Pharmacy, Optometry, Allied Health	9527	7950	13308	13250
12	Public Health	9527	7950	10821	13250
13	Human movement	6684	14500	10821	1100
14	Teaching	6684	3950	11260	13250
15	Business	11155	14500	2198	1100
16	Politics, Sociology, Curatorial, S&R	6684	14500	10821	1100
17	Social work	6684	7950	10821	13250
18	Psychology (professional pathway)	6684	7950	13308	13250
19	Law and Economics	11155	14500	2198	1100
20	Languages and Literature*	6684	3950	6116	13250
21	History, Philosophy, Legal Studies	6684	14500	6116	1100
22	Creative Arts	6684	7950	13308	13250
23	Communications, Journalism, Media	6684	14500	13308	1100
24	Science (broad)	10115	7545	19938	15946
25	Health (broad)	8256	6995	15151	15634
26	Arts (broad)	8195	11755	7267	5761
27	Creative Arts (broad)	6684	11192	13308	7237

Notes: Figures published by the Department of Education and Training, Australian Government. S&R = Sports and Recreation. * Government contributions based on English and Literature rather than Foreign Languages as the former are the majority of enrolments. Foreign languages had higher government contributions: $13,308 in 2020 and $16,250 in 2021.

Table A3: Higher Education Institutions by Group, UAC data

Group	University
Top-ranked Research	Australian National University
	University of New South Wales
	University of Sydney
Metropolitan	Australian Catholic University
	Griffith University
	Macquarie University
	University of Technology Sydney
	Western Sydney University
Regional	University of Canberra
	Central Queensland University
	Charles Sturt University
	University of New England
	Southern Cross University
	University of Newcastle
	University of Wollongong
	La Trobe University
Other	Australian College of Physical Education
	Australian Maritime College
	Australian College of Applied Psychology
	Charles Darwin University
	International College of Management, Manly
	Macleay College
	Melbourne Institute of Technology, Sydney
	National Art School
	SAE Creative Media Institute
	Sydney Institute of Business and Technology
	Torrens University Australia
	Top Education Institute

Notes: UAC grouping of universities and other higher education institutions.

Table A4: Field of Study by Group, Estimation of Preferences

	Group	Field of Study Codes
1	Maths and Stats	10100 to 10199
2	Natural and physical sciences	10301 to 19900, 19903 to 19999
3	Medical science	19901
4	Information technology	20000 to 29999
5	Engineering	30000 to 39999
6	Architecture and Building	40100 to 40399
7	Agriculture	50100 to 50799
8	Environmental studies	50900 to 59999
9	Medicine, Dentistry, Veterinary	60100 to 60199, 60700 to 60799, 61101
10	Nursing	60300 to 60399
11	Pharmacy, Optometry, Allied Health	60113, 60501, 60900 to 60999, 61305, 61500 to 61713, 69901, 69905
12	Public Health	61300 to 61303, 61307 to 61399, 61799 to 69900, 69999
13	Human movement	69903
14	Teaching	70000 to 79999
15	Business	80000 to 89999
16	Politics, Sociology, Curatorial, Sports and Recreation	90100 to 90303, 90309, 90313, 90399, 91303, 92100 to 99999
17	Social work	90500 to 90599, 90799
18	Psychology	90700 to 90701
19	Law and Economics	90900 to 90999, 91901
20	Languages and Literature	91500 to 91599
21	History, Philosophy, Legal Studies	90305, 90307, 90311, 91100 to 91199, 91701, 91703
22	Creative Arts	100100 to 100599, 109900, 109999
23	Communications, Journalism, Media	100700 to 100799
24	Science (broad)	10000
25	Health (broad)	60000
26	Arts (broad)	90000
27	Creative Arts (broad)	100000

Notes: Authors' grouping of fields of study for estimation of student preferences via CML. Students preferencing general education or mixed field programs (codes 120100 to 129999) not included.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