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The Effect of Tuition Fees on University Applications and Attendance: Evidence from the UK

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ABSTRACT

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This article uses variation in university tuition fees over time and across countries in the UK to examine the effect of fees on university applications and attendance. It focuses on two policy changes: the removal of upfront tuition fees in Scotland in 2001 and the increase in fees in England in 2012. It finds that applications decrease in response to higher fees, especially for courses with lower salaries and lower employment rates after graduation. Attendance also falls in response to higher fees, but there is no evidence of a larger reduction for students from disadvantaged backgrounds.

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1   Introduction

The cost of a degree is an important determinant of the decision to apply to university. In the UK, there have been significant changes in tuition fee policy in recent years. Before 1998, the cost of a university degree was entirely supported by the government. Since then, students pay part of the cost of higher education, with some significant variation in the level of tuition fees across UK countries.

This article uses variation in tuition fees over time and across countries in the UK to study the effect of fees on the demand for higher education, university attendance and course choice. I focus on two policy changes: the removal of upfront fees in Scotland in 2001 (2001 reform) and the increase in fees in England in 2012 (2012 reform). The 2001 reform replaced upfront fees of £1,000 per year with an endowment scheme in which students pay a total of £2,000 after graduation. This applied only to Scottish-domiciled students attending university in Scotland. The 2012 reform increased fees from £3,375 to a maximum of £9,000 per year for students at English universities.

Using difference-in-differences estimation, I find that the 2001 reform increased applications by 21 log points, while the 2012 reform reduced applications by 25 log points. The results imply an elasticity of applications with respect to fees between −0.14 and −0.26. To test whether the effect of fees on applications varies by course, I merge data on applications with information on average salaries and employment rates six months after graduation, disaggregated by subject, institution and gender. I find that applications to courses that offer weaker employment prospects are more sensitive to changes in tuition fees. This suggests that applicants take expected future earnings and employment prospects into account when making their course choices.

In addition to applications, I look at the effect of tuition fees on the number of first-year undergraduate students. I find that the increase in fees in 2012 reduced the number of first-year undergraduates by 33 log points. This effect is smaller for non-white students and for students from local authorities with low rates of participation in higher education. This suggests that credit constraints do not seem to play an important role in the decision to go to university. There are two factors that may explain this finding. First, the vast majority of students finance their studies with government-provided student loans. Second, universities that charge higher fees need to have access agreements approved by the Office for Fair Access (OFFA) outlining their measures to attract and

support students from disadvantaged backgrounds.

This article contributes to the literature on the effect of schooling costs on schooling outcomes. The identification challenge in this literature is the fact that unobservable individual characteristics affect schooling outcomes. Therefore, a simple regression of schooling outcomes on schooling costs would suffer from an omitted variable bias.

A number of studies use quasi-experimental methods to get around this issue. Deming and Dynarski (2009) review this literature for the US and find that most studies provide evidence that reducing college costs can increase college entry and persistence. The evidence for other countries also points to a negative effect of tuition fees on enrollment. Neill (2009) uses the political party in power in Canadian provinces as an instrument for provincial tuition fees and finds a negative effect of fees on enrollment. Hübner (2012) uses the introduction of tuition fees in some German states in 2007 to design a natural experiment to identify the effect of fees on enrollment. His results also suggest that tuition fees reduce enrollment, by a similar magnitude to the effects identified with US data. Nielsen et al (2010) look at the effect of a reform that increased the amount of study grants in Denmark in 1988. Using variation in the level of educational grants as a function of parental income, the authors find that the increase in grants had a positive effect on college enrollment. Garibaldi et al (2012) look at the effect of tuition fees on the probability of late graduation, i.e., completing a degree in more than four years, for students at Bocconi University in Italy. They adopt a regression discontinuity design to exploit variation in the level of tuition paid by students as a function of parental income. Their findings suggest that an increase in tuition fees reduces the probability of late graduation.

For the UK, Dearden et al (2011) use data on university participation from the UK Labour Force Survey from 1992 to 2007 to estimate a fixed-effects regression of participation rates on the level of tuition fees and grants. They find that fees have a significant adverse effect on university participation, while maintenance grants have a positive impact. Crowford and Dearden (2010) study the effect of the introduction of higher tuition fees in England in academic year 2006/07 on university participation. They use difference-in-differences estimation, comparing attendance rates of English students living near Scotland and English students living far from Scotland. The intuition for this identification strategy is that English students attending university in Scotland still have to pay fees, but at a lower level than if they were attending university in England. The

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results suggest that the reform did not have a significant effect on participation. However, the authors attach little weight to these finding because participation trends prior to the reform appear different for the two groups of students.

Some policy reports use descriptive statistics to examine the effect of the most recent increase in fees in England in 2012 on university applications. The report of the Independent Commission on Fees (ICOF, 2012) shows that the number of applicants decreased significantly in 2012 compared with 2010. This reduction was mainly seen in England, with applications broadly constant in Scotland. The reduction in applications affected students from all backgrounds, but was larger for students from local areas with higher rates of participation in higher education. Similar findings are reported in UCAS (2012).

To my knowledge, this article is the first to evaluate the effect of the removal of upfront fees in Scotland in 2001 and the increase in fees in England in 2012 using quasi-experimental methods. It also adds to the existing academic literature by looking at applications as well as attendance and by looking at differences across courses with different employment prospects and across demographic groups.

The rest of the article is organised as follows. The next section presents the institutional framework, summarising the main changes in tuition fees across the UK and over time. Section 3 presents a theoretical framework which provides clear predictions about the effect of tuition fees on the decision to go to university for students with different levels of access to credit and for courses that lead to different salaries after graduation. Section 4 discusses the empirical methodology. Section 5 discusses the data and presents descriptive statistics. Empirical results are presented and discussed in Section 6 and Section 7 concludes.

2 Institutional Framework

University tuition fees were first introduced in all UK countries in September 1998. Fees were set at £1,000 per year, with the expectation that means testing would imply that one third of students would not pay any fees.[1] Since then, there have been several changes in the level of tuition fees, with

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[1] Students were exempt from fees if their families earned less than £23,000 per year and were charged reduced fees on a sliding scale if their families earned between £23,000 and £35,000. Students whose families earned more than £35,000 were charged full fees.

important variation across countries. In 1999, a devolution government was established in Scotland. The new Scottish Parliament received separate legislative powers in many areas, including tuition fees. From its creation, the Scottish Parliament adopted a distinctively different policy regarding tuition fees from that followed in the rest of the UK.

Figure 1 shows a time line with the evolution of tuition fees in England and Scotland. In Scotland, tuition fees were replaced with an endowment scheme in 2001. Instead of paying fees upfront, Scottish-domiciled students were required to pay a total of £2,000 after graduation if their annual earnings exceeded £10,000. In 2007, the Scottish government went one step further and eliminated fees altogether for Scottish-domiciled students graduating on or after April 2007. Students at Scottish universities qualify for no tuition only if they have been living in Scotland for at least three years by the time they start university or if they have moved to Scotland for a reason other than study.

England has also made changes to tuition fees since their first introduction in 1998. In 2004, it was announced that, from academic year 2006/07, upfront tuition fees of £1,000 per year would be replaced with variable fees to be paid after graduation if annual earnings exceeded £15,000. Universities had discretion over the amount of fees they charged, up to a maximum of £3,000 per year.[2] In 2010, the government announced that this cap would be raised to £9,000 per year for students entering university in academic year 2012/13. This announcement generated intense discontent among students and led to a number of public demonstrations.

Although universities have discretion over the amount of fees they charge, there is evidence that most universities in England have increased their fees substantially in response to increases in the maximum tuition limit. According to Universities UK (2009), almost all higher education institutions in England chose to set fees at the £3,000 cap from 2006/07. Regarding the most recent reform, evidence from HEFCE (2013) shows that, in 2012/13, 42 of 124 higher education institutions in England were charging the maximum level of fees of £9,000 and no institutions were charging less than £6,000. The sector average fee was £8,040 in 2012/13 and £8,507 in 2013/14.

In Wales, the cap on tuition fees was also increased to £9,000 in 2012, but the Welsh Assembly pays fee costs above £3,465 per year for Welsh students studying at any UK university. In Northern Ireland, fees were capped at £3,465 in 2012 for students from Northern Ireland, to rise in line with

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[2] This limit increased slightly every year in line with inflation and was at £3,375 in 2011/12.

inflation in subsequent years. Fees for students from outside Northern Ireland were not capped, but were not expected to exceed £9,000.

This article uses variation in tuition fees in Scotland and England to identify the causal effect of fees on schooling decisions. It focuses on two reforms: the replacement of tuition fees with an endowment scheme in Scotland in 2001 (2001 reform) and the increase in the cap on tuition fees in England in 2012 (2012 reform). The 2006 reform in England is not analysed because it would be difficult to separately identify its effect from the removal of fees in Scotland in 2007.

Both reforms analysed in this article introduced significant changes in the amount of tuition fees paid by affected students. From the introduction of upfront fees in 1998 until the 2001 reform, Scottish students had to pay £1,000 per year, making the tuition cost of a degree equal to £3,000.[3] After the 2001 reform, the tuition cost of a degree for Scottish students attending university in Scotland fell to £2,000, with the added advantage of only being paid after graduation. In England, the 2012 reform increased the tuition cost of a degree from just over £10,000 to £27,000, for students at universities that charge maximum fees.

The increase in fees in England led to a significant change in the sources of funding used by students. Figure 2 reports the percentage of English-domiciled students studying full time at universities in England by funding source. Until the increase in fees in 2006, the fraction of students who borrowed to cover the cost of tuition was about the same as the fraction who did not receive any financial support. The increase in fees led to an increase in the fraction of students who fund their education with loans and a reduction in the fraction of self-funded students. This trend continued and in 2012 the vast majority of students (74%) were borrowing to pay tuition fees.

Student loans are provided by the government-owned Student Loans Company (SLC). Students can borrow to pay tuition fees and maintenance costs and only start repaying their loans once they earn more than £21,000 a year. The average amount of debt owed by students in England at the time when they start repaying their loans has been increasing steadily over time, according to data from the SLC. The amount of student debt on entry into repayment (including both tuition and maintenance loans) was just over £20,000 in 2014, which is about the same level as the average

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[3]The typical duration of a university degree for full-time students is four years in Scotland and three years in England. However, fees for the final year of study in Scotland were waived to bring the total cost of a degree in line with the rest of the UK.

annual salary of English graduates six months after graduation.[4] This is expected to rise even further once students who pay fees at £9,000 start repaying their loans. By contrast, student debt in Scotland is much lower (at £7,600) because students do not have to pay fees and only borrow to cover maintenance costs.

3   Theoretical Framework

The model presented in this section follows closely the one in Cameron and Taber (2004). It is used to derive predictions about the effect of tuition fees on university attendance for credit-constrained and unconstrained individuals and for courses with different expected salaries after graduation. These predictions are useful for understanding the results of the empirical analysis. Heterogeneity in credit access is introduced by assuming that some individuals have to pay a higher interest rate to borrow while they are in college.

In period $t = 0$, individuals choose between two schooling levels: not going to university ($S = 0$) and going to university ($S = 1$). They enter the labour market at $t = 0$ if they do not go to university and at $t = 1$ if they go to university. The lifetime utility for schooling choice S is given by:

$$V_S = \sum_{t=0}^{\infty} \delta^t \frac{c_t^{\gamma}}{\gamma}$$

where c_t is consumption at time t, δ is the rate of time preference, and $\gamma \in (-\infty, 1)$ measures the curvature of the utility function. Individuals select S to maximise lifetime utility:

$$S = \arg\max\{V_S | S \in \{0, 1\}$$

The borrowing constraint takes the form of a higher rate of interest for constrained individuals during school years. In particular, I follow Cameron and Taber (2004) and assume that unconstrained individuals can borrow at the market rate $R_m = 1/\delta$ in any period, while constrained individuals can borrow at some rate $R > 1/\delta$ while in school and face the market rate R_m after they enter the labour market. Individuals who do not go to university do not have any credit con-

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[4] According to data from the HESA Destinations of Leavers from Higher Education survey, the average annual salary of English-domiciled students who graduated in 2011/12 and were in full-time paid employment was £20,015 six months after graduation.

straints and face the market rate in all periods. This heterogeneity in interest rates during school years could reflect differences in the ability to collateralise loans with personal or family assets during school. I solve the model for credit-constrained individuals. The solution for unconstrained individuals can be obtained as a special case where $R = 1/\delta$.

The lifetime budget constraint for each schooling choice is given by:

$$\sum_{t=0}^{\infty} \delta^t c_t \leq I_0 \text{ if } S = 0$$

$$c_0 + \frac{1}{R} \sum_{t=1}^{\infty} \delta^{t-1} c_t \leq I_1 \text{ if } S = 1$$

where I_0 is the present value of income if the individual does not go to university; and I_1 is the present value of income if he goes to university, net of direct schooling costs.

The first order conditions for utility maximisation are given by:

$$c_t = c_0, \ \forall t \text{ if } S = 0$$

$$c_t = c_0, \text{ if } t = 0 \text{ and } S = 1$$

$$c_t = (R\delta)^{\frac{1}{1-\gamma}} c_0, \text{ if } t \geq 1 \text{ and } S = 1$$

Substituting these values in the budget constraint gives:

$$I_0 = \frac{c_0}{1 - \delta} \text{ if } S = 0$$

$$I_1 = c_0 + (R\delta)^{\gamma/(1-\gamma)}[\delta/(1-\delta)]c_0 \text{ if } S = 1$$

Solving for c_0 as a function of I_S and inserting into the utility function gives the lifetime utility for each schooling choice:

$$V_0 = \frac{I_0^\gamma [1/(1-\delta)]^{1-\gamma}}{\gamma}$$

$$V_1 = \frac{I_1^\gamma \{1 + (R\delta)^{\gamma/(1-\gamma)}[\delta/(1-\delta)]\}^{1-\gamma}}{\gamma}$$

The present value of income (I_S) depends on the schooling choice. Individuals who do not go to university receive a wage w_{0t} in each period t. Individuals who go to university have zero earnings

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while studying and pay a direct cost τ, which includes tuition fees and maintenance costs. After graduation, they receive a wage w_{1t} in each period t. The present discounted value of income for each schooling choice is given by:

$$I_0 = \sum_{t=0}^{\infty} \delta^t w_{0t} = W_0$$

$$I_1 = \frac{1}{R}\sum_{t=1}^{\infty} \delta^{t-1} w_{1t} - \tau = \frac{1}{R}W_1 - \tau$$

where $W_0 \equiv \sum_{t=0}^{\infty} \delta^t w_{0t}$ is the present value of earnings for an individual who does not go to university, discounted to time $t = 0$ and $W_1 \equiv \sum_{t=1}^{\infty} \delta^{t-1} w_{1t}$ is the present value of earnings for an individual who goes to university, discounted to time $t = 1$.

Substituting in the lifetime utility values above gives:

$$V_0 = \frac{W_0^\gamma [1/(1-\delta)]^{1-\gamma}}{\gamma}$$

$$V_1 = \frac{[(W_1/R) - \tau]^\gamma \{1 + (R\delta)^{\gamma/(1-\gamma)}[\delta/(1-\delta)]\}^{1-\gamma}}{\gamma}$$

An individual chooses to go to university if $D = V_1 - V_0 > 0$.

The model can be used to study how changes in tuition fees (τ) affect the decision to go to university:

$$\frac{\partial D}{\partial \tau} = \frac{\partial V_1}{\partial \tau} = -\frac{\gamma V_1}{I_1} < 0$$

Proposition 1 *An increase in tuition fees makes it less likely that an individual will choose to go to university.*

The effect of credit constraints on the decision to go to university is captured by the effect of changes in the interest rate R:

$$\frac{\partial D}{\partial R} = \frac{\partial V_1}{\partial R} = -\frac{\gamma V_1}{RI_1}(c_0 + \tau) < 0$$

Proposition 2 *An increase in credit constraints makes it less likely that an individual will choose to go to university.*

The model can also be used to study whether individuals with a higher R are more sensitive to

changes in fees:

$$\frac{\partial^2 D}{\partial R \partial \tau} = -\frac{\gamma V_1}{R I_1^2}[(c_0 + \tau)(1 - \gamma) + c_0 (R\delta)^{\gamma/(1-\gamma)}\frac{\delta}{1 - \delta}] < 0$$

Proposition 3 *An increase in tuition fees reduces the value of going to university by more for individuals who are credit constrained.*

Cameron and Taber (2004) do not examine whether the effect of tuition fees on the decision to attend university depends on the present value of earnings of a university graduate (W_1). However, their model can be easily used to analyse this differential effect:

$$\frac{\partial^2 D}{\partial W_1 \partial \tau} = \frac{\gamma V_1}{R I_1^2}(1 - \gamma) > 0$$

Proposition 4 *An increase in tuition fees reduces the value of going to university by less for courses that lead to higher salaries after graduation.*

4 Empirical Methodology

The identification challenge associated with estimating the effect of schooling costs on schooling decisions is discussed, for example, in Dynarski (2003). In principle, this effect could be captured by a reduced-form model with a measure of educational attainment as the dependent variable (for example, an indicator variable for whether an individual attends university or the number of university applications) and a measure of schooling costs as independent variable. The problem with this approach is that the cost of education is likely a function of omitted variables correlated with the demand for education. Institutional changes that introduce a discrete shift in the cost of education can induce variation that is uncorrelated with these unobserved determinants of schooling.

In the UK, the 2001 and 2012 reforms created variation in the cost of higher education that can be used to identify its effect on schooling decisions. I use variation in tuition fees over time and by country of domicile and estimate the following difference-in-differences (DD) model:

$$\ln(y_{djt}) = \gamma_d + \lambda_t + \delta D_{dt} + X'_{djt}\beta + \varepsilon_{djt} \tag{1}$$

where d denotes country of domicile, j denotes gender, age group, institution and subject group

(as described in the data section) and t denotes year. When looking at the effect on applications, the dependent variable is the log of the number of university applications. When looking at the effect on attendance, it is the log of the number of first-year undergraduate students. The model includes country of domicile fixed effects (γ_d) and year fixed effects (λ_t). The vector of controls (X_{djt}) includes dummies for gender and age group and the log of population living in country d, in gender and age group j in year t.

The regressor of interest is D_{dt} and indicates observations for students who lived in the country affected by the change in tuition fees before they started university (treatment group) in the period after the change. When analysing the removal of upfront fees in Scotland in 2001, this indicator is equal to one for Scottish-domiciled students in the period from 2001 to 2004 (the pre-treatment period goes from 1998 to 2000). The analysis stops in 2004 as this is the year when variable tuition fees where announced in England. When analysing the increase in fees in England in 2012, the indicator D_{dt} takes the value one for English-domiciled students in 2012 and 2013. The pre-treatment period goes from 2008, after the removal of fees in Scotland, to 2011.

The causal effect of tuition fees on university applications is captured by δ and can be interpreted as the change (in log points) in the number of applications induced by the reforms. The specification controls for changes over time in log applications and for average differences in log applications between students from Scotland and students from England. The key identifying assumption is that trends in log applications would have been the same for English and Scottish students in the absence of the reforms. The reforms induce a deviation from this common trend, which is measured by the DD estimator. Although the log level of applications in England and Scotland may be different, this difference should be captured by the country of domicile fixed effects (γ_d).

To check the common trends assumption, I add country-specific time trends in equation (1) and estimate:

$$\ln(y_{djt}) = \gamma_{0d} + \gamma_{1d}t + \lambda_t + \delta D_{dt} + X'_{djt}\beta + \varepsilon_{djt} \tag{2}$$

where γ_{0d} is a country-specific intercept, as before, and γ_{1d} is a country-specific trend coefficient multiplying the time trend variable t.

An important feature of the UK reforms is that students at Scottish institutions only qualify

for no tuition if they have been living in Scotland for at least three years by the time they start university or if they have moved to Scotland for a reason other than study. English students who move to Scotland to attend university still have to pay tuition fees. This is important because it reduces the potential for selection bias. If students were able to qualify for no fees simply by going to university in Scotland, we would probably observe that those who move to Scotland are more likely to go to university, i.e. there would be a positive selection bias in the DD estimator for the 2001 reform and a negative bias for the 2012 reform. The requirement that a student must have lived in Scotland for at least three years to qualify for no tuition implies that membership of the treatment and control groups is arguably unrelated to individual choices.

Scottish-domiciled students still have to pay higher tuition fees if they decide to go to university in England. For the 2001 reform, this implies that the coefficient δ captures the effect of being eligible for reduced or no fees rather than the effect of actually paying reduced fees. For the 2012 reform, this implies that some students assigned to the control group actually receive treatment. In the language of experiments, δ captures the intention-to-treat effect. In practice, however, the vast majority of Scottish-domiciled students apply to university in Scotland. In 2012, 96.5% of Scottish-domiciled applicants applied to university in Scotland (UCAS (2012)). Therefore, the coefficient δ is a close approximation of the effect of the treatment on the treated.

5 Data and Descriptive Statistics

Data on applications was produced on request by the Universities and Colleges Admissions Service (UCAS), which manages all applications to undergraduate courses in the UK. The information provided is the number of applications to English and Scottish universities by country of domicile (England and Scotland), institution (156 universities and colleges), gender, age group (18 years and under, 19, 20, and 21 and over), and subject (16 categories), for the period from 1998 to 2013.

Applicants are allowed to make more than one application to university. Until 2007, each applicant could apply to up to six courses. From 2008, the maximum number of choices was reduced to five. Data from UCAS shows that the number of applications per applicant fell from 4.4 to 3.7 in 2008. Apart from that year, the number of applications per applicant has been broadly constant in the periods before and after 2008. This implies that the results that I obtain

for applications should also provide information about the effect of tuition fees on the number of applicants.

Data on the number of undergraduate students was obtained from the Higher Education Statistics Agency (HESA). The information is disaggregated at the same level as the data from UCAS and covers the period from 2008 to 2013. In addition, these data contain information on year of study (first year and non-first year), ethnicity (white, Asian, black and other) and the local authority where the student was domiciled before going to university. I use information on ethnicity and local authority to test whether the increase in fees in 2012 had a larger negative effect on students from minority groups or from local areas with low rates of participation in higher education. Information on rates of participation in higher education by local authority is obtained from the Higher Education Funding Council for England (HEFCE) and is known as POLAR 3. The numbers used measure rates of participation in higher education for people who reached age 18 between 2005 and 2009.

Data on salaries and employment rates after graduation are from the HESA Destinations of Leavers from Higher Education (DLHE) survey, which covers the universe of all leavers who were domiciled in the UK prior to attaining higher education (with a response rate of 75%) and is conducted six months after graduation. The survey provides information on the activity of first-degree graduates: in full-time paid employment (including self-employment), in part-time paid employment, in voluntary/unpaid employment, in further study and assumed to be unemployed. It also reports the salaries of graduates in full-time paid employment and contains information on age, gender, institution and subject. I use data for students who graduated in 2002/03 and 2011/12 and calculate average salaries and average employment rates by gender, institution and subject. I combine this information with applications data to examine how changes in tuition fees affect applications to courses with different expected future earnings and employment rates.

The model controls for the log of population by country, year, gender, and age group (obtained from the Office for National Statistics mid-year population estimates). Between 1998 and 2013, population aged 17 to 24 increased by 20.1% in England, compared with 12.9% in Scotland. This should lead to a relative increase in applications and attendance by English-domiciled students, regardless of the level of tuition fees. I account for this by controlling for population in the model.

The common trends assumption is investigated in Figures 3 and 4. Figure 3 shows the evolution

in the log number of applications in England and Scotland. This variable follows a slight downward trend in both countries until 2001. After the removal of upfront fees in Scotland in 2001, log applications continue to decrease slightly in England but begin to increase slightly in Scotland. In 2008, log applications fall in both countries because of the reduction in the number of choices that each applicant was allowed to make, from six to five. Between 2008 and 2011, log applications increase in both countries. There is a clear reduction in England in 2012, when higher tuition fees were introduced, followed by a slight increase in 2013. Figure 4 shows the evolution in the log number of first-year undergraduates in both countries between 2008 and 2013. This variable follows a slight downward trend in both countries until 2011. There is a marked reduction in England in 2012, when higher fees were introduced. This number remains broadly constant between 2012 and 2013.

These two figures support the assumption of common trends and suggest that changes in fees have induced transitory deviations from the trend. They provide suggestive evidence that higher tuition fees discourage university applications and attendance. In the next section, I use regional variation in the level of fees to measure the causal effect of changes in tuition fees on applications and attendance.

6 Results

6.1 Applications

Table 1 reports the results with the log of university applications as the dependent variable. To account for correlation in the error terms within country in each year, heteroskedasticity-robust standard errors clustered by country×year are reported in parentheses. As emphasised in Moulton (1986), ignoring such clustering can greatly underestimate the true OLS standard errors. However, because I estimate a difference-in-differences model, there is the added concern that there may be serial correlation in the error terms within country, as highlighted in Bertrand, Duflo and Mullainathan (2004). To account for this, I also report standard errors clustered by country (in square brackets).[5]

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[5] A practical limitation of inference in my study is the small number of clusters: with two countries and six years of data, there are only 12 clusters when clustering by country×year and two clusters when clustering by country. To account for this, Stata uses a small-sample correction and forms critical values using a t-distribution with $G - 1$

The results suggest that the removal of upfront fees in Scotland in 2001 increased applications by 21.4 log points. This effect is even stronger (at 22.9 log points) in the model with country-specific time trends. The increase in tuition fees in England in 2012 reduced applications by 25 log points (20.5 in the model with country-specific time trends).

These results are not entirely comparable with previous estimates, because previous studies have focused on attendance rates rather than applications. Nonetheless, it is useful to benchmark them against previous estimates for attendance rates. Deming and Dynarski (2009) summarise the findings of a number of quasi-experimental studies conducted for the US. These studies find that an increase in student subsidies to higher education by $1,000$ increases the college attendance rate by about four percentage points. This is equivalent to an increase of about 6.9%, evaluated at an average attendance rate of 58% for 23 year olds in 2005.

The 2001 reform replaced upfront tuition costs of £3,000 for a degree with an endowment scheme in which students paid £2,000 after graduation. It is plausible that applicants viewed this reform as a first step towards complete elimination of fees in Scotland. If the 2001 reform is treated as complete removal of fees, an increase in applications by 21.4 log points corresponds to an increase of 8% for a £1,000 reduction in fees. Converting to US dollars using the 2001 exchange rate, this implies an increase in applications of 5.4% for a $1,000 reduction in fees, which is in line with the effects on attendance in the US literature. The 2012 reform increased the cost of a degree from £10,395 to about £24,120.[6] A reduction in applications by 25 log points corresponds to a reduction of 1.6% for a £1,000 increase in fees or about 1% for a $1,000 increase in fees (at the 2012 exchange rate), a smaller effect than that found in the US literature for attendance.[7]

The results can also be expressed in terms of price elasticity of demand for higher education. Treating the 2001 reform as complete elimination of fees and the 2012 reform as an increase in fees from £10,395 to £24,120, the coefficients in Table 1 imply an elasticity of applications with respect to fees between −0.14 and −0.26.

The third column in table 1 studies the timing of the effect for the 2012 reform. Because the increase in fees was announced in 2010 to take effect in 2012, it may have affected the decision of

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degrees of freedom, where G is the number of clusters.

[6] I assume that, if the cap on fees had not been increased, tuition fees in 2012/13 would have been set at £3,465 (the same level as in 2011/12, adjusted for inflation). The level of fees after the reform (£24,120) is calculated assuming annual fees of £8,040 (the average level set by universities and colleges in 2012/13).

[7] I use the end of year spot exchange rates in 2001 and 2012, reported by the Bank of England.

when to apply to university. In particular, it is possible that students who were deciding whether to take a gap year or apply to university in 2010 or 2011, decided to apply earlier to avoid paying higher fees. I test this hypothesis by including leads and lags of the reform indicator. This approach is similar to the one adopted in Autor (2003) to study the dynamic effects of employment protection on the use of temporary help workers. The results suggest that there was some positive effect on applications in 2010, but this effect is small compared with the reduction in applications observed after the implementation of the reform.

6.2   Course Choice

The theoretical model discussed in Section 3 suggests that changes in tuition fees should have a larger effect on applications for courses that lead to lower wages after graduation. To test this hypothesis, I combine data on average salaries and employment rates after graduation by gender, institution and subject group with applications data and study the effect of the 2001 and 2012 reforms on applications at different quartiles of the distribution of expected future salaries and employment rates.

Salary and employment data are obtained from the HESA DLHE survey. The survey reports salaries of first-degree graduates in full-time paid employment (including self-employment) six months after graduation. To reduce the effect of outliers, I calculate average salaries for workers age 20 to 30 earning less than £60,000 per year. For employment, the survey reports the activity of graduates six months after graduation. I calculate average employment rates as the share of the population of graduates in full-time paid employment six months after graduation. When analysing the 2001 reform, I use data for students who graduated in academic year 2002/03. For the 2012 reform, I use data for students who graduated in academic year 2011/12.

Table 2 reports average salaries and employment rates by subject for students who graduated in academic year 2011/12. The table reveals large heterogeneity in average salaries and employment rates across subjects. Graduates in medicine and dentistry have the highest annual average salary (at almost £29,000) and also the highest employment rate (at 92%). Graduates in creative arts and design have the lowest annual average salary (at just over £16,000) and graduates in law have the lowest employment rate (at 35%).[8] There is also large variation across institutions within subject,

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[8] The ranking of salaries across subjects is similar to the one reported in Chevalier (2011) for 2002/03 graduates.

as suggested by the standard deviations reported in the table.

To test how changes in fees affect applications along the distribution of expected salaries and employment rates, I first calculate the quartiles of the distribution of salaries and employment rates by subject, institution and gender. I then estimate the model including an indicator for each quartile and interactions of these indicators with the treatment variable (D_{dt} in model (1)).

The results, reported in Table 3, suggest that the removal of upfront fees in Scotland in 2001 increased applications by more for courses with lower expected future earnings. Applications to courses in the lowest quartile of the salary distribution increased by 75.2 log points. The effect decreases monotonically as we move to higher quartiles of the salary distribution and is essentially zero for courses in the top quartile. The results for employment are similar and show a much larger increase in applications for courses with weaker employment prospects.

Turning to the 2012 reform, the increase in fees in England reduced applications by less for courses with higher expected future earnings. Applications to courses in the lowest quartile of the salary distribution decreased by 32.2 log points, compared with 22 log points for courses in the top quartile. A similar pattern is found when looking at employment rates. I find a negative effect on applications to courses that lead to lower salaries after graduation despite the fact that students who borrow to cover the cost of higher education only start repaying their loans when their annual earnings reach £21,000. Without this design feature of the student loans system, I would expect higher tuition fees to have an even larger negative effect on applications to courses with poor job prospects.

These findings are consistent with the predictions of the theoretical model and suggest that students take expected future earnings and employment prospects into account when making their course choices. They are also consistent with the findings in Chevalier (2011), who reports large differences in earnings by subject and calculates a graduate tax – in the form of tuition fees – that captures these subject wage premia. He concludes that there is some scope for charging subject-specific fees. My findings suggest that students are indeed willing to pay higher fees for institutions and subjects that lead to better employment prospects after graduation.

Average salaries are higher in Chevalier (2011) because he works with a version of the DLHE which is conducted three years after graduation.

6.3 Attendance

Another prediction of the theoretical model is that credit-constrained students should be more sensitive to changes in tuition fees than unconstrained students. To test this hypothesis, I use data from HESA on the number of first-year undergraduate students at English and Scottish universities by country of domicile (England and Scotland), gender, age group and two further levels of disaggregation: ethnicity or the local authority where the student was domiciled before going to university. These data are not available for the period before the 2001 reform. For this reason, I only analyse attendance for the 2012 reform.

Table 4 reports the results of estimating model (1) with the log of the number of first-year undergraduate students as the dependent variable. In panel I, the model is estimated separately for each ethnic group. In panel II, local authorities are divided into two groups according to the rate of participation in higher education of people who reached age 18 between 2005 and 2009. Local authorities with a rate of participation below the median are classified as low participation areas.

The results show that the increase in fees in 2012 reduced attendance of white students by 33.3 log points, with a much smaller effect for other ethnic groups. When comparing different local authorities, the results show that the 2012 reform reduced attendance by more for students from local authorities with higher rates of participation in higher education.

These results suggest that students who face tighter credit constraints — those from ethnic minorities and less advantaged local areas — do not appear to be more affected by the increase in fees in 2012. This could be explained by the fact that government-provided student loans relax credit constraints. In addition, universities that change tuition fees above £6,000 need to have an access agreement approved by the OFFA, setting out the measures adopted to improve access for students from less advantaged backgrounds. These findings are consistent with the evidence in Carneiro and Heckman (2003), who find no evidence of significant credit constraints in the decision to attend college in the US. Dearden at al (2004) obtain similar results for the UK.

7 Conclusions

In the UK, changes in tuition fees have created large heterogeneity in the cost of higher education over time and across countries. However, few studies exploit these sources of variation to estimate the causal effect of tuition fees on schooling outcomes. This article studies the effect on applications and attendance of two policy changes: the removal of upfront fees in Scotland in 2001 and the increase in fees in England in 2012.

The results from both experiments are consistent and suggest that increases in tuition fees have a negative effect on applications to higher education. I find that the removal of upfront fees in Scotland in 2001 increased applications by 21 log points, while the increase in fees in England in 2012 reduced applications by 25 log points. These results imply an elasticity of demand for higher education with respect to fees between -0.14 and -0.26.

Looking at the impact on applications by subject and institution, I find evidence that changes in tuition fees have a smaller effect on applications to courses with higher employment probabilities and higher average wages after graduation. This suggests that, when faced with higher fees, students take future employment prospects into account when deciding which subjects and institutions to apply for. There is, therefore, scope for fees to vary by course and be set at a higher level for courses that offer better employment prospects after graduation.

Turning to the effect on attendance, I find that the increase in fees in England in 2012 reduced attendance of white students by 33 log points. The effect is smaller for ethnic minorities and for students from local authorities with lower rates of participation in higher education, suggesting that credit constraints do not play a significant role in the decision to attend university.

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Figure 1. Tuition fees in England and Scotland

England

No fees

1998: Tuition fees introduced at £1,000/year

2004: Announcement of variable tuition fees, with a cap at £3,000/year. Applicable to students starting university from academic year 2006/07.

2010: Announcement of increase in cap on tuition fees to £9,000/year. Applicable to students starting university from academic year 2012/13.

No fees

1998: Tuition fees introduced at £1,000/year

2001: Endowment scheme. Students to pay £2,000 after graduation, starting with cohort graduating in April 2005. Only applicable to Scottish-domiciled students.

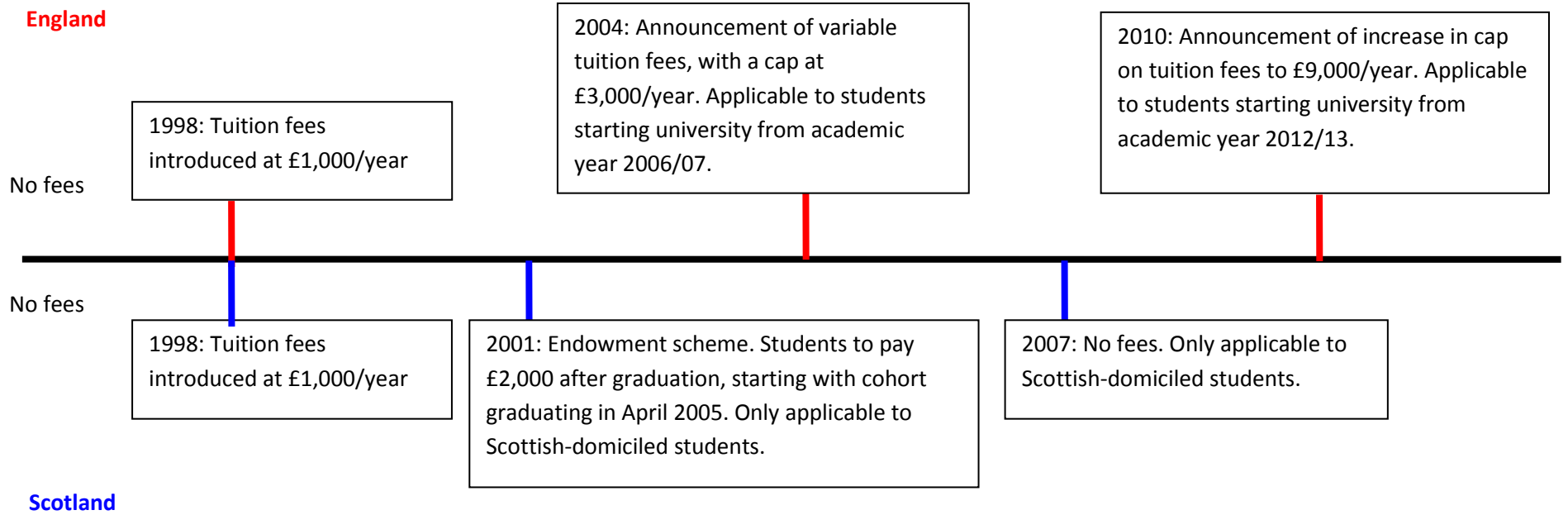2007: No fees. Only applicable to Scottish-domiciled students.

Scotland

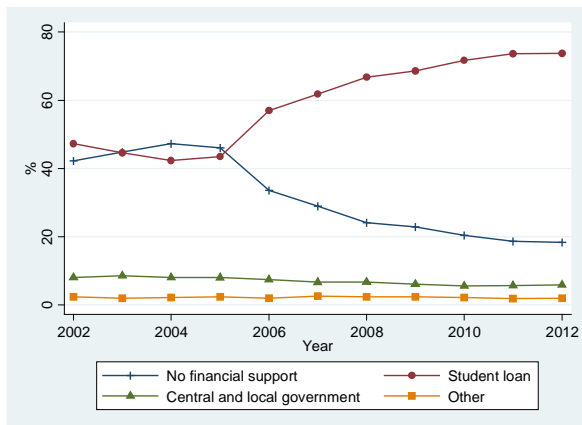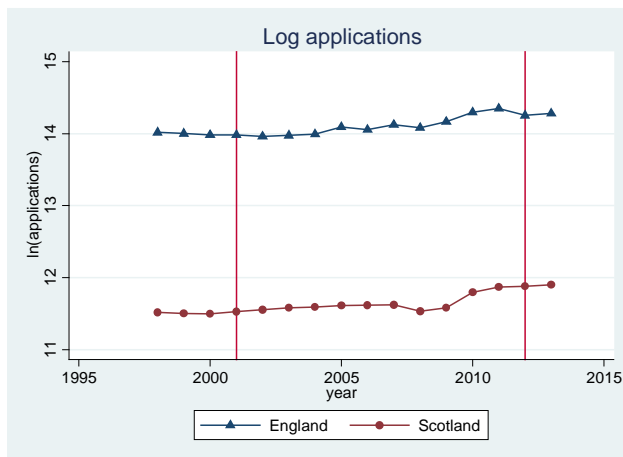**Figure 2.** Percentage of students by major source of tuition fees
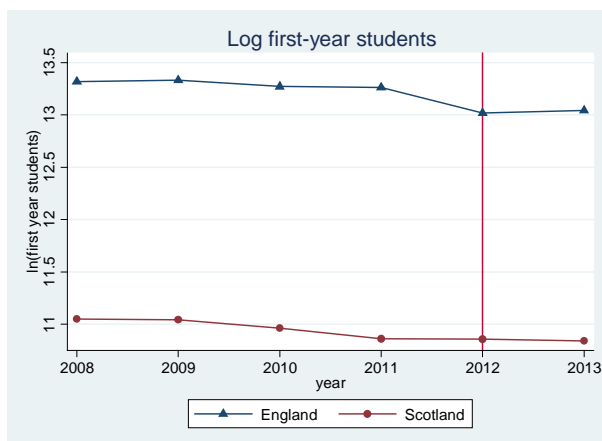

Source: HESA student database. Note: Percentages calculated for students with domicile in England attending English institutions.

Figure 3. Log number of applications by country of domicile

Source: UCAS.

Figure 4. Log number of first-year undergraduate students by country of domicile

Source: HESA student database.

Table 1. Effect on applications

	Log applications		
I. 2001 reform			
Treatment group × post treatment	0.214	0.229	
	(0.041) ***	(0.112) *	
	[0.028]*	[0.022]*	
Observations	81,847	81,847	
R-squared	0.238	0.258	
II. 2012 reform			
Treatment group × post treatment	-0.250	-0.205	
	(0.013) ***	(0.070) **	
	[0.014]**	[0.009]**	
Treatment group × 2010			0.023
			(0.023)
			[0.001]*
Treatment group × 2011			0.002
			(0.023)
			[0.016]
Treatment group × 2012			-0.237
			(0.023) ***
			[0.018]**
Treatment group × 2013			-0.251
			(0.023) ***
			[0.017]**
Observations	72,892	72,892	72,892
R-squared	0.190	0.219	0.190
Country-specific trends	No	Yes	No

Notes. Robust standard errors clustered by country × year in parentheses and by country in square brackets. Regressions include year and country of domicile fixed effects, the log of population, and indicators for gender and age group. Leads and lags of the reform (Treatment group × year) are equal to one in the year indicated for students with domicile in England and zero otherwise. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 2. Average salaries and employment rates by subject for graduates in 2011/12

Subject	Average salary (£)		Average employment rate (%)	
Medicine and dentistry	28,988	(1,623)	92	(14)
Engineering and technology	24,028	(3,149)	63	(11)
Mathematical and computer sciences	21,922	(3,109)	57	(10)
Architecture, building and planning	21,451	(4,236)	69	(9)
Subjects allied to medicine	20,728	(1,764)	66	(13)
Business and admin. studies	19,804	(3,093)	60	(9)
Social studies	19,765	(2,790)	50	(8)
Education	19,403	(2,278)	64	(16)
Physical sciences	19,123	(2,799)	43	(6)
Veterinary science and agricultural and related studies	19,090	(4,776)	60	(15)
Law	17,926	(2,583)	35	(11)
Historical and philosophical studies	17,323	(2,322)	40	(6)
Languages	17,266	(2,046)	45	(7)
Biological sciences	17,021	(2,145)	42	(8)
Mass communications and documentation	16,581	(1,899)	55	(10)
Creative arts and design	16,051	(1,858)	48	(9)

Source: HESA DLHE survey.

Note: Average salaries calculated for workers age 20 to 30 in full-time paid employment (including self-employment) earning less than £60,000 per year six months after graduation. Employment rate is the share of the population of graduates in full-time paid employment six months after graduation. Standard deviation across institutions in parentheses.

Table 3. Effect on course choice

	Log applications			
	2001 reform		2012 reform	
	By salary quartile	By employment quartile	By salary quartile	By employment quartile
	(1)	(2)	(3)	(4)
Treat×post×Q1	0.752	0.517	-0.322	-0.386
	(0.085) ***	(0.062) ***	(0.028) ***	(0.047) ***
	[0.059]**	[0.015]**	[0.019]**	[0.121]
Treat×post×Q2	0.304	0.216	-0.325	-0.262
	(0.067) ***	(0.064) ***	(0.023) ***	(0.049) ***
	[0.072]	[0.078]	[0.003]***	[0.133]
Treat×post×Q3	0.143	0.317	-0.293	-0.262
	(0.063) **	(0.085) ***	(0.020) ***	(0.036) ***
	[0.099]	[0.056]	[0.001]***	[0.075]
Treat×post×Q4	0.004	0.200	-0.220	-0.222
	(0.052)	(0.059) ***	(0.044) ***	(0.029) ***
	[0.114]	[0.025]*	[0.102]	[0.007]**
Observations	43,624	37,482	50,182	37,493
R-squared	0.405	0.444	0.294	0.354

Notes. Robust standard errors clustered by country × year in parentheses and by country in square brackets. Regressions include year and country of domicile fixed effects, the log of population, and indicators for gender, age group and salary/employment rate quartile. Columns (1) and (3) report coefficients on the treatment indicator interacted with an indicator for each quartile of the distribution of expected average salaries of graduates in full-time paid employment six months after graduation. Columns (2) and (4) report coefficients on the treatment indicator interacted with an indicator for each quartile of the distribution of expected average employment rates of graduates six months after graduation. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 4. Effect on attendance by demographic group – 2012 reform

	Log students			
I. Ethnicity	White	Black	Asian	Other
Treatment group × post treatment	-0.333	-0.053	-0.088	-0.023
	(0.038) ***	(0.037)	(0.030)**	(0.016)
	[0.004]***	[0.006]*	[0.002]**	[0.004]
Observations	12,224	6,644	7,399	6,979
R-squared	0.188	0.076	0.186	0.183
II. Participation in higher education	Low participation		High participation	
Treatment group × post treatment	-0.158		-0.376	
	(0.038) ***		(0.056) ***	
	[0.001]***		[0.004]***	
Observations	10,933		11,841	
R-squared	0.154		0.131	

Notes. Robust standard errors clustered by country × year in parentheses and by country in square brackets. Regressions include year and country of domicile fixed effects, the log of population, and indicators for gender and age group. *** significant at 1%, ** significant at 5%, * significant at 10%.