Testing Means-Tested Aid

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June 2016

Abstract: Inequalities do not end once students enter higher education. Yet, the majority of studies into the effectiveness of higher education aid examine its impact on college enrolment. In this paper, we provide evidence on the causal impact of means-tested but otherwise unconditional financial aid on the outcomes of students who have already enrolled in college. To do so, we exploit a unique non-salient financial aid program which varies both across and within institutions, and for which eligibility is a highly non-linear function of parental income. Using student-level administrative data collected from 9 English universities, we study the effects of aid receipt on college completion rates, annual course scores, and degree quality. Our findings suggest that each £1,000 of financial aid awarded increases the chances of gaining a good degree by around 3.1 percentage points, driven by increases in annual rates of completion and course scores.

JEL classification: I22, I23, I28

Keywords: higher education, financial aid, degree completion

Acknowledgements: We thank Damon Clark, Susan Dynarski, Caroline Hoxby, Sarah Turner and John Van Reenen and for their comments and suggestions. We would also like to thank participants of the AEFP 2016, NBER Education 2015, CESifo 2015 and Royal Economic Society 2014 conferences, the Russell Sage Foundation and the CEP, LSE, University of Texas at Austin and UCL Education workshops. We also thank Steve Barnes, Charley Greenwood, Prasanthi Ramakrishnan and Claudia Hupkau for their excellent assistance in collecting and cleaning the data. Wyness acknowledges ESRC funding (ES/L000105/1). All errors are our own.

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1. Introduction

Given the substantial economic returns to higher education (Leslie and Brinkman, 1998; Psacharopoulos, 1994, Blundell et al, 2000), increasing the probability of degree acquisition among disadvantaged students is important for governments' human capital accumulation and social mobility strategies. It is no surprise, then, that billions of dollars per year is spent on student aid in higher education (HE) systems around the world (OECD, 2016).

To date, the majority of student aid research has focused on its effects on the extensive margin, specifically focusing on matriculation decisions (Kane 1999, Dynarski, 2003; 2003, Seftor and Turner 2002, Nielsen et al., 2010, Dearden et al, 2010). The consensus from these studies is that aid programmes increase enrolment to the tune of around 1-3 percentage points per $1,000.

However, there is comparatively little research estimating the causal effect of aid on the intensive margin. The perennial issue is that the vast majority of financial aid programs will impact on both the extensive and intensive margins simultaneously, making it hard to isolate the impact of financial aid on student graduation. Moreover, whilst much research has looked at the impact of merit based incentives on the outcomes of enrolled students (Scott-Clayton, 2011; Garibaldi et al., 2012, Joensen,2013), generally finding that these incentives improves student outcomes, only a small number of studies have examined the effectiveness of non-incentive based aid on the outcomes of enrolled students, invariably focusing on Pell Grants (Bettinger, 2004; Denning, 2016). However, even the Pell grant has federal standards requiring the student to maintain a minimum GPA and credit ratio, with over 40 percent of first year community college students failing to meet them (Schudde & Scott-Clayton, 2014), meaning that even this funding is not completely unconditional.[1]

[1] Pell Grants have ongoing requirements called "Satisfactory Academic Progress" standards. The federal government requires that students on federal aid maintain a certain GPA and credit ratio, as well as complete their program within a specified timeframe, in addition to reapplying for aid every year. Colleges have some flexibility in how they implement the policy, but most require a 2.0 cumulative GPA and that students complete 2/3 of their credits attempted at the end of year 1.

In the absence of incentives, why would an unconditional cash transfer have any impact on student outcomes? It is often thought that liquidity constraints faced by some students limits their ability to learn, for example via not being able to afford learning materials, poor living environment, or increased time in paid employment. Providing students with fungible aid would relieve liquidity constraints. In addition to the financial benefits there may also be psychological benefits to the receipt of aid. Students receiving funds may increase effort treating the interaction as some form of gift exchange, or could increase their confidence if they perceive it to be awarded on the basis of ability. While the precise channels through which financial aid may impact student outcomes is interesting, it is beyond the scope of this paper. The paper answers the question 'what impact does unconditional financial aid have on students' outcomes from enrolment up to graduation?' This is a fundamental question as the socio-economic gaps do not disappear once students enter the door of HE. Low income students are more likely to drop out of college or perform poorly in exams (Bettinger, 2004; Crawford, 2013). And whilst college participation has grown substantially among young people from the poorest background over the past 20 years, completion rates have remained stubbornly low for this group relative to their richer counterparts (Bailey and Dynarski, 2011). The resulting 45 percentage point gap in college completion among rich and poor students, in conjunction with the high wage returns to a degree (Card, 1999), is a concern for income inequality and social mobility.

However, as is widely acknowledged in the literature (Dynarski, 2003; Bettinger, 2004) estimating the impact of student aid on educational attainment is an empirical challenge. There are three main issues at play. First, student aid tends to be correlated with many observable and unobservable factors that also affect an individuals' educational attainment. Aid recipients are more likely to be from poor backgrounds and so are more likely to drop out for reasons unrelated to receipt of aid. Hence, estimates of the impact of aid on attainment are likely to be downward biased. To overcome this issue, researchers would ideally study a form of aid in which students from the same income group receive varying amounts.

A second problem is that aid is often related to student ability. This can arise directly, through merit based programmes, or since more able students congregate at prestigious universities, who may in turn provide more generous financial packages. Since students attending these colleges generally have better university outcomes, this will exert a positive bias on coefficients measuring the impact of aid on student attainment. To overcome this issue, researchers would ideally study a form of aid in which students of the same ability level receive varying amounts.

Finally, the prospect of aid receipt at university may be correlated with the extensive margin in terms of a) a students' likeliness to attend college in general, and b) a students' likeliness to attend a particular college, making it difficult to separate the effects of aid receipt from enrolment effects. To isolate the effect on the intensive margin, researchers would ideally study a form of aid which could not have any influence on a student's decision to attend college, but could only impact their behaviour once they had enrolled.

In this paper we study a particular form of student aid – the English higher education bursary scheme – which we argue has unique features which help to overcome these three problems, and establish the causal impact of this element of financial aid on student performance at university.

As is the case in most student aid systems around the world, poor students are more likely to receive financial aid under the English bursary scheme. However, the definition of a poor student, and how much they receive in aid, varies across institution. In other words, whilst typically there would be no observable counterfactual to a poor student receiving aid (since all poor students receive aid), our data contain a range of counterfactuals at different levels of parental income. The scheme also varies within institution over time, meaning that students from different cohorts within institution receive substantially different amounts of aid. This setup effectively solves the first two of our problems; students with the same parental income and ability can have access to very different amounts of aid.

As well as this variation in aid within university over time, in our set up, aid eligibility is based on strict formulas, which are highly non-linear functions of parental income. Thus, in our most

restrictive specification, we can also exploit sharp changes in aid awarded for a small change in parental income within a university cohort to identify their effects.

The English higher education bursary system is also unique in that it is unadvertised to students, highly opaque, and does not require students to apply to receive it. This, in conjunction with the intricacies and timings of the English university application system, make it near impossible for students to know how much bursary aid they will receive in advance of attending university, making it irrelevant to their decision making (Corver 2010; Calendar and Jackson, 2013). This system ensures that bursary aid does not impact both forms of extensive margin, neither the decision to apply to college at all, nor the decision to apply to a particular college. Thus, we can be confident that our estimates of the impact of financial aid relate purely to the intensive margin.

All undergraduate students attending English universities are eligible for the aid scheme, regardless of their age. Moreover, the existence of multiple discontinuities in aid across a wide range of parental income groups means our results are more generalizable than studies which exploit single discontinuities. Thus, our study advances on work by Denning (2016), whose investigation of the impact of aid on enrolled students relates only to older students, and to students with parental incomes around a specific discontinuity. Unlike our work, his estimates also rely on students applying for the scheme, meaning they are more likely to be a highly motivated group receiving aid that is conditional on minimal standards. Similarly, we also advance on work by Bettinger (2004) who also uses discontinuities in the Pell Grant formula arising from family size to identify the impacts of aid. Again, students must apply for Pell, and moreover, whilst discontinuities in the Pell grant formula are likely to be independent of college choice, they are unlikely to be independent of the decision to attend college.

To examine the impact of bursary aid on college completion and degree performance we collected administrative data from 9 higher education institutions in England which contains detailed information on student's finances and attainment throughout college, as well as detailed measures of their human capital upon arrival at university. Our preferred within university-cohort estimates show

that each £1,000 of financial aid that students are eligible for in the first year increases the chances of obtaining a good degree by 3.1 percentage points. This is driven by improvements in both degree completion and course scores. We find that at the mean each £1,000 of financial aid awarded in the first year increases completion by 1.5-1.9 percentage points, and increases test scores by 0.03 to 0.06 standard deviations, depending on the year of study.

The remainder of this paper proceeds as follows. Section 2 outlines the UK student aid system, and the unique features of the higher education bursary scheme. Section 3 describes our dataset. Section 4 outlines our empirical strategy and results and robustness checks. Section 5 concludes.

2. Institutional setup

The UK higher education system is now characterised by high tuition fees and high financial support. During the period covered in this paper tuition fees for domestic students was capped at £3,000 and was binding for all bar a couple of institutions.[2]. These fees are typically not payed up front, instead students can take a variable nominal interest rate loan from the government (since March 2009 this has not exceeded 1.5 percent) which covers the entirety of the tuition fees and is paid directly to the university. Students can also take out a maintenance loan at the same rate, with the amount being limited by varying factors including parental income. The highest amount for the lowest income student living away from home, outside of London was £2,700 (2006/07).[3] Both of these loans are only repaid after graduation once the graduate is in employment and earning above £15,000 per year. In addition to student loans the government also provides a non-repayable means-tested maintenance

[2] In 2012 they increased from £3,300 to £9,000 per year, meaning they are now the highest in Europe and on a par with many US institutions. While tuition fees are decided at the institution level, in practise the vast majority of universities charge the full £9,000 per year, and the average fee stood at £8,830 in 2015 (See OFFA (2015): Table 2)

[3] For full-time undergraduates living away from home and studying at English universities outside London. Different rates apply for those living at home or studying in London. See https://www.gov.uk/student-finance/loans-and-grants for full details.

grants of up to £2,906 per year for students with parental incomes less than £19,000 (2006/7).[4] This culminates in a large level of state support, students starting in 2006/7 with zero reported parental income would receive £6,470 in maintenance loans and grants per year in addition to the entirety of the tuition fees being covered with a loan. This hybrid system of loans and grants is long established.

The financial aid program that is the focus of this paper is the English higher education bursary scheme. This was introduced by the UK government in 2006, alongside the raising of maximum tuition fees from £1,200 to £3,000 per year, as a way to placate opponents of the fee increase. As part of these tuition fee reforms English institutions were required to offer financial aid in the form of a bursary to all students in receipt of a full maintenance grant. Universities were prevented from having other requirements, such as prior academic attainment or academic performance whilst at university, though the student has to be enrolled at the university each year to receive their bursary. The minimum bursary that institutions could offer to these students was set to be the difference between full fee charged and the maintenance grant received by the student. Thus, the minimum bursary for the most deprived students at the time was £300 per year (£3,000 in fees minus £2,700 grants). From 2010 onwards, the rules were redefined so that the minimum bursary became 10% of fee charged.[5] In practice, universities have typically spent more than the minimum required on these forms of aid, and have extended it to more students. These regulations led to the bursaries program becoming large consisting of £300m of aid annually. around 44% of students receive a bursary, with the average the amount received per holder is £860 per bursary holder per year.

Other than the regulations described above, universities were provided with no guidance or research with how to allocate these funds. Rather, they were given complete independence in how

[4] However, maintenance grants will be abolished from September 2016 (with maintenance loans increased to make up the difference), meaning higher education bursaries – the form of aid studied in this paper – will become the sole non-repayable form of student financial aid. Bursaries also represent the sole form of aid which is governed at an institutional rather than a national level, giving rise to significant variation in eligibility across institutions, unlike the other national forms of aid. See http://www.ifs.org.uk/publications/7905 for more details

[5] Since 2012, no minimum bursary requirement has been in place. The bursary system was supplanted by the National Scholarship Programme (NSP) in which universities were allocated a set amount of money to distribute among their disadvantaged students in the form of bursaries, fee waivers or other benefits. The NSP has since been disbanded.

much they gave out and to whom.This resulted in universities designing their schemes on a somewhat arbitrary basis, with substantial variation in bursary generosity across institutions, ranging from £50 to £3,000. Moreover, there is a large degree of cross-cohort variation within institution over time as universities experimented with their schemes from year to year.

This set up effectively solves the first of the identification issues, that aid recipients are more likely to be from poor backgrounds. With the English bursary scheme, the definition of a poor student, and how much they receive in bursary, varies across institutions and within institutions over time. Therefore, while typically there would be no observable counterfactual to a poor student receiving aid (since all poor students receive aid), our data contain a range of counterfactuals at different levels of parental income. This is best illustrated by Figure 1. This shows average bursary paid over deciles of the parental income distribution of students that received bursary aid. Within each household income bracket, each point on the chart represents a university. As is evident, for students of similar income backgrounds, there is a substantial range of bursaries on offer. For example, students with parental incomes of less than £10,000 per year could receive as little as £350 and as much as £2,800 per year depending on the university attended.

The second concern is that aid can be related to student ability. Typically financial aid schemes award students with high entry test scores. Hence, we might be concerned that students with high prior attainment also receive high amounts of aid. In this case estimates of the effect of aid on student performance would be biased upwards. However the English scheme is non-merit based. So, conditional on parental income, bursary receipt is orthogonal to entry test scores. Moreover, as Figure 3 shows, whilst universities vary in quality, there is substantial overlap in entry test score requirements. This is driven by universities having different entry requirements for different subjects, particularly arising when a university has a spectrum of reputations across subject areas. Hence, there is a high incidence of common support in test scores across institutions.

However, we may also be concerned that high ability students attend certain institutions which may also offer higher bursaries. Our set up also alleviates this issue by exploiting changes in the

bursary schemes within universities over time. By way of example, Figure 2 shows how the bursary scheme of a single university changed between 2006 and 2011. During this time the maximum bursary that could be received increased from £3000 and then subsequently decreased to £1000, while the maximum parental income of eligible students increased from £15,000 to £25,000. Moreover the number of different levels of bursaries awarded and at this university decreased from three to two.[6] Thereby including university fixed effects along with controls for subject studied and enrolment test scores, we are ostensibly accounting for student ability and using the variation within a university across cohorts.

In our most preferred specification, we exploit the sharp changes in bursaries awarded for a small change in parental income within a university cohort. Again see Figure 2, which highlights the discontinuities in bursary aid awarded within universities according to parental income. In this specification we include university-cohort fixed effects, whilst also accounting for up to a third order polynomial in parental income, and nonlinear controls for entry test scores, a set of student characteristics and subject area studied. We also account for non-compliance by universities by instrumenting with the institutions' bursary rules. Here, the impact of aid is identified through imposing a smooth relationship of outcomes with parental income coinciding with sharp changes in aid eligibility.

Finally, our estimates of the intensive could still be biased if students choose to go to university because of the financial aid on offer, or indeed, select their institution based on its financial aid package, knowing that they will eligible for certain amount of aid – the third of our identification problems. For example, students from poor backgrounds might choose a particular institution if doing so would mean they gain from a particularly generous aid package, and may also be more likely to graduate for unobservable reasons unrelated to the generosity of aid e.g. motivation. However, in our

[6] In practise, for around half of institutions in our sample, students are subject to the bursary rules in place upon year of entry to the course, so that policy change occurring during the duration of their course do not affect them, only new entry students. However, for the remainderpolicy rule changes affect all students regardless of entry year.

setting, students are unlikely to sort on parental income, conditional on entry test scores, because students have very little possibility of knowing what their bursary is likely to be ahead of enrolling in college. This arises in part because university bursary schemes are highly opaque, participation is passive, and the uncertainty and timings involved in the English university application scheme. We argue that these factors lead to the program being relatively unknown and means that we are estimating the impact on the intensive margin only, rather than the program also changing the student composition through a) affecting students' decision to go to university, or b) affecting their choice of university. The ability to ignore the extensive margin is a major aspect of our findings, therefore we now explain in more depth the three features that make this a reasonable assumption.

First, each university has its own unique bursary scheme in place which typically change on a yearly basis. Universities are required to submit their bursary scheme to the Office for Fair Access (OFFA), in order to show they are complying with government regulations, but they are not required to advertise the scheme.[7] This has resulted in schemes being rarely advertised in university prospectuses or included in aggregated university guides. In order to know what bursary students are entitled to, they would have to actively search navigate the finance pages of each institution they are interested, or if unavailable know of the OFFA website, download the OFFA agreements and search the documentation for information relating to bursaries.[8] This may not be surprising as universities have an implicit disincentive to attract poor students to attend, since this will then cost the university in aid expenditure, in addition to any concerns surrounding peer effects.

Second, there is a large uncertainty at the time of application about which university they will eventually attend – and hence, which bursary scheme would be applicable to them. In the autumn

[7] Universities must report their bursary offer to the Office for Fair Access (OFFA), the English fair access watchdog, in order to satisfy requirements that they are making efforts to widen participation. Universities that do not satisfy OFFA that they are taking steps to attract poor students may not charge fees above £6,000 per year. In practice, no university has ever been refused the right to charge higher fees.

[8] To remedy this situation, Murphy and Wyness have recently collated the complete set of financial bursary rules for English universities and hosted a simplified version on the Guardian newspaper website for perspective students' use. This is available at http://www.theguardian.com/education/2015/jun/10/which-universities-offer-the-best-bursaries

before students would attend university, students apply to up to six universities through the Universities and Colleges Admissions Service (UCAS) a centralised application system, for a fixed fee by submitting their predicted entry scores and a personal statement.

In the spring students receive conditional offers from each of their chosen universities. At this point students rank their top two conditional offers (most favoured and a backup university), with this decision recorded by UCAS. Student then take their examinations in May and during August students receive their grades, and will know which of their ranked conditional choices they have been accepted to. The institutions are committed to accept the applicant and the applicant is committed to going if they meet the requirements. Only once the student has obtained their final results do they then receive a letter informing them of the bursary aid they will receive.

The upshot of this process is that students would not know ahead of time what bursary they will end up with, since they do not know which university will be attending until late in the process. Moreover, not knowing which bursary scheme will be applicable to the student will mean that they cannot game the system by mis-reporting parental income.

Third, participation in the bursary system is passive, as the students do not have to apply for a bursary in order to receive one. When applying to university courses in the Autumn, in addition to including their predicted entry test scores, students can also include household parental income if they which to apply for any of the government funded student finances (fee and maintenance loans and grants). Around 90% of undergraduate students choose to do so (Bolton, 2016). This income information is not passed on the universities, but sent to the Student Loans Company (SLC) to administer student finances.[9] The SLC also administers the bursary program, as each university supplies it with their bursary schedule, and in combination with the parental income information, calculates how much each student will receive.[10] Therefore when the student receives their first

[9] Universities can opt to administer their own scheme but the vast majority choose to do so through the SLC

[10] Similarly, the offer and bursary letters received by the student appears to be from the university the student is attending, but actually comes from the SLC.

instalment of their maintenance payment into their bank account at the start of the first term, in the same payment the SLC will make the bursary payment on behalf of the universities. This means that it is possible that students are not aware that they are in receipt of a bursary as it would be a combination of maintenance grant and loan and bursaries. Not only does this substantially reduce the salience of bursaries from the students' point of view, but it also means our estimates will represent a treatment effect as students are defaulted into the system, rather than an intention to treat which is more common in the literature.[11] Finally as the SLC validates the parental income with the government tax department, this again reduces the likelihood of gaming by students.

There is also empirical evidence that bursaries do not impact the enrolment choices of students in England. Calendar and Jackson (2013) survey students who enter English universities in 2008, coinciding with the mid-point year of our sample period. In accordance with the above, they point out that *"[students] are notified [about bursaries] only after they accept a place, when it is too late to inform their entry decision and HEI choice",* and *"A third of students surveyed had not yet been told whether or not they would receive a bursary, despite the fact that they were surveyed in October 2008 and had started their HEI course, or were about to."*

More substantive evidence that Evidence that English bursaries do not influence enrolment choices of students has been provided by Corver (2010) who looks at the impact of bursaries on application to university using detailed administrative data. Corver uses individual-level UCAS data on students' choice of university when students rank preferences of conditional offers. and finds no influence of bursary eligibility on student choice. Given the empirical evidence and institutional details, we are confident that bursaries do not, and indeed cannot, impact on the extensive margin.

[11] A further important implication is that take-up of bursary each year is not endogenously related to eligibility in the previous year. For example, it may be the case that students who receive large bursaries in first year (and who may also be more likely to be low income) may be more likely to take up their bursaries the next year (and vice versa). As take-up is not governed by the students' wishes, our results do not suffer from this bias.

But bursary aid may still influence the intensive margin, by impacting students' likeliness to complete each year of their degree, achieve higher university course scores and achieve a good quality degree. This is where we now turn our attention.

3. Data and institutional compliance

This paper makes use of a unique administrative dataset collected from 9 UK universities. The data comprise the entire undergraduate population of UK and EU students for up to 6 cohorts of students beginning their studies between 2006 and 2011.

We begin with a sample of 341,398 students. As our estimation strategy relies on using the variation in financial aid for a given level of entry test scores to estimate the effect of bursaries on student outcomes, we first discard those students for whom we have no knowledge of parental income (as stated in Section 2, we only hold parental income information for students who applied for some form of student aid) or those at universities that only provided banded parental income. We also discard those students undertaking vocational courses or those above or below degree level. This reduces our sample substantially, leaving us with 35,969 students.

Our sample is truncated, meaning we observe some students all the way through their studies (3 years), whilst we can only observe the first or second year of some students, since they would not have had the chance to complete their degrees at the time we obtained the data. Thus, in our preferred specifications, we use only the non-truncated sample of students, for whom we are able to observe their full transition through college, including dropouts. This is a total of 22,860 students. In a robustness check, looking only at completion in years 1 and 2, we include students for whom we only observe part of their transition through college – i.e. the full sample of 35,969 students.

The dataset tracks students throughout the course of their degree. Therefore we have information on each student's final degree outcome, including whether they dropped out, and their year of drop out, their annual course scores (generally this was provided as an annual average of all courses taken).

Since these scores are not comparable across universities, or individuals we standardised test scores by university subject and year.

In Table 1 we present some descriptive statistics on the individuals in our sample. The average bursary during the first year per bursary holder is £775. To compare bursary aid to state aid that is intended to relieve liquidity constraints in 2006/7 a student with zero reported parental income would receive £6,470 in maintenance loans and grants in our sample this student would also receive £1,138 of bursary aid. . Average parental income in our sample is £23,296 – though in our sample, we only observe the parental income data of students who provide their data to the SLC (see Section 2) for means-testing of student maintenance loans and grants. Since the upper limit for means-testing is £50,000 we generally observe the parental income of those at or below this limit. This does not bias our estimates since our empirical strategy relies on comparing bursary amounts within bursary holders, the vast majority of whom have parental incomes below this amount. As Table 1 also shows, 43% of the sample are male, 75% are under 22 and 80% of the sample are white. According to the most recent Higher Education Statistics Agency (HESA) statistics (HESA, 2015: Table 6a), 45% of full-time undergraduates are male, 61% are under 22, and 60% are white. Therefore, our sample is representative in terms of gender, but is younger and whiter than the UK undergraduate population, which is expected given our sample restrictions. Students receive on average £1,800 per year in non-repayable grant aid from the government. This implies the average bursary received among our sample of students is substantial, representing an additional 40% on grant aid.

In our sample the university completion rate is 86% meaning that only 14% of students fail to complete university. This is compatible with the dropout rate from UK official statistics, of around 8% (HEFCE, 2014) bearing in mind our stricter (degree students) and poorer (income under £50,000) sample. Drop out is highest in first year, at 8%, and steadily declines.

Our main outcome measure is whether a student obtains a *good degree*. We define a good degree as a student graduating from the course with at least an upper second class degree. Unlike the US, students in England rarely drop out from college, however this means many students graduate with

low marks. To differentiate students in the subsequent labour market much emphasis is placed on the final grade of the student's degree. The possible grades awarded are Fail, Third Class, Lower Second Class, Upper Second Class and First Class degrees. We define students obtaining a good degree as those being awarded a First or Upper Second Class degree as obtaining a good degree, which equates to 61% of all first year enrolees. These graduates have a distinct wage premium compared to other graduates. As a point of comparison the six-year graduation rate for students who started in the fall of 2006 was 60.5 percent at public four-year colleges, and 62.5 percent at private nonprofit colleges (Shapiro et al, 2014).

Despite the strict institutional setup described in Section 2, we observe a degree of non-compliance in our data. This is illustrated in Figure 4, which plots household income and bursary receipt for every student within one particular university cohort in our sample. The horizontal and vertical lines show the different bursary levels stated by the university at each parental income level. As can be seen in this figure, the vast majority of students receive the bursary amount that corresponds with their observed household income. However in a small but significant number of cases, students receive more or less than they are entitled to. Across all our universities, we observe varying rates of non-compliance, with the average of around 5% of students receiving a bursary that is "too high" and around 7% receiving a bursary that is "too low".

One concern is that these issues are not simply random measurement error, but are arising from systematic issues that could generate biases. Administrators at these universities stated three situations where the amount of bursary received does not equal that which should be received for that level of parental income. First, a reassessment of parental income indicated that the student would be eligible for a different student aid amount (either due to student error, or a sudden change in circumstances). Hence, the actual bursary paid by the institution differed from that expected according to their parental income records. Assuming that the measurement error may have overstated or understated parental income, this would downward bias the estimates. The second type of non-compliance concerns student pre-dropout. If students register for a course, but then withdraw from

the course before arrival, they will not receive a bursary but may still be recorded in the administrative records. Typically, such students would have been removed from the data, but it is possible that could still appear in our data as having dropped out in year one. The result would be to bias our estimates upward.

The final example of non-compliance concerns the university using its discretion to award additional funds to some students. If it is the case that institutions are systematically awarding high ability students more than they are entitled to, this will again bias our estimates upwards.[12] In order to eliminate the biases caused by this non-compliance, we adopt an instrumental variables (IV) methodology for our preferred specification. This two-stage least squares approach, where the amount of grant aid an individual receives is predicted using the bursary rules set out by the institutions themselves, will provide an unbiased estimate of the local average treatment effect (LATE). Hence the 2SLS estimates will be based on the compliers only.

4. Estimation strategy

Our empirical strategy exploits two sources of variation in financial aid awarded to estimate the casual impact of aid on outcomes. First, we exploit variation of bursary aid for a given parental income within university over time, which arises due to the considerable number of changes to bursary schemes within institutions (best illustrated in Figure 2). We effectively compare two individuals of the same parental income background, but receiving different bursary awards due to their university entry year. Given the opaque nature of the student aid system for students applying to university it is unlikely that students delay or bring forward their enrolment at a specific institution in response to changes in bursary schemes.

[12] Despite students' prior test scores being uncorrelated with indicators of whether the students received above or below their designated amount, one my still be concerned that those receiving more may have other unobservable positive abilities.

A second source of variation is more restrictive. We exploit the non-linear nature of the bursary schemes within an institution entry cohort, which is again seen in Figure 2. As can be seen, there are sharp discontinuities in the amount of aid awarded for only small changes in parental income. For example, we can see an individual with parental income of £15,000 in 2006 would have received a bursary of £3,000, but an individual with parental income of only £1 more would receive a bursary of £1,545. Identification comes from exploiting this highly non-linear relationship between aid received and parental income. In this specification we include university-cohort fixed effects, whilst also accounting for up to a third order polynomial in parental income, and nonlinear controls for entry test scores, student characteristics and subject area studied. This method ensures that student outcomes should vary smoothly with parental income and so we attribute any remaining non-linearities to the causal effect of bursaries.

Our empirical strategy is somewhat similar to the "heavily parameterized regression kink design" (Clark & Del Bono, 2016), which in turn is analogous to "regression kink design" (Card et al. 2012, Dong, 2013), but requires a stronger assumption, specifically that our third-order polynomial in income must capture the underlying outcome-parental income relationship across the full range of scores. Following Clark & Del Bono, we provide two validity tests of this assumption. First, we test if there is an "effect" of bursaries on pre-determined characteristics, in this case, university entry scores. This tests to ensure that there are no other sharp discontinuities that may be generating the effect (e.g. ability). Second, we check our estimates are robust to alternative polynomial specifications.

In addition to these assumptions, we need to satisfy those required for standard regression discontinuity designs, that students are similar each side of the cutoffs and students cannot dictate the treatment status by 'gaming' parental income (Lee & Lemieux, 2010). Given the institutional setting there are three strong reasons to believe that students are not sorting around these cutoffs. First, students don't know which university they will be attending. Two, students are not aware of the bursary rules, the main purpose of submitting parental income to the SLC is to be eligible for the

centralized government aid. And third, the parental income submitted to the SLC is validated by the government and therefore makes it hard to cheat. Regardless in addition for checking for discontinuities in predetermined characteristics, we also check differential densities each side of the cutoffs using McCary (2000) tests.

Whilst our estimates, in line with standard regression discontinuity designs (Jacob and Zhu, 2012) will generate "LATE" estimates, i.e. the impact of aid for students close to the discontinuities, the presence of multiple discontinuities across much of the parental income range allows us to use all of the data to help identify the effects of interest, and results in a more generalizable effect than that generated by estimations around a single discontinuity. As highlighted in Section 3, some universities have not complied with their own stated bursary rules, and so we are concerned that our results may suffer from biases caused by non-compliance. To account for this, we adopt an instrumental variables approach. The estimation consists of two-stage least squares instrumenting the actual aid amount awarded with the amount of aid the student is eligible for, according to the university's own rules. In the first stage, the size of the aid coefficient therefore represents the average increase in aid the student is eligible for, rather than that awarded. The second stage estimates the relationship between students' aid eligibility and the outcome of interest. Specifically we use the following equations:

$$y_{ijt} = \beta_1 \widehat{Aid_{ijt}} + f(Inc_{ijt}) + \beta X_{ijt} + \delta_{jt} + \varepsilon_{ijt} \quad (1)$$

$$Aid_{ijt} = \mu(Eligible) + f(Inc_{ijt}) + \beta X_{ijt} + \delta_{jt} + \mathcal{E}_{ijt} \quad (2)$$

where *y* is the outcome of student *i* attending university j, who started in year of entry cohort t . *Aid* is a continuous variable representing the amount of financial aid received by student *i* in thousands of pounds. Parental income *Inc* is accounted for with a third-order polynomial. The detailed nature of the data also allow us to condition on a large vector of background characteristics of all undergraduates in the study (*X*), such as university entry grades, age, ethnicity, gender and subject of study. In keeping with our estimation strategy, we control for these characteristics in the most flexible way possible, using dummies for each age, gender, ethnicity type, and for university entry grades (the

latter variable spans from 0-300, therefore we have a series of 30 dummies for each 10 point range in entry grades). Included with these we additionally control for the national student financial aid award, which is means tested but differs from bursaries since it is awarded at the national rather than institutional level, hence has no across university variation, and only has two kinks.[13] Finally in our most demanding specification we include a set of university-year effects (δ_{jt}), which will provide us with the parameter of interest β_1 the impact of an additional £1000 of financial aid on student outcome y, exploiting the nonlinear jumps in bursary awarded for a small change in income within an institution year group. We also present estimates that also use the within university variation over time, by including the institution and the year dummies separately.[14]

5. Empirical results

We now use the empirical strategy described above to estimate the causal effects of means tested aid on enrolled students' outcomes such as obtaining a good degree, completing the three years of university and test scores in each year.

A. Obtaining a *'Good Degree'*

Table 2 reports our estimates of the impact of aid on the probability of obtaining a good quality degree. In Panel A, we assume constant returns to financial aid, whilst in Panel B we allow for decreasing marginal returns by adding a quadratic term in aid. We report the effects for aid and aid squared, and for ease of interpretation, we present the marginal impact of £1000 of aid at the mean level of year 1 bursary aid (£782). In Panel C, we present the results of our 2SLS specification (i.e. equation 2), presenting marginal effects at mean coefficients of the reduced form and finally, the

[13] Excluding the national grant scheme in the set of student characteristics does not significantly alter any of the results.

[14] All standard errors presented are robust and clustered at the university level.

2SLS coefficients (column 2). The quadratic term is always significant and the marginal effect at mean follows the same pattern as the linear effects.

Table 2 shows that, on average, at the mean value, a £1,000 increase in aid results in a 0.6 percentage point reduction in students' chances of graduating with a good degree (column 1, Panel B). There will be both positive and negative biases at play here. On the one hand, students from low income households are more likely to receive more financial aid, and are also less likely to achieve a good degree, generating a negative bias. On the other hand, students with high ability are likely to perform well at university, and are also more likely to attend prestigious richer institutions, which can afford to give out bigger bursaries; these factors would generate positive biases. In column 2 we address the first of these issues by controlling for a third order polynomial in parental income. As expected, this raises the coefficient (since poorer students, who tend to have worse outcomes receive bigger bursaries).

Students with higher prior test scores are likely to achieve good outcomes regardless and to the extent that they also attend institutions which give out larger bursaries, not controlling for them would bias up the estimate. In column 3 we additionally control for student characteristics (test scores, age, gender, ethnicity) which reduces the marginal impact to 0.075.

In column 4 we account for any differences across universities by including university fixed effects. The impact at the mean holds stable. Column 5 adds year effects accounting for any general increase in the probability of achieving a good degree over time. The final column (6) replaces the university and year effects with a set of indicators for each year university combination. This exploits the non-linear relationship between aid awarded and parental income. This shows that, at the mean bursary value a £1,000 increase in bursary aid at the mean increases the probability of gaining a good degree by 6.9 percentage points.

As is evident from Panel C, the 2SLS estimates are smaller than this. Here, the marginal effect coefficient reveals an increase in the possibility of gaining a good degree by 3.1 percentage points for a £1,000 increase in aid (significant at the 1% level). It is interesting that the results from this

specification are identical to those found in column 5 (Panel C), in which we exploit the variation arising from changes in bursary rules across cohorts within university. This is a less restrictive specification, but has the advantage of using more variation, and as the results indicate, may be sufficient.

The reduced form estimates also show a very similar estimate of the impact of aid eligibility on degree performance of 2.6 percentage points. This is perhaps unsurprising, given that there is only a small degree of non-compliance in our data. Nevertheless, our IV estimator is lower by a significant amount – enough for us to be concerned that there is a degree of (positive) bias caused by non-compliance in our data. Therefore the 2SLS estimator is our preferred specification; we conclude that a £1,000 increase in bursary aid increases students' likeliness of obtaining a good degree by 3.1 percentage points.

B. Degree completion and course scores

What could be driving this increase in the chances of getting a good degree? We explore this in tables 3-4 by looking at the impact on completion of each academic year and annual course scores. All effects presented in these tables are the marginal impacts at the mean and are obtained from separate regressions. Table 3 first shows the impact of an additional £1,000 bursary award in first year on degree completion in the current and subsequent years. In each case, the full set of controls and a quadratic in bursaries is used. For our preferred 2SLS estimator (Panel B), we find evidence that bursary aid has a positive impact on completion. We find a £1,000 increase in aid improves students' likeliness to complete each year of the degree by between 1.4-1.9 percentage points, depending on the year of study. Note that this is a relatively small effect compared with that found by Bettinger (2004), bearing in mind exchange rates and inflation, who finds that a $1,000 (£660 aprox) increase in Pell aid corresponds to a 4 percent reduction in the likelihood that students withdraw from college in first year. However, we should also bear in mind that completion rates are very high in the UK. So, if we consider that an average student attending an average university has

an 86% likelihood of completing their degree, this implies that bursary aid increase the chances of completion by less than 2%.

It is interesting that the impact of aid on completion of final year is slightly lower than the impact of aid on obtaining a good degree – suggesting there may be some additional impact of aid coming through course scores.

This is examined more fully in Table 4, in which we present the results for an additional £1,000 of bursary on mean standardised course scores each year. Here we see a largely positive impact of bursaries – with the IV estimator showing an additional £1,000 of bursaries in the first year generating a 0.057 standard deviation increase in course scores in that year, and a 0.034 standard deviation in course scores in the second year.

In summary, our analysis shows a positive impact of bursary aid on degree performance, to the tune of 3.1 percentage points per £1,000. This positive impact appears to be driven by both an increased probability of completion (of as much as 1.9 percentage points) and improvements in test scores (of as much as 0.057 standard deviations). These impacts are relatively small (and smaller than those obtained by Bettinger (2009)). Around 62% of students in our sample currently obtain a good degree, whilst 86% complete their degrees.

6.2 Robustness Checks

We perform a series of robustness checks on our IV estimates to determine their stability. These are shown in Table 5. The first row presents the marginal effects of aid in the first year of study at the mean for both the standard and IV models, with the outcome varying across the columns. The outcomes are complete the 1st year, standardised 1st year course scores, and obtain good degree in columns one, two and three respectively. As described in Section 4, we also conduct a falsification test of the effect of bursary aid on a predetermined outcome, in this case, standardised prior attainment test scores.

Our main specification only uses students who could have potentially completed their course. However, we have data on all students that are currently studying at these 9 universities. Therefore the second panel shows estimates includes additional cohorts, including all current students (i.e. those for whom we can only observe to the end of first or second year), this increases the sample size by around 10,000. Reassuringly the estimates do not change significantly for completing the 1st year or 1st year test scores. We do not present estimates for Good Degree as they would be the same as the row above.

One of the arguments that we put forward is that comparisons can be made across universities, which we support by showing that there is common support in the entry test scores of students (See Figure 3). Three universities appear to be exceptions to this, university one has test scores mostly below that of the others, and universities nine and ten appear to only enrol high ability students. Therefore in the third panel we re-estimate the results excluding these universities. Again this appears to have very little effect on the results.

Finally, we show for each of these specifications, that there is no relationship between bursary aid and university entry scores. This is reassuring, suggesting that our set up is capturing the underlying relationship between outcomes and this score. However, we provide a further test of this, by experimenting with alternative polynomial specifications. This can be seen in Table 6.

7 Conclusion

Financial barriers to higher education have the potential to exacerbate existing earning inequalities. Our findings suggest that higher levels of bursary aid improve student performance. Students who have been awarded a bursary increase their likelihood of gaining a good degree by 3.1 percentage points for each additional £1,000 awarded. The effect is driven by both improvements in test scores and completion rates. Our results are robust to different specifications and samples.

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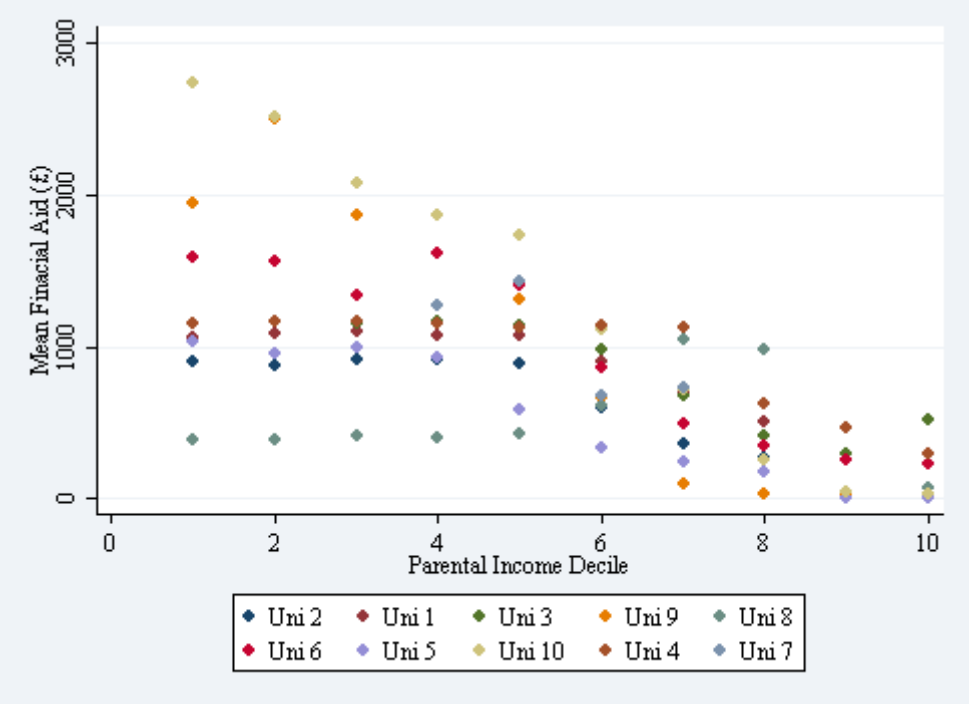
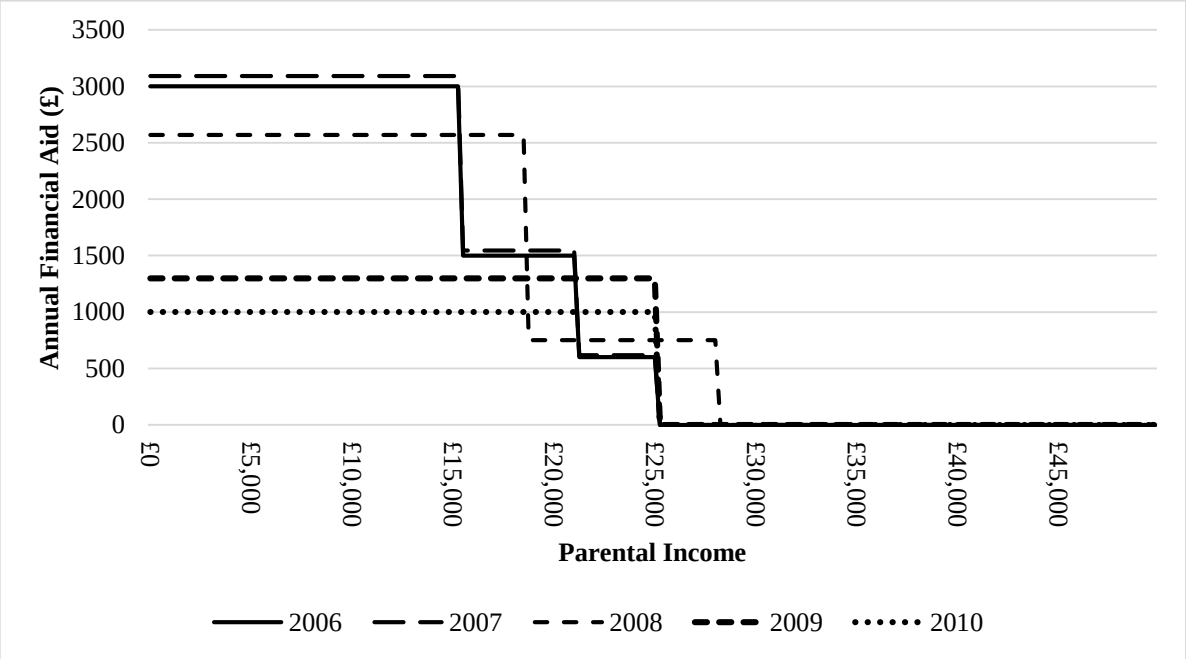
Figure 1: Average bursary by parental income and university



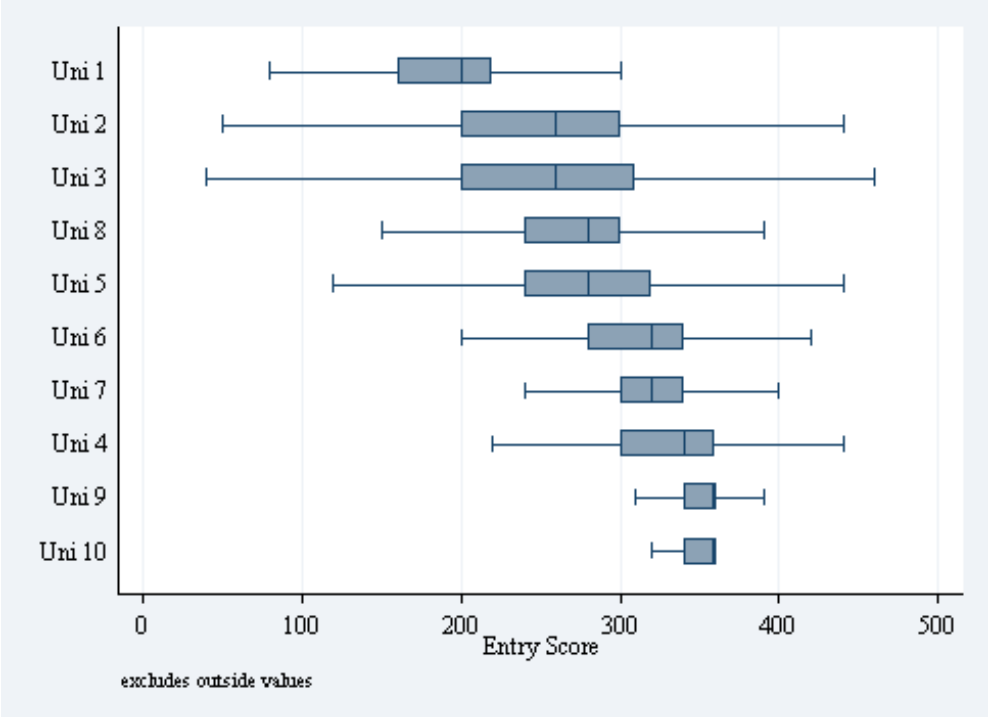
Notes: Each point represents the mean financial aid received at each university by parental income deciles of the estimation sample. Financial aid averaged over all academic years and cohorts. Source administrative data from the 10 universities.

Figure 2: Financial Aid Schedules at University X over time



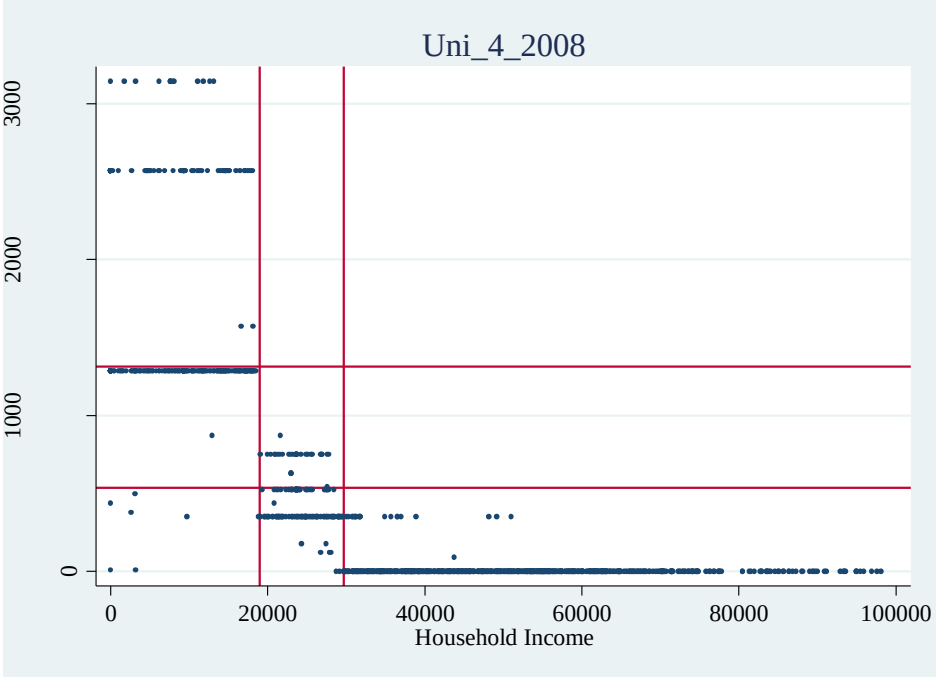
Notes: Figure 2 represents the financial aid schedules for first year students for an anonymous English university for students entering in the years 2006 through to 2010.

Figure 3: Entry scores by university



Notes: Figure 3 shows box plots of the entry qualification scores of students attending each university in the estimation sample. The ends of each box represent the 25th and 75th percentiles in entry qualification scores. Source administrative data from the 10 universities.

Figure 4: university aid rules and compliance at university 4, 2008



Notes: Figure 4 shows household income and bursary receipt for every first-year student within university 4, in 2008. The horizontal and vertical lines show the different bursary levels advertised by the university at each income level.

Table 1: Characteristics and student outcomes

	Mean	Std dev.
Household Inc	£23,399	£18,397
Grant	£2,063	£1,032
Bursary	£782	£640
Entry Points	283.76	79.71
Male	0.43	0.50
White	0.80	0.40
Age on Entry	20.15	4.92
Complete		
1st Year	0.92	0.27
2nd Year	0.88	0.32
3rd Year	0.86	0.35
Dropout		
1st Year	0.08	0.27
2nd Year	0.04	0.20
3rd Year	0.02	0.14
Standardised Scores Yr1		
1st Year	0.00	1.00
2nd Year	0.00	1.00
3rd Year	0.00	1.00
"Good Degree"	0.61	0.49
N	28,844	

Notes: sample consists of those who have had a bursary at some point during university. Also sample consists only of those students whose final outcome can be observed

Table 2: Impact of financial aid on probability of obtaining a good degree

P(Good Degree)	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
1st year financial aid awarded	0.011	0.087***	0.041**	0.032**	0.035***	0.032**
	(0.017)	(0.018)	(0.016)	(0.013)	(0.012)	(0.012)
Panel B						
1st year financial aid	-0.039	0.134***	0.122***	0.142***	0.140***	0.129***
	(0.039)	(0.030)	(0.023)	(0.024)	(0.024)	(0.024)
1st year financial aid squared	0.021*	-0.017*	-0.030***	-0.042***	-0.040***	-0.038***
	(0.011)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)
Marginal effect at mean	-0.006	0.107***	0.075***	0.077***	0.077***	0.069***
	(0.025)	(0.019)	(0.013)	(0.013)	(0.013)	(0.012)
R-squared	0.001	0.023	0.114	0.127	0.127	0.137
Panel C						
Reduced form – 1st year financial rules	-0.049**	0.057*	0.038**	0.027**	0.026***	0.026***
	(0.020)	(0.028)	(0.015)	(0.012)	(0.009)	(0.009)
IV- 1st year Financial aid	-0.058***	0.061**	0.036**	0.030**	0.031***	0.031***
	(0.022)	(0.028)	(0.016)	(0.012)	(0.011)	(0.010)
R-Squared	0.004	0.022	0.113	0.125	0.126	0.136
Sheas's Adj-P R^2 Bursary	0.756	0.590	0.529	0.490	0.474	0.472
Sheas's Adj-P R^2 Bursary^2	0.796	0.673	0.610	0.567	0.552	0.548
Parental Income		✓	✓	✓	✓	✓
Student Characteristics			✓	✓	✓	✓
University Effects				✓	✓	
Year Effects					✓	
University*Year Effects						✓

Notes: Coefficients in panel C show marginal effect at mean bursary amount. Good degree defined as being equal to 1 for those students obtaining a first class or upper second class degree, and 0 for all other outcomes, including drop out. Sample consists only of those students whose final outcome can be observed. Standard errors are in parenthesis, and are clustered at institution*year level.* $p < 0.1$. ** $p < 0.05$. *** $p < 0.01$

Table 3: Impact of financial aid on probability of completion

P(Complete)	Complete 1st year	Complete 2nd year	Complete 3rd year	Good degree
	(1)	(2)	(3)	(4)
Panel A				
1st year financial aid awarded	0.074***	0.086***	0.087***	0.069***
	(0.019)	(0.018)	(0.018)	(0.012)
Panel B				
IV- 1st year Financial aid	0.025**	0.031**	0.033**	0.056***
	(0.011)	(0.014)	(0.016)	(0.018)
IV- 1st year Financial aid squared	-0.007**	-0.010**	-0.009*	-0.016***
	(0.003)	(0.004)	(0.005)	(0.005)
Marginal effect at mean	0.014**	0.016**	0.019**	0.031***
	(0.006)	(0.008)	(0.009)	(0.010)
R-Squared	0.126	0.113	0.114	0.136
Parental Income	✓	✓	✓	✓
Student Characteristics	✓	✓	✓	✓
University*Year Effects	✓	✓	✓	✓

Notes: Coefficients presented are of marginal effects at mean bursary amount. Sample sizes vary by year as students drop out. Sample consists only of those students whose final outcome can be observed. Sample consists only of those students whose final outcome can be observed. Standard errors are in parenthesis, and are clustered at institution*year level.* p < 0.1. ** p < 0.05. *** p < 0.01

Table 4: Impact of financial aid on course scores

P(Course Scores)	Course scores 1st year	Course scores 2nd year	Course scores 3rd year	Good degree
	(1)	(2)	(3)	(4)
Panel A				
1st year financial aid awarded	0.093***	0.052**	0.055***	0.069***
	(0.026)	(0.021)	(0.018)	(0.012)
Panel B				
IV- 1st year Financial aid	0.119***	0.073**	0.035	0.056***
	(0.027)	(0.031)	(0.039)	(0.018)
IV- 1st year Financial aid squared	-0.039***	-0.024**	-0.008	-0.016***
	(0.007)	(0.011)	(0.013)	(0.005)
Marginal effect at mean	0.057***	0.034**	0.022	0.031***
	(0.016)	(0.016)	(0.021)	(0.010)
R-Squared	0.085	0.096	0.085	0.136
Parental Income	✓	✓	✓	✓
Student Characteristics	✓	✓	✓	✓
University*Year Effects	✓	✓	✓	✓

Notes: Coefficients presented are of marginal effects at mean bursary amount. Sample sizes vary by year as students drop out. Sample consists only of those students whose final outcome can be observed. Sample consists only of those students whose final outcome can be observed. Standard errors are in parenthesis, and are clustered at institution*year level.* p < 0.1. ** p < 0.05. *** p < 0.01

Table 5: Robustness Checks

	IV Financial Aid Rules			
	Complete 1st Year	Course Scores 1st Year	Good Degree	Std Prior Test Scores
Specification	(1)	(2)	(3)	(4)
Main Specification	0.014**	0.057***	0.031***	-0.018
	(0.006)	(0.016)	(0.010)	(0.029)
Include Continuing Students	0.005	0.060**	NA	-0.009
	(0.006)	(0.024)		(0.040)
Exclude Outlying Entry Score Universities (1, 9, 10)	0.007	0.053*	0.022*	-0.012
	(0.011)	(0.032)	(0.011)	(0.0787)

Notes: Sample sizes vary by year as students drop out. Sample consists only of those students whose final outcome can be observed. Coefficients presented are of marginal effects at mean bursary amount. Outlying Universities based on the lack of overlap in prior test scores with other universities. Accounting for test scores reflecting different ability by test scores, additionally controls for test scores multiplied by log(1/(Income+1)). Standard errors are in parenthesis, and are clustered at institution level. * p < 0.1. ** p < 0.05. *** p < 0.01

Table 6: Alternative polynomial specifications

	IV Financial Aid Rules		
	Course Scores 1st Year	Course Scores 3rd Year	Good Degree
Specification	(1)	(2)	(3)
$Income$	0.065**	0.045*	0.025**
	(0.021)	(0.025)	(0.012)
$+Income^2$	0.067**	0.049*	0.027**
	(0.019)	(0.025)	(0.011)
$+Income^3$	0.058***	0.034	0.025**
	(0.019)	(0.022)	(0.011)
$+Income^4$	0.040*	0.014	0.018*
	(0.023)	(0.021)	(0.011)
$+Income^5$	0.040*	0.014	0.018*
	(0.023)	(0.022)	(0.011)