Department for Education

# Demand determinants and elasticities for English higher education: International student model

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# Executive Summary

## Introduction

Alma Economics was commissioned by the Department for Education (DfE) to produce robust, comprehensive and up-to-date estimates of the determinants of demand for higher education among both domestic and international students. The central aim is to assess how student demand responds to changes in tuition fees, student finance, visa arrangements, and other policy levers to inform future policy decisions. This report focuses on international students. A separate report will focus on domestic students.

Price elasticities are central concepts referred to and empirically estimated in this report. The price elasticity of demand measures how sensitive students‘ demand for higher education (HE) is to changes in its price.[1] Elastic demand, where the elasticity is greater than one in absolute value, means that a given percentage increase in fees leads to a proportionally larger percentage fall in demand. Inelastic demand, where the elasticity is less than one, means students are relatively unresponsive to fee changes; demand falls by a smaller proportion than the fee increase. The price elasticity of supply captures the responsiveness of providers to changes in fee revenue: A more elastic supply means institutions can adjust the number of places they offer more strongly in response to changes in tuition fees or other revenue they receive.

## Data

The study uses a quantitative approach based on annual data from 2002 to 2023, drawing primarily on Higher Education Statistics Agency (HESA) data on enrolments, tuition fees, and other income sources for HE providers. This is supplemented with broader macroeconomic data and qualitative information on visa policies. Due to data constraints, the analysis focuses on two main student segments: full-time undergraduate and full-time postgraduate taught students.[2] Part-time students, as well as full-time and part-time postgraduate research students, are not included.

The analysis also distinguishes between EU and non-EU students. Until 2021, EU students were entitled to home fee status[3], and they may respond differently from non-EU students to price and non-price factors (e.g. due to their geographic

[1] Formally, price elasticity of demand is defined as the percentage change in quantity demanded resulting from a one per cent change in price, holding all else constant.
[2] In this report, the term “undergraduate students” refers to all undergraduate students, including those listed as “first degree” and “other undergraduate” in HESA data. This includes Level 4/5 undergraduate students who are captured in these categories. The term “postgraduate taught” includes students from all postgraduate taught programmes.
[3] Home fee status determines whether students pay the lower domestic tuition rate rather than the higher international rate.

proximity[4]). To account for these differences, the analysis is carried out separately across four groups: full-time undergraduate students (EU and non-EU) and full-time postgraduate taught students (EU and non-EU), which together represent more than 90% of international student enrolments.[5]

## Methodology

A series of econometric models was estimated, with demand and supply modelled as functions of their respective drivers. On the demand side, the factors considered included price, international student income, visa policies, policy reforms, and external events such as the Brexit referendum and the UK's exit from the EU in 2021. Sensitivity checks also incorporated additional variables, including competitor tuition fees[6], living costs, and the rankings of English HE providers. On the supply side, providers' decisions about how many places to offer were modelled as a function of the income they receive (tuition fee revenue, government funding and grants) and the cost of provision. It is expected that providers want to offer more places when fee revenue is higher, and the cost of provision is lower—consistent with a standard supply function, whereby quantity supplied increases with price and decreases with input costs.[7]

A major challenge in estimating demand and supply elasticities is that the underlying demand and supply curves—which trace the relationship between demand or supply and price—are not directly observed. What is observed is equilibrium prices and quantities at different points in time, which are the outcome of demand and supply interacting. For example, if one price-enrolment combination is observed at one point in time, and another price-enrolment combination is observed at another point in time, this does not mean that the change in enrolment reflects the response of demand to the change in price (i.e. the price elasticity). It could also be that demand changed for another reason, which caused the change in the market price. This has important implications for the modelling strategy. A standard (reduced-form) econometric

[4] EU students have a relatively cheaper and shorter journey home. This means the overall cost of studying in England (when travel costs are factored in) is lower for them than for distant international students, potentially making them more sensitive to tuition fee changes.
[5] The other 10% covers part-time students and postgraduate research students.
[6] The analysis considered three comparator countries: Australia, Canada and the US. European countries such as Germany and France were also reviewed; however, they were excluded because their courses typically have either no tuition fees or comparatively low tuition fees.
[7] This demand-supply framework works best when prices are free to adjust in response to market forces, which applies naturally to international students. Because their tuition fees are largely unregulated, universities can set prices that reflect their costs, reputation, and competitive pressures, while students respond to those prices based on their willingness and ability to pay. The resulting fee and enrolment levels are therefore market outcomes, shaped by the interaction of demand and supply. This is true to a lesser extent for EU undergraduate students, for whom fees were regulated through a government-imposed cap until 2021, when they became subject to international fee rates.

approach that analyses the association between enrolment and tuition fees would not be able to reliably disentangle demand and supply responses.

To obtain credible estimates of the price elasticity of demand, as well as the effects of other demand drivers, it is necessary to address this challenge—referred to as simultaneity or endogeneity. The modelling strategy used, described in Section 2.4, does this by using instrumental variables (IV) techniques. Essentially, to estimate demand elasticities, IV techniques use variables that shift prices for non-demand-related reasons (e.g. factors that shift supply). The changes in enrolment associated with those price shifts therefore reflect demand responses to price, rather than being caused by them. The robustness of the results is examined across estimation methods, data types (panel and time-series), and model specifications.

The analysis is also conducted by provider tier to examine whether the price elasticity of demand varies across providers. Providers were classified into four tiers based on their ranking in the Complete University Guide league table for England, with tier 1 representing the highest-ranked providers and tier 4 the lowest-ranked providers.[8]

# Key findings: Demand

## Summary

- International student demand responds to price changes but is, on average, relatively insensitive or inelastic, meaning that the percentage decrease in demand is smaller than the percentage increase in price that caused it.
- There is limited evidence of substantial differences in price responsiveness between undergraduates and postgraduates, or between EU and non-EU students, suggesting that the price elasticity of demand is broadly similar across levels of study and student domicile.

[8] Tier 1 includes the three top providers in the Complete University Guide: the University of Cambridge, the University of Oxford, and Imperial College London. These providers are also in the top 10 worldwide according to QS World University Rankings. Tier 2 includes the remaining top 20 institutions in the CUG league table. The remaining institutions are divided into two tiers such that total first-year enrolment is balanced between them.

- The price elasticity of demand varies across estimation methods, data types, and model specifications; however, the estimated range is quite narrow: between -0.30 and -0.75. These estimates correspond to long-run price elasticities, capturing the full effect of price changes, including both immediate and lagged responses. All elasticities reported in the Executive Summary represent long-run elasticities.
- There is strong evidence of systematic variation by provider tier. For higher-ranked providers (tier 1), the price elasticity of demand is close to zero, indicating that students are not sensitive to price changes, whereas for lower-ranked providers (tier 4), it is considerably higher and may exceed one, indicating that they are quite sensitive to tuition fee changes.

## Detailed findings

Table 1 presents the estimated long-run price elasticity of demand across the four student groups based on the preferred models. A key finding is that the elasticity is substantially below one in all cases, indicating that demand is relatively insensitive to changes in price. The estimates are statistically significant, indicating that the observed relationship is unlikely to have arisen by chance.

Specifically, the non-EU undergraduate elasticity of -0.32 indicates that a 10% increase in the price of HE from English providers leads to an estimated 3.2% decrease in non-EU undergraduate demand. Because the fall in demand is proportionally smaller than the increase in price, which caused it, demand is described as inelastic.

**Table 1: Price elasticity of demand**

| Student region of domicile | Undergraduate | Postgraduate taught |
|---|---|---|
| Non-EU | −0.32 | −0.42 |
| EU | −0.37 | −0.45 |
| EU RAB adjusted* | −0.57 | *NA* |

**Note:** Price elasticity of demand is estimated using panel data econometric models, based on data from 2004 to 2023—the estimates reflect the average elasticity over this period; for EU undergraduate students, the elasticity is based on an OLS approach, while the remaining elasticities are estimated using IV methods. *−0.37 is the elasticity obtained from the model, whereas −0.57 is the elasticity obtained after the Resource Accounting and Budgeting (RAB) charge adjustment is applied; all estimates represent long-run elasticities.

The non-EU postgraduate taught elasticity is similar in magnitude to that for undergraduates (-0.42), implying that a 10% increase in price leads to a 4.2%

decrease in demand for postgraduate programmes among non-EU students. The EU postgraduate elasticity is very close to the non-EU elasticity, with a value of -0.45.

For EU undergraduates, the estimated elasticity should be interpreted with some caveats. First, it is based on a single observed price change associated with the 2012 fee reform and therefore, relies on limited variation in the data. Second, until 2021, EU students were eligible for income-contingent tuition fee loans. Students whose subsequent earnings were not high enough to pay off all these loans were therefore implicitly subsidised—they did not ultimately pay the full tuition fee. As a result, the effective cost faced by some students was lower than the headline tuition fee. If this possibility were factored into students' decisions, the effective price changes they responded to would be lower than the headline fee changes. This would mean the estimated price elasticity may understate the true responsiveness of demand to price.

To address this, estimated elasticities for EU undergraduates are reported on two bases. The first uses the headline tuition fee as the price measure. The second uses an adjusted version of the fee that reflects only the proportion of the student loan that is repaid on average (see Appendix A.8 for further details).

If EU undergraduates correctly anticipated, on average, the share of their loan that would be repaid, then the RAB-adjusted elasticity would provide a better estimate of their responsiveness to price. That elasticity is −0.57. If, on the other hand, students only respond to the headline fee (equivalently, if they all assumed that they would fully repay their loans), the non-adjusted elasticity is more appropriate. That elasticity is −0.37. Both elasticities are close to those obtained for other student groups.

The elasticity estimates across different student groups and sensitivity checks overlap considerably. For non-EU undergraduates, the estimated elasticity ranges from −0.32 to −0.56; for non-EU postgraduates, from −0.36 to −0.64; for EU undergraduates, from −0.36 to −0.74[9]; and for EU postgraduates, from −0.42 to −0.62. Therefore, the price elasticity of demand seems broadly similar across student groups, with estimated values ranging between −0.30 and −0.75.

Finally, Table 2 presents the long-run price elasticity of demand by provider tier, reflecting provider rankings in the Complete University Guide league table. While the analysis was conducted separately for each student domicile group (EU and non-EU) and level of study (undergraduate and postgraduate), the Table provides a more parsimonious summary, averaging estimates across all student groups and levels of study. Group-specific estimates within tiers also come with relatively wider confidence intervals due to the lower sample sizes involved.

[9] −0.36 is obtained from a model that includes competitors' fees, while −0.74 is derived from the time-series model with a RAB adjustment.

**Table 2: Price elasticity of demand by provider tier**

| | Tier 1 | Tier 2 | Tier 3 | Tier 4 |
|---|---|---|---|---|
| **Price elasticity of demand** | −0.07 | −0.36 | −0.50 | −1.12 |

**Note:** Price elasticity of demand is estimated using time-series econometric models, based on data from 2004 to 2023. The estimates reflect long-run price elasticities by HE provider tier. Each tier-specific elasticity is calculated by averaging four elasticities obtained by conducting the analysis separately for each of the following full-time student groups: EU undergraduate students, EU postgraduate students, non-EU undergraduate students, and non-EU postgraduate students. Source: Alma Economics analysis.

The results suggest that demand for higher-ranked providers is significantly less sensitive to price changes than demand for lower-ranked providers. For tier 1 providers, the elasticity of demand is close to zero, indicating little response to changes in tuition fees, whereas tier 4 providers exhibit relatively elastic demand, with students responding more strongly to fee changes.[10] The differences in price elasticities may also reflect providers' responses to lower demand. It is possible that providers lower their admission standards to mitigate reduced demand—providers with a higher reputation may have greater flexibility to adjust admission standards, which translates into lower price elasticity of demand.

Besides price effects, the analysis found no consistent, statistically significant impacts from other factors, including income (measured by student domicile GDP per capita), indicating that price is the main demand driver. In the EU models, the Brexit referendum coefficient is also not statistically significant in the preferred model. While some alternative specifications estimate an 8%–10% reduction in enrolment from 2017 onwards following the referendum, these effects are not robust.

The results also suggest that each additional (or fewer) year of post-study work rights is associated with approximately an 8% increase (or decrease) in demand for undergraduate and postgraduate taught programmes. However, the precise magnitude of this effect should be interpreted cautiously, as it is sensitive to the set of visa policies included.

## Key findings: Supply

The supply of HE refers to the total number of study places and courses that HE providers are willing and able to offer. Estimating the supply equation is more challenging than estimating the demand equation, partly due to the relatively slow

[10] Statistical significance is not reported because it is not meaningful when averaging across different models. Most of the individual elasticities—by tier, level of study, and student domicile—are statistically significant.

adjustment of HE provision to changes in market conditions. It can be challenging for providers to quickly expand or contract capacity, and changes in provision often lag. To address this, an approach designed to account for these longer-term dynamics was applied, resulting in an estimated price elasticity of supply ranging between 0.4 and 1.0. This implies that a 10% increase in price ultimately leads to an increase in the supply of HE of approximately 4% to 10%.

These estimates come with more caveats than the demand elasticity estimates. Statistical tests failed to confirm, with standard levels of confidence, a key technical assumption ("cointegration") on which these estimates are based. The supply elasticity estimates were also not consistently statistically significant. However, these indicative elasticities are useful as anchors for a reasonable range of assumptions on which to base policy simulations.

## Limitations

An important caveat is that the analysis cannot account for any changes in admission standards that providers may implement alongside price changes. For example, providers may choose to relax entry requirements while increasing prices in order to maintain enrolment in the face of falling demand. This would effectively lead to an underestimation of the underlying demand elasticity. Reductions in selectivity may also impose costs on providers, such as declines in academic standards or prestige, which may not be reflected in immediate changes in enrolment or income.

Other limitations include:

- **Stability:** The estimates are based on historical data and therefore reflect average elasticities over the period analysed (2002-2023). These elasticities may change over time and may not adequately represent the elasticities determining future outcomes. Policymakers should mitigate this risk by considering a range of elasticities.
- **Estimation uncertainty:** Estimated impacts are inherently subject to estimation error, particularly for EU undergraduate students, for whom the elasticity is estimated using a single policy change event. However, this has been mitigated by considering a range of elasticities. In addition, the similarity of elasticity estimates across student groups, together with the results of sensitivity checks, provides a reasonable degree of confidence in these estimates.
- **Accounting for endogeneity:** While considerable care was taken to account for potential bias induced by endogeneity, the approach may not have fully addressed this challenge. If so, the true price elasticity of demand could be higher than the range of estimates presented in the report (as any remaining bias

would tend to bias the estimated elasticity towards zero).

- **Part-time and postgraduate research students:** The analysis focuses on full-time students due to challenges in modelling part-time students. Given the potential differences between students undertaking full-time and part-time studies and their motivations compared with full-time students, it is not clear whether the findings in this report can be generalised to part-time students. Likewise, the demand for postgraduate taught courses was not modelled, and it is uncertain whether the findings for postgraduate taught courses can be applied to postgraduate research courses.

# 1. Introduction

Alma Economics was commissioned by the Department for Education (DfE) to undertake research aimed at producing robust, comprehensive and up-to-date estimates of domestic and international student demand for higher education (HE). While the primary focus is on the price elasticity of demand, the research also considers other relevant demand factors and the supply side. Ultimately, the insights from the analysis will be used to assess how demand may respond to future policy changes related to tuition fees, student finance, visa policies, and the introduction of an international student levy, thereby informing policy development.

The research is structured around three main workstreams.

- **Literature review:** A review of existing literature, focusing on the empirical frameworks and econometric approaches used in previous studies to estimate demand for HE.
- **International student demand model:** Econometric analysis to estimate demand for HE among international students.
- **Domestic student demand model:** Econometric analysis to estimate demand for HE among domestic students.

This report presents the international student demand model; the literature review and domestic demand model are presented in separate reports. The report draws on econometric methods and quantitative analysis. Where possible, results are explained in plain terms, though some technical detail is retained throughout.

The remainder of this report is structured as follows:

- Section 2 presents the methodology.
- Section 3 sets out the data used in the analysis.
- Section 4 provides summary statistics.
- Section 5 presents the results.
- The appendices provide additional technical details and findings.

# 2. Methodology

## 2.1 Framework

As with most goods or services, market outcomes in HE, namely price (tuition fees) and quantity (enrolment), are determined by the interaction of demand and supply.[11]

On the demand side, students' enrolment decisions, specifically whether to attend HE or not, are shaped by tuition fees, household income, and the availability of student finance, among other factors. For example, the higher the tuition fees, the fewer students we expect to enrol, all else being equal. The price elasticity of demand measures how sensitive students are to changes in tuition fees.[12] Elastic demand, where the elasticity is greater than one in absolute value, means that a given percentage increase in fees leads to a proportionally larger percentage fall in demand. Inelastic demand, where the elasticity is less than one, means students are relatively unresponsive to fee changes; demand falls by a smaller proportion than the fee increase, reflecting fewer perceived alternatives.

On the supply side, Higher Education Providers' decisions about how many places to offer are driven by the income they receive (in particular, tuition fee revenue and government funding and grants), the cost of provision, and potentially regulatory constraints. It is expected that Higher Education Providers (HEPs) want to offer more places when fee revenue is higher, and the cost of provision is lower—consistent with a standard supply function, whereby quantity supplied increases with price and decreases with input costs (see Varian (2010)[13] or OpenStax for an online source). The price elasticity of supply captures the responsiveness of HEPs to changes in fee revenue: a more elastic supply means institutions can expand or contract the number of places they offer by a greater percentage when they face an increase or decrease in the income they receive for those places.

[11] This is particularly true for international students, where the market is generally less regulated, and to a lesser extent for domestic students, where greater regulation applies. For EU undergraduate students in England, however, tuition fees were regulated through a government-imposed cap until 2021, when the UK's departure from the EU meant that EU students became subject to international fee rates.
[12] Formally, price elasticity of demand is defined as the percentage change in quantity demanded resulting from a one per cent change in price, holding all else constant.
[13] Varian, H.R. (2010) *Intermediate Microeconomics: A Modern Approach*. 8th edition. New York: W.W. Norton & Company.

The main objective of the research is to identify the determinants of demand for HE. However, supply conditions are also policy-relevant, particularly in the context of a potential international student levy. The impacts of a levy will depend on the interaction between demand and supply. In particular, the impact of an international student levy on market price and student enrolment depends on the relative elasticities of demand and supply.

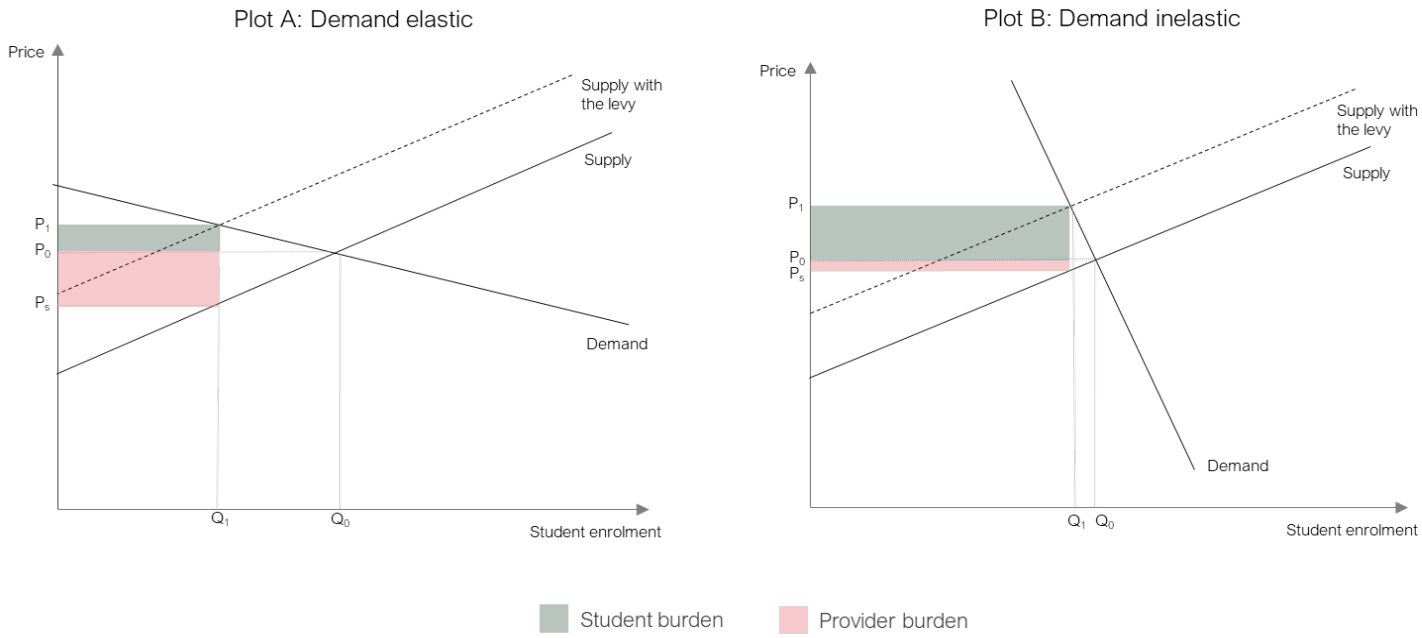
In a market in which prices are not regulated, they will naturally tend to settle at the level which equilibrates demand and supply. If prices were below that level, there would be more demand than places available, meaning that providers could charge more while still filling all available places. If prices were above that level, places would be unfilled, meaning providers would have an incentive to reduce prices. This means that, in the event of a shift in supply or demand, the market price (fees) will adjust until demand and supply re-equilibrate at a new level of enrolment. The exact adjustments that actually take place depend on the relative elasticities of supply and demand.

Figure 1 illustrates the textbook case of a levy's impact. The introduction of the levy shifts the supply curve to the left, meaning that HEPs are willing to provide fewer student places at a given fee, due to the levy that they must pay.[14] This means that demand must fall in order to re-equilibrate it with the (now lower) level of supply, meaning a fee rise. The resulting change in fees and student enrolment is illustrated assuming two different demand elasticities.[15] When demand is elastic (Plot A), fees rise only a relatively small amount before demand is brought back down in line with supply—HEPs cannot pass much of the levy on to students. The burden of the levy falls relatively more on providers with only a modest increase in fees ($P_1 - P_0$) and a substantial decline in enrolment ($Q_1 - Q_0$). When demand is inelastic (Plot B), students have few alternatives and continue to enrol even as fees rise, so HEPs can pass a greater share of the levy on through higher fees; the fee increase is larger, but the fall in enrolment is smaller. In both cases, the total levy is split between students, who pay a higher fee ($P_1 - P_0$), and providers, whose net revenue per student falls ($P_0 - P_s$), but the inelastic case shifts that burden toward students.

**Shows how a levy is shared between students and providers, depending on how responsive student demand is to changes in price**

[14] See Varian (2010) and OpenStax .
[15] Different supply elasticities would also lead to different market outcomes; however, they are not discussed here.

**Figure 1: Demand and supply framework**




A major challenge in estimating demand and supply is that the underlying demand and supply curves are not directly observed. What is observed is equilibrium prices and quantities at different points in time, which are the outcome of demand and supply interacting. For example, if we observe two different price-quantity combinations at two different points in time, this only reveals the price elasticity of demand (the slope of the demand curve in Figure 1) if both of those price-quantity combinations lie on the same demand curve. This is only the case if the demand curve has not itself changed, meaning that the change in price and quantity has been caused by a supply shift. If, in fact, the demand curve has shifted, then price and quantity changes will both be observed, but the relationship between them does not reveal the demand elasticity. As a result, a standard (reduced-form) econometric approach analysing enrolment and tuition fees would not recover the true causal effect of price on demand or supply—the estimated coefficient would conflate demand and supply effects, yielding biased estimates of the price elasticity of demand and supply.

To obtain credible estimates of the price elasticity of demand and supply, as well as the effects of other demand and supply drivers, it is necessary to address this challenge—referred to as simultaneity or endogeneity. The modelling strategy used, described in Section 2.4, does this by treating price as endogenous and exploiting instruments via instrumental variable estimation. It is important to note that addressing this endogeneity challenge would be crucial even if we were only interested in the demand elasticity. However, given the current policy relevance of an international student levy, the supply elasticity is also examined in order to inform a simulation of the likely impacts of such a levy.

## 2.2 Sample size and composition

This study considers all international students studying at English HE providers that are in the Approved (fee cap) category on the Office for Students (OfS) register[16] from 2002/03 to 2023/24 academic years across all levels and modes of study.[17] Specifically:

- **Group of countries**. The analysis covers students from across the globe, grouped into two categories: EU and non-EU countries.
- **Levels of study.** The analysis is conducted separately for undergraduate and postgraduate taught students.[18] Postgraduate research students were also considered, but constraints in the price data[19], combined with the relatively small size of this student segment, means that the findings are not credible to inform policy.
- **Modes of study:** The analysis considers separately full-time and part-time students. However, for part-time students, it is difficult to identify the demand equation (see Section 4 for further details).[20]

This results in a total of (2 regions) × (3 levels of study) × (2 modes of study) = 12 student segments. **However, the analysis focuses primarily on undergraduate and postgraduate taught students studying full-time—that is, two key levels of study across two regions, resulting in four main segments.**

1. Full-time EU undergraduate students.
2. Full-time EU postgraduate taught students.
3. Full-time non-EU undergraduate students.
4. Full-time non-EU postgraduate taught students.

[16] Other HEPs in the Approved category on the OfS register are outside the scope of this research, as are further education providers. We also restrict the sample to international students enrolled at these HEPs on higher education courses at Qualification Level 6 or above; students on Level 4/5 courses are therefore excluded. Definitions of the Qualification Levels can be found on the Gov.uk website.
[17] While most of the data up to the 2024/25 academic year is available, complete tuition fee income data is missing.
[18] In this report, the term “undergraduate students” refers to all undergraduate students, including those listed as “first degree” and “other undergraduate” on the Higher Education Statistics Agency, the main data source used; and the term “postgraduate taught” includes students from all postgraduate taught programmes.
[19] The tuition fee series is highly skewed, as it is constructed by dividing income from fee-paying students by total student numbers—the latter includes self-funded students and those receiving external funding paid directly to them rather than the provider. As a result, the series is subject to considerable measurement error.
[20] Due to unobserved confounders, it is not possible to estimate the price elasticity and other demand drivers with reasonable accuracy (the model has a low model fit, and coefficient estimates are not statistically significant and/or have counterintuitive signs).

These four segments represented 92% of full-time equivalent student enrolments and 96% of total tuition fee income in the 2023/24 academic year.

The estimates provided in this report, which use full-time students, may not be applicable to part-time student demand.

## 2.3 Price measure

Tuition fees are charged in British pounds, but for most international students, the effective cost depends on the fees expressed in their local currency. A weaker pound reduces the cost in their local currency, while a stronger pound increases it. To account for this, tuition fees are converted into local currency terms, capturing changes in both the listed tuition fee and the exchange rate movements.[21]

In addition to tuition and exchange rate effects, two further cost components are included: visa fees and the immigration health surcharge. All international students, including EU students since 2021, are required to obtain a student visa. The visa fee was £36 in the early 2000s and has steadily increased, reaching £524 in 2024. Additionally, an immigration health surcharge was introduced in 2015 at £150 per year, rising to £776 by 2024.[22] These charges constitute additional mandatory expenses associated with studying in England and are therefore included in the overall price measure. Finally, nominal costs are converted into real terms using the consumer price index of each country of origin. This adjustment accounts for inflation and ensures that values reflect changes in purchasing power.

The price measure used in this study reflects the overall financial burden faced by international students and is therefore the appropriate measure for both research and policy purposes.[23] In doing so, it improves upon much of the existing literature, which typically focuses solely on tuition fees and treats the exchange rate as a control variable.[24]

Some of the major price movements for EU students happen as a result of "events" which led to price changes as well as to other changes or policy shifts. For EU undergraduates, two major events involve simultaneous fee increases and additional policy shifts: the 2012 reform, which raised the undergraduate tuition fee cap and introduced changes to the student finance system, and EU exit, when the loss of

[21] Market exchange rate is used for the conversion.
[22] While visa fees are one-off costs, the health surcharge is charged annually.
[23] Policymakers should use this measure to assess how policies affect the price paid by international students.
[24] In addition, by integrating multiple cost components into a single variable, a parsimonious model specification is used, thereby conserving degrees of freedom. It also reduces endogeneity risks, as a significant part of the price variation is driven by exogenous factors.

Home Fee status coincided with the loss of access to government student finance and the removal of the right to work and study in the UK without a visa.

Acknowledging this, the price variable is interacted with indicator variables capturing these key events. As explained in Box 4, this allows the price elasticity of demand to vary over time as a function of these events. **The key policy implication is that the price coefficients cannot be interpreted as pure price effects.**

**Box 1: Price measure**

$$Price_{i,t} = \frac{\left( Tuition_{i,t} + Visa_{i,t} + Health_{i,t} \right) \times FX_{i,t}}{Deflator_{i,t}}$$

**Price:** Real effective price of higher education.

**Tuition:** Nominal tuition fees, expressed in British pounds.

**Visa:** Cost of obtaining a UK student visa.

**Health:** Immigration Health Surcharge payable by international students.

**FX:** Bilateral exchange rate between the British pound and the student's home (local) currency.

**Deflator:** Implied Consumer Price Index deflator for the student's country of domicile (indexed to 1 in the base year 2002).

**i:** student's country or region of domicile.

**t:** year.

## 2.4 Identification of the demand equation

To estimate the demand elasticity for a particular group of students—either all international students or those from specific countries or regions of origin—the key requirement is to identify price variation that is not itself driven by changes in demand from that group (see Section 2.2). There are two broad ways of meeting that challenge.

- **Control for factors influencing demand:** All relevant factors affecting demand from the group whose elasticity is estimated should be controlled for. Various non-price factors that could shift demand can be measured and thus controlled for directly, helping isolate price changes not driven by those demand shifts. For example, when estimating the demand elasticity of non-EU students, one

should account for demand shifts caused by factors such as non-EU students' income, graduate visa policies, and the perceived quality of English universities.[25] Including these controls increases the credibility of the claim that the residual price variation is not itself caused by demand shifts. However, on its own, there is a risk that this is insufficient: it is always difficult to be sure that all relevant factors have been controlled for.

- **Identify exogenous (non-demand-related) sources of price changes:** When observing changes in price and enrolment, it is not possible to tell whether demand changed in response to price, or whether price itself changed due to changes in demand (this is the simultaneity or endogeneity challenge). To trace out the demand curve, we need to isolate price variation that students respond to but did not themselves cause. As well as simply controlling for demand shifters, one can also try to identify specific sources of exogenous (non-demand-related) price changes, such as shifts in price driven by policy changes or supply-related factors.[26]

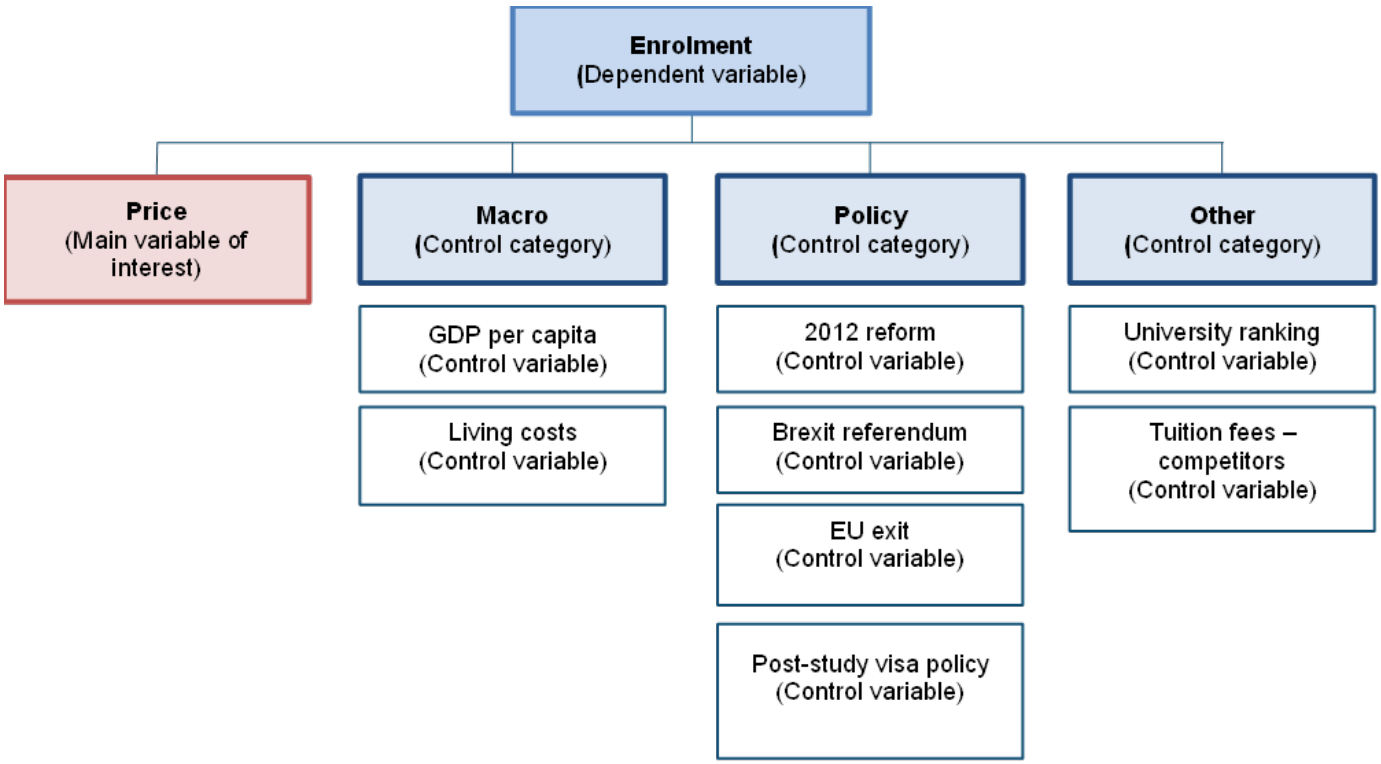
These two steps are discussed in greater detail in the remainder of this section.

### 2.4.1 Control variables

Figure 1 summarises the general demand equation specification, summarising the control variables considered. Effectively, student enrolment[27] is modelled as a function of price and three groups of control variables: macroeconomic, policy, and other variables. The model specification is consistent with the literature, which typically models demand as a function of tuition fees, university quality, GDP per capita, and exchange rates.[28] However, the "price" measure used in this study is more comprehensive than those commonly used, capturing broader effects (exchange rates, which affect the price faced by international students in their home currency, as well as visa and healthcare surcharge costs).

[25] Technically, this is not required if valid exogenous price shifters have been identified; however, the ability to control for confounders generally strengthens the credibility of the exogeneity assumption and improves the statistical precision of the estimates.
[26] For EU undergraduate students, there is an additional challenge associated with the tuition fee cap. If the cap generates non-trivial excess demand, then observing changes in enrolment alongside changes in prices—even if the price changes are exogenous—would not allow us to accurately identify the demand curve, potentially leading to a price elasticity of demand that appears more inelastic than it actually is.
[27] Student enrolment is the "quantity" variable. Applications could serve as an alternative, but were ruled out due to insufficient historical data.
[28] Some studies also incorporate measures of distance—such as geographic distance, time zone differences, and cultural distance—as well as demographic variables like the proportion of the population that is of tertiary age. However, because these factors tend to remain largely constant over time, they are mainly employed in cross-sectional analyses to account for differences in student flows between countries rather than for changes within countries over time.

**Figure 2: General demand specification**




Demand shifts related to changes in income in students' countries of domicile are controlled for by GDP per capita. In some of the sensitivity analyses, differences in living costs between England and the country of origin are also controlled for. If England becomes relatively more expensive to live in compared with the domicile country, demand is expected to decline, holding other factors constant. Following Crawford et al. (2025), the ratio of the price level index in the country of origin relative to the UK is used to account for differences in living costs.

The EU undergraduate demand equation accounts for the 2012 reform, while both the EU undergraduate and postgraduate demand equations incorporate the effects of the EU exit. The 2012 reform and EU exit are accounted for using interactions with the price variable, as discussed in Section 2.3. Although the Brexit referendum and the period leading up to the UK's departure from the EU did not alter tuition fees or other policies for EU students, they may have generated adverse sentiment or influenced EU students' expectations regarding post-study work opportunities, thereby affecting demand. Following Amuedo-Dorantes and Romiti (2024) and Clifton-Sprigg et al. (2025), a Brexit referendum indicator variable (equal to 1 from 2017 onward) is included to control for potential Brexit-related effects that began prior to its formal implementation in 2021.[29]

[29] The indicator variable aims to assess whether the referendum had a permanent effect on demand.

Regarding non-EU demand, the analysis controlled for changes in post-study visa policies. Several changes occurred during the sample period within scope, with the most recent being the 2021 introduction of the Graduate Route, which allows two years of post-study work for most graduates and three years for PhD graduates. The changes in visa policies considered in the modelling are presented in Appendix A3.

In some of the sensitivity analyses, additional controls are included to capture factors related to the reputation of English universities and tuition fees in competitor countries. A stronger reputation of English universities and higher tuition fees abroad are expected to be positively associated with greater demand for English HE among international students. However, identifying the impact of these factors is challenging, as they remain relatively constant over the sample period.

Finally, COVID-19 may also have influenced enrolment in 2020 and 2021. However, isolating its effect is challenging, as it overlaps with other developments such as the EU exit and changes to visa policies for non-EU students. In sensitivity analyses, a 2020 dummy variable was included across the EU and non-EU models, as well as the undergraduate and postgraduate specifications; however, it was not statistically significant and had no impact on the other coefficient estimates.[30]

[30] In the EU postgraduate model, the 2020 dummy was marginally significant at the 10% level; however, even in this case, it did not alter the estimates of the other regressors.

**Box 2:** General demand model specifications

The general model specifications for EU and non-EU student demand are set out below (different versions of these specifications have been estimated).

EU student demand

$$\log(Enrolment_t) = \alpha + \varphi \log(Enrolment_{t-1}) + \beta_1 \log(Price_t) + \beta_2 \log(Price_t) \times 2012_t + \beta_3 \log(Price_t) \times EU\ exit_t + \beta_4 \log(GDP_pc_t) + \beta_5\ Brexit_ref_t + \beta_6 \log(LivingCost_t) + \beta_7 \log(Rank_t) + \beta_8 \log(CompFee_t) + \varepsilon_t$$

Non-EU general demand model specification

$$\log(Enrolment_t) = \alpha + \varphi \log(Enrolment_{t-1}) + \beta_1 \log(Price_t) + \beta_2 \log(GDP_pc_t) + \beta_3 \log(LivingCost_t) + \beta_4 \log(CompFee_t) + \beta_5 \log(Rank_t) + \beta_6\ \mathrm{D2019}_t + \beta_7\ \mathrm{PSW}_t + \varepsilon_t$$

where:

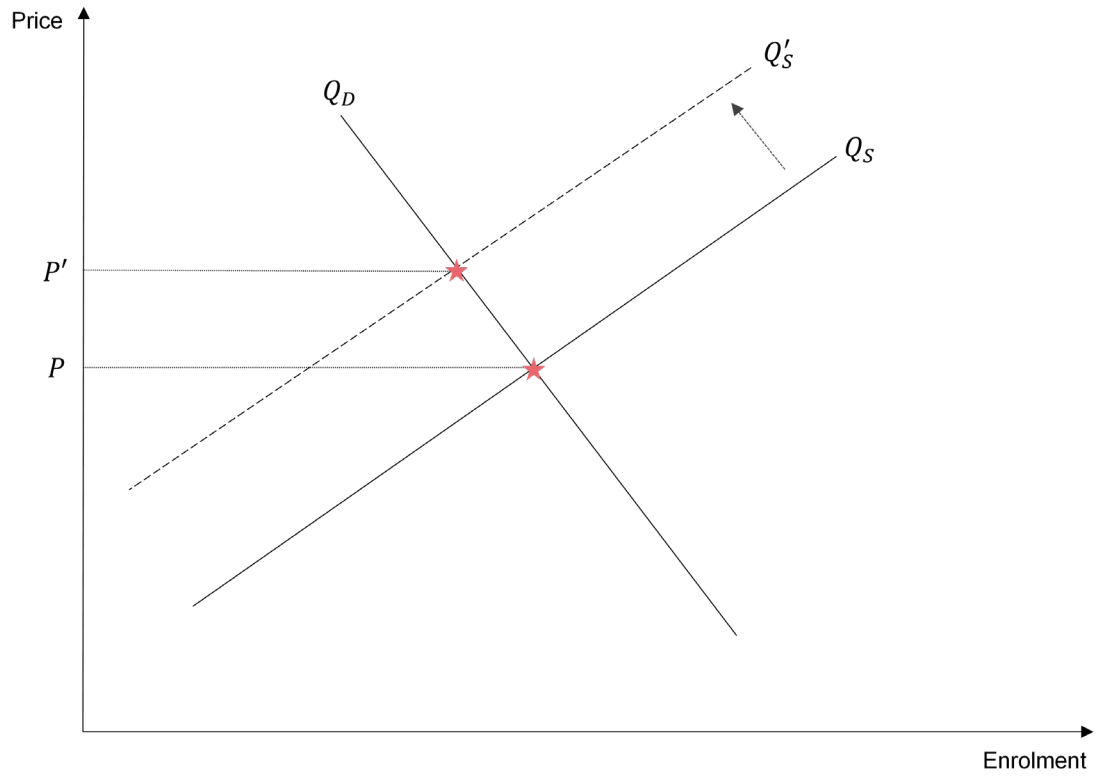
- Enrolment: number of international students enrolled
- Price: higher education price
- GDP pct: real GDP per capita
- LivingCost: Cost of living relative to the UK
- CompFee: average tuition fee at competing markets
- Rank: higher education provider ranking
- 2012: binary variable = 1 in 2012; 0 otherwise
- EU_exit: binary variable = 1 in 2021; 0 otherwise
- Brexit_ref: binary variable = 1 from 2017 onwards
- D2019: binary variable = 1 in 2019; 0 otherwise
- PSW: Post-study work visa index
- ε: Idiosyncratic error term

### 2.4.2 Exogenous price variation

This section discusses the approach used to identify the demand curve and address the simultaneity/endogeneity challenge. The objective is to identify exogenous price changes—price changes driven by factors unrelated to student demand, such as policy reforms or supply-side shocks. When such price changes are identified, any associated change in enrolment can be attributed to students responding to price, allowing us to identify the demand equation.

This is illustrated in the plot below. The two highlighted price points stem from exogenous supply-side shifts—changes that occur independently of demand. Since these price movements were not demand-induced, the resulting changes in enrolment can be attributed solely to price changes. Graphically, they result in moving from one price-quantity combination on the demand curve to another combination on the same demand curve. This means that comparing the changes in price and the change in quantity reveals the slope of that demand curve—that is, the demand elasticity.

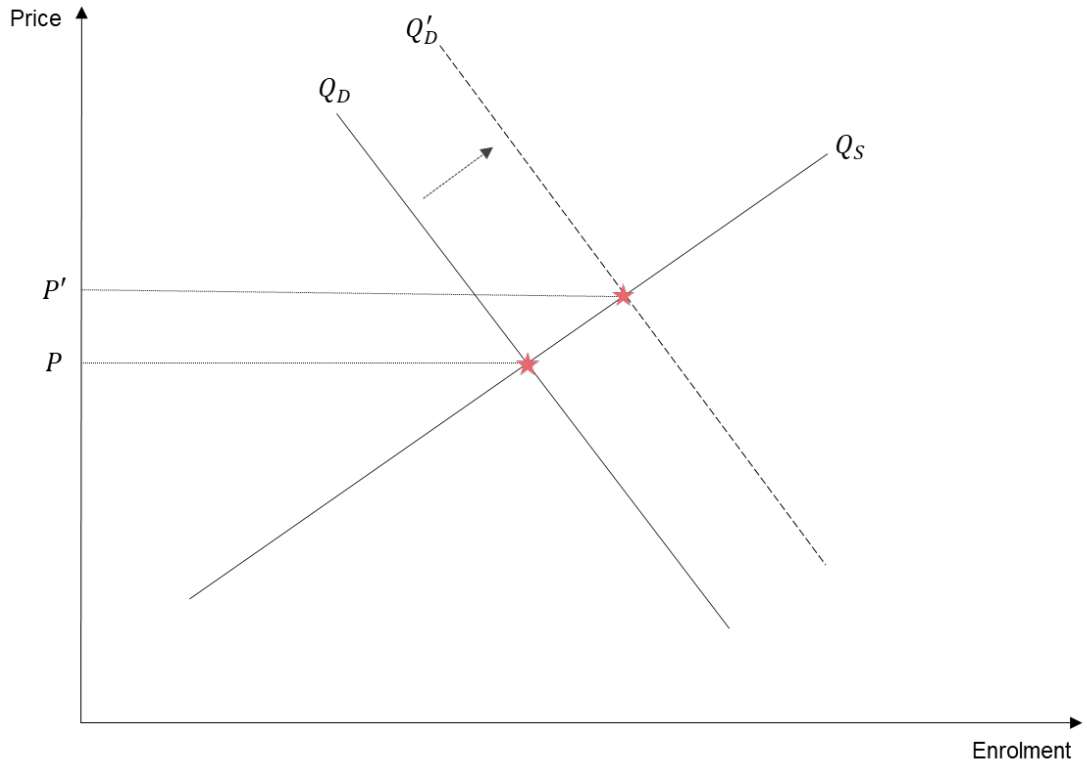
**Figure 3: Exogenous price variation**




By contrast, a rise in student income, for example, may stimulate demand—shifting the demand curve to the right, meaning more demand at a given fee—and consequently push prices higher (see Figure 4). This price change is endogenous: it reflects prices responding to demand, rather than demand responding to prices, which is the relationship we seek to isolate. The figure demonstrates that a comparison of the two price-quantity combinations in this instance would reveal nothing about the

demand elasticity—instead, it would be tracing out the slope of the supply curve. Relying on such price variation to estimate the demand curve would therefore be inappropriate and would produce unreliable estimates. In other words, we want to discard this endogenous price variation and use only the price variation caused by exogenous sources.

**Figure 4: Endogenous price variation**




A common textbook strategy for identifying exogenous sources of price variation is to exploit factors (instruments) that shift the supply curve without moving the demand curve. However, although "supply shifters" are the most standard way of tracing the demand curve, there are other possibilities as well. Four sources of exogenous price variation are considered.

1. **Supply shifters:** Two supply shifters are considered: average academic salaries and non-tuition fee income.[31] An increase in costs, all else equal, reduces the amount of education that can be supplied for a given level of fee income and shifts the supply curve to the left. In contrast, higher per-student funding shifts the supply curve to the right.

[31] Both variables are supply shifters and therefore good candidates for instruments. We focus on costs and income as the main supply shifters—we are not aware of other major supply drivers. Other cost measures could in principle be used, such as fixed costs, but these are a function of student numbers, which would render them invalid instruments.

2. **Demand shifters from *other* countries.** This is relevant given that demand elasticities for specific groups of international students are estimated separately. These variables can include the same types of variables listed under "control variables" but defined only for other countries/regions rather than the country/region under study (e.g., income levels, exchange rates, and policies or events that affect demand from students in other countries). This represents a more novel source of exogenous price variation. The logic is that if the demand curve of another country within the same international market shifts, the equilibrium market price will change. If the demand curve of students from the country of interest remains unchanged, then enrolment from that country (and price) moves along its demand curve, allowing us to trace out its demand elasticity. This is illustrated in Box 3.
3. **Own-country exchange rate.** Tuition fees are denominated in students' home-country currencies, so changes in bilateral exchange rates introduce variation in the effective price that students face. These exchange rate movements can be treated as exogenous because they are determined by broader macroeconomic and financial factors and are not influenced by conditions in the HE market. As a result, they provide a source of price variation that is plausibly independent of HE market dynamics and not caused by student demand.[32]
4. **Exogenous events or policy reforms.** EU exit and the 2012 reform can be treated as exogenous events unrelated to student demand and therefore help identify the price elasticity in the EU equation. However, a caveat is that these events may also be associated with non-price changes, making it more difficult to isolate a pure price elasticity.

These sources of exogenous variation are considered as instruments to estimate the price elasticity of demand within an instrumental variable estimation framework—see next section. The approach used in this study represents an improvement over the existing literature, which either treats prices as exogenous or relies on a more limited

[32] Another way to think about this is that, once we express prices in local currency terms, an exchange rate movement effectively operates like a supply shift. UK universities care about the number of pounds they receive, not about the amount this corresponds to in another country's currency—it is the pounds they obtain that determine how many places they are willing to supply. By definition, if the supply curve is fixed in pounds, then the supply curve expressed in local currency shifts whenever the exchange rate changes. This is analogous to a standard textbook supply-and-demand framework in which a supply shift arises from the introduction of a sales tax when prices are expressed on a pre-tax basis. When a sales tax is imposed, producers require a higher gross price to supply the same quantity as before because part of the price is absorbed by the tax. Similarly, when tuition fees are set in pounds, a change in the exchange rate acts like a tax on the student's effective local-currency price. A depreciation of the local currency (i.e., a fall in the exchange rate from the student's perspective) raises the effective local-currency price, shifting the local-currency supply curve leftward. Universities would then require a higher local-currency price to obtain the same number of pounds as before, and thus to supply the same number of places. In this way, exchange rate movements generate supply shifts—that is, exogenous variation in prices—when prices are expressed in local currency terms.

set of instruments (sources of exogenous price variation). Wales (2013), for example, instruments postgraduate tuition fees using two variables: (i) the exchange rate, and (ii) the level of public teaching grants per full-time academic staff member. This study extends this strategy by considering a broader set of instruments, including cost shifters, demand shifters from other countries, and exogenous policy shocks.

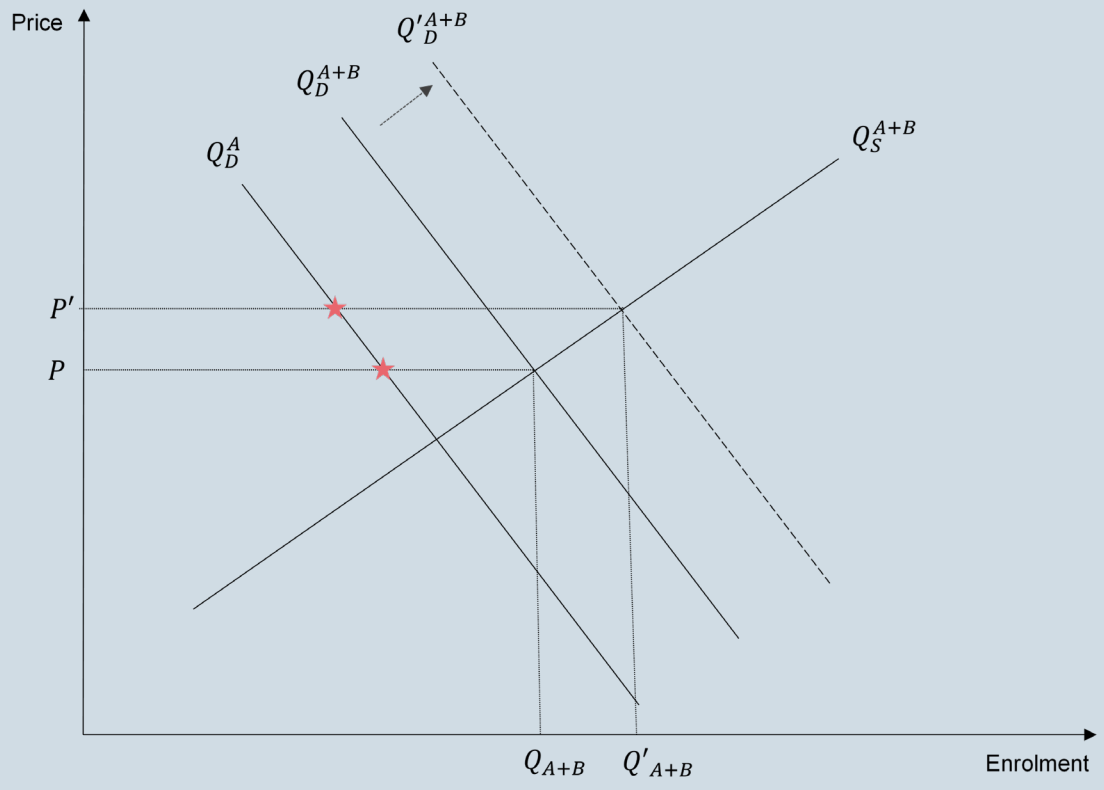
In practice, the instruments discussed above were tested and evaluated empirically.

**Box 3: Demand shifters from other countries**

The plot below illustrates how an increase in demand from students domiciled in Country B shifts total demand, student domiciled in countries A and B (A + B), generating exogenous variation in the market price for students domiciled in country A.

Suppose there is an increase in demand from students domiciled in Country B, for example due to higher income levels. This raises total demand (A + B), leading to a new equilibrium price. The new equilibrium price applies to students from both Country B and Country A. However, while this price change is endogenous to students from Country B (as it is driven by their increased demand), it is exogenous to students from Country A. Consequently, shifts in demand from Country B can be used as an instrument to identify exogenous price variation in the demand of students from Country A.

**Demand shifters from another country of origin**



The most useful instruments—based on the diagnostic tests presented in the findings section—were the own-country exchange rate and demand shifts from other countries.

### 2.4.3 Model estimation

The econometric modelling strategy adopted acknowledges that the key variables of interest, including enrolment and prices, are non-stationary.[33] In simple terms, a variable is non-stationary when it displays persistent trends and does not revert to a stable mean or deterministic path over time. The conventional ways to address non-stationarity are to apply cointegration techniques or to transform the data by taking first differences to achieve stationarity.[34]

Several alternative methods were considered, and the demand equation was ultimately estimated in first differences. This approach captures changes in the determinants of demand, which appear to affect outcomes relatively quickly, making it well-suited to identifying short-run responses. In addition, a lagged dependent variable is included to allow for persistence and long-run effects—any delayed adjustment in demand over time.[35]

The first-difference demand models are estimated using Ordinary Least Squares (OLS) as well as two-stage least squares (2SLS) with instrumental variables (IV). The OLS approach assumes that price is exogenous, whereas the IV approach treats price as endogenous and assumes that endogeneity can be adequately addressed using available instruments (sources of price variation that are not themselves related to demand shifts among the group of students in question).

[33] We performed unit root tests and found that enrolment, price, and GDP per capita are non-stationary in levels but stationary in first differences, suggesting that they are integrated of order one (I(1)). The test results are reported in Appendix A1.
[34] Applying conventional regression methods to non-stationary variables can lead to spurious results, producing coefficient estimates that appear statistically significant even when no meaningful relationship exists between the underlying variables. Therefore, it is essential to take this feature into account.
[35] In this model, the short-run elasticity is the immediate response of demand to a change in price or other determinants within the same year. The long-run elasticity captures the total cumulative effect once demand has fully adjusted. The relationship between the two is governed by the coefficient on the lagged dependent variable: the long-run elasticity equals the short-run elasticity divided by one minus the coefficient of the lag dependent variable. If the coefficient of lag dependent variable is close to zero, adjustment is rapid and the short and long-run elasticities are similar. If the coefficient of lag dependent is close to one, adjustment is slow and the long-run effect is substantially larger than the short-run effect. The speed of adjustment does not assume a fixed horizon; rather, demand converges gradually toward its long-run level, with the pace determined by the coefficient of lag dependent. In practice, for a typical lag dependent variable coefficient, the majority of adjustment occurs within two to three years, though the model does not impose this. Also, see Box 4.

For EU undergraduate demand, the main price changes are associated with policy reforms and EU exit and can therefore be regarded as exogenous. Accordingly, the EU undergraduate demand equation is estimated using OLS. The EU postgraduate and non-EU demand models are estimated using both OLS and IV, with primary emphasis placed on the IV estimates. As instruments, the analysis draws on the full set of candidates discussed in the previous section, which provide plausible sources of exogenous variation: supply shifters, demand shifters from other countries, the bilateral exchange rate with pounds sterling, and policy changes.

Both time-series and panel data methods are employed. The time-series analysis uses historical data aggregated across all countries of origin within scope (EU or non-EU), with enrolment, price, and other variables combined at this level.

The panel approach combines time-series data across multiple countries of origin, allowing the parameters of interest to be estimated using variation over time across countries.[36] Many countries have relatively low levels of student enrolment and are therefore not included in the analysis individually. Instead, the panel dataset used for estimation includes the top ten countries, with all other countries grouped together.[37] In other words, the panel estimates are based on data from eleven groups—the top ten countries and an aggregated "other" category.[38] Panel methods are generally preferred, as they provide greater variation in the data, leading to more precise estimates.

Although panel data and IV methods are preferred, the sensitivity of the results is assessed using time-series and OLS methods.

[36] In a time-series setting, the model uses variation over time to estimate the model parameters. In a panel setting, the model uses variation over time within each country included in the sample. If there are ten countries, the model effectively uses ten separate time series to estimate the model parameters.
[37] The top 10 countries in each group were selected based on total student enrolment in the 2022/23 academic year and account for more than 75% of total international students. The top 10 EU countries, excluding Ireland, are Cyprus, France, Germany, Greece, Italy, Norway, Poland, Portugal, Romania, and Spain; the top 10 non-EU countries/regions are Bangladesh, China, Hong Kong, India, Malaysia, Nepal, Nigeria, Pakistan, Saudi Arabia, and the US.
[38] Eleven groups for EU and eleven groups for non-EU students.

**Box 4: Coefficient interpretation - Interaction terms and lag dependent variable**

The models presented in this report, using either OLS or IV, and based on both time-series and panel data, include interaction terms and lagged dependent variables, which make them more complex to interpret. This section provides guidance to help interested readers understand how the model estimates discussed in the Findings section can be interpreted.

A model of (log) enrolment as a function of a lag dependent, (log) price and price/ EU exit interaction effect can be written as follows (other regressors have been omitted to simplify exposition).

$$\log(Enrolment_t) = \alpha + \varphi \log(Enrolment_{t-1}) + \beta_1 \log(Price_t) + \beta_2 \log(Price_t) \times (EU\ exit) + \varepsilon_t$$

EU exit represents an indicator variable taking the value of 1 in 2021 and 0 otherwise.

The interaction term allows for the possibility that the price elasticity of demand in a given period or year differs from the average elasticity. In the case of EU students, this is likely, as the 2021 price change coincided with other factors (such as the loss of access to student loans and the ability to study and work without a visa).

Including a lagged dependent variable on the right-hand side of a regression allows past values of enrolment to influence the current value. This approach implicitly incorporates the effects of past values of the independent variables. Rather than including multiple lags of each independent variable—which would increase the number of parameters and reduce estimation efficiency—the lagged dependent variable summarises these cumulative past effects in a parsimonious single term. To facilitate exposition, the following **hypothetical** coefficient values are assumed: $\varphi$ = 0.15; $\beta_1$ = −0.4; $\beta_2$ = −0.5.

- The $\beta_1$ value of −0.4 suggests that the short-run price elasticity of demand is −0.4: a 10% increase in price leads to 4% reduction in demand.
- The impact of the price increase associated with the EU exit is the sum of two co-efficients: $\beta_1 + \beta_2$ = −0.9.
- The long-run price elasticity of demand (the total impact) is given by this formula: $\frac{\beta_1}{(1-\varphi)}$ = − 0.47.
- The long-run price elasticity of demand for the EU exit price change is: $\frac{\beta_1+\beta_2}{(1-\varphi)}$ = −1.06.

The formula to calculate the impact over time is: $t + k = \beta_1 \times \varphi^k$. Applying this formula to the coefficients above yields the impacts shown in the table below. Because the coefficient on the lagged dependent variable is relatively small (a large coefficient would be between 0.7 and 1), most of the impact (85%) occurs at time $t$ (−0.4 compared to −0.47, which is the total long-run impact), with the remaining effect primarily realised in the following year.

| Period | Effect | % |
|---|---|---|
| t | $\beta_1 \times \varphi^0$ = −0.4 | (−0.4/−0.47) = 85% |
| t+1 | $\beta_1 \times \varphi^1$= −0.4×0.15 = −0.06 | (−0.06/−0.47) = 13% |
| t+2 | $\beta_1 \times \varphi^2$= −0.4×(0.15)$^2$ = −0.009 | (−0.009/−0.47) = 2% |
| t+3 | $\beta_1 \times \varphi^3$= −0.4×(0.15)$^3$ = −0.0014 | (−0.0014/−0.47) = 0% |

**In all models presented in the Findings section, the coefficient on the lagged dependent variable is either small or not statistically significant. This suggests that the bulk of the effect occurs at time *t* and is fully realised by *t*+2.** This is not unexpected for two reasons. First, tuition fees are typically announced around 12 months in advance, giving students sufficient time to respond to price changes. Second, the macroeconomic variables are measured on a calendar-year basis, whereas enrolment is recorded by academic year. As a result, the majority of annual economic changes—approximately eight months' worth—occur before the start of the academic year (typically in September). This means that most macroeconomic conditions at time *t* are already reflected in students' decisions by the time enrolment occurs.

## 2.5 Higher education provider typology

It is possible that the price elasticity of demand varies across providers. For highly ranked or prestigious HEPs, demand may be less sensitive to price, as the perceived value of attending a highly ranked institution may reduce the importance of price.[39] Furthermore, highly ranked providers may have greater flexibility in adjusting admission standards in response to price increases, which would lead to a lower estimated price elasticity of demand for highly ranked HEPs compared with lower-ranked HEPs. To account for potential heterogeneity in price elasticities across providers, the demand equation is estimated separately for different groups of HEPs.

[39] This is consistent with evidence suggesting that international students attach more importance to HEPs' reputation and may therefore be willing to pay more to study at these institutions.

HEPs are classified into four tiers based on their ranking in the Complete University Guide (CUG) league table for England (2022). Tier 1 includes the three top providers in CUG: the University of Cambridge, the University of Oxford, and Imperial College London. Tier 2 includes the remaining top 20 institutions in the CUG league table. The remaining institutions are divided into two tiers such that total first-year enrolment is balanced between them.[40] This results in 29 HEPs being classified in Tier 3 and 55 HEPs in Tier 4.[41]

The CUG was selected over global rankings such as QS and Times Higher Education (THE) because it includes a wider range of UK universities, particularly lower-ranked institutions that are less consistently represented in global rankings.[42]

It is acknowledged that grouping providers into a small number of tiers is a coarse approximation and that alternative groupings are possible. The approach is motivated by the need to balance homogeneity with statistical power: tiers are defined to ensure providers within each group are reasonably comparable, while maintaining sufficient observations within each tier to support reliable estimation.

A further limitation is that provider rankings vary over time, meaning the four tiers may include providers that have improved or declined over the sample period. In practice, however, most provider rankings do not change sufficiently to move between tiers, and our tiering therefore provides a reasonable approximation of relative provider ranking over the full sample period, e.g., universities in Tier 2 are, on average, ranked higher than those in Tier 3, across all years.

The full list of institutions in each tier is provided in Appendix A.5.

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[40] Tier 1 represents 5% of all international HE students studying in England, while each of the remaining three tiers accounts for roughly 32% of total international student enrolment.

[41] There are 335 providers in the Approved (fee cap) category of the OfS Register for the academic year 2025/26, before applying the England and study-scope restrictions used in this analysis. The final sample included 179 HEPs after excluding providers outside the study scope: primarily FE colleges and college groups, specialist providers, private or alternative HE providers, and employer-led or professional training providers. Institutions that are not ranked in the Complete University Guide are excluded from the HEP ranking tier-based analysis, which is based on 101 institutions that can be matched to the Complete University Guide ranking and for which sufficient data are available. Where sufficient data are available, institutions outside the HEP ranking tier-based analysis are retained in the baseline analysis.

[42] Alternative classification schemes include those proposed by Boliver (2015) and the TRAC peer groups. Although the correlation between CUG rankings and both Boliver's and TRAC's groupings is high, there are several advantages of adopting the CUG-based classification. First, Boliver's classification is based on older data and may not fully capture subsequent changes in HEP performance and ranking. Over the past decade, several universities have experienced substantial shifts in research intensity, student composition, and market positioning, making a more recent classification preferable (nonetheless, there is great overlap (77%) between Boliver groupings, and the tiers used in this research). Second, TRAC peer groups are constructed primarily based on HEPs' cost structures and research intensity. Consequently, TRAC groupings are not intended to measure reputation, as is the case with CUG rankings. However, results by TRAC groups are provided in the Appendix.

## 2.5 Identification of the supply equation

So far, the discussion has focused primarily on demand. This section outlines the methodology used to estimate the supply equation.

In principle, the supply for a typical good or service is a function of price and input costs, with higher prices and lower input costs increasing supply. Applying this to the HE market, the supply of HE places, capturing HEPs' decisions about how many places to offer, would be a function of the tuition fee received per student and the average cost of provision.

Specifying the supply curve for HE is, however, more challenging than for a standard good or service due to the heterogeneous composition of the student body. HEPs simultaneously serve multiple student types—domestic and international, undergraduate and postgraduate—each subject to different tuition fees and attracting different levels of funding. On the cost side, postgraduate degrees are generally more costly to deliver than undergraduate programmes.[43]

Due to this heterogeneity, supply for different student segments may be determined separately to some extent, but it would be very difficult to know to what extent, as there are many shared costs (estates, central administration, and library and IT infrastructure, as well as academic staff) and there is likely cross-subsidy between student segments as well. For these reasons, the baseline supply equation uses total enrolment, both domestic and international, across all levels of study. However, a separate supply equation using only international students is also estimated, given that this is the student type that is the focus of this research.[44]

Besides tuition fee income and costs, the supply equation considers three additional variables.

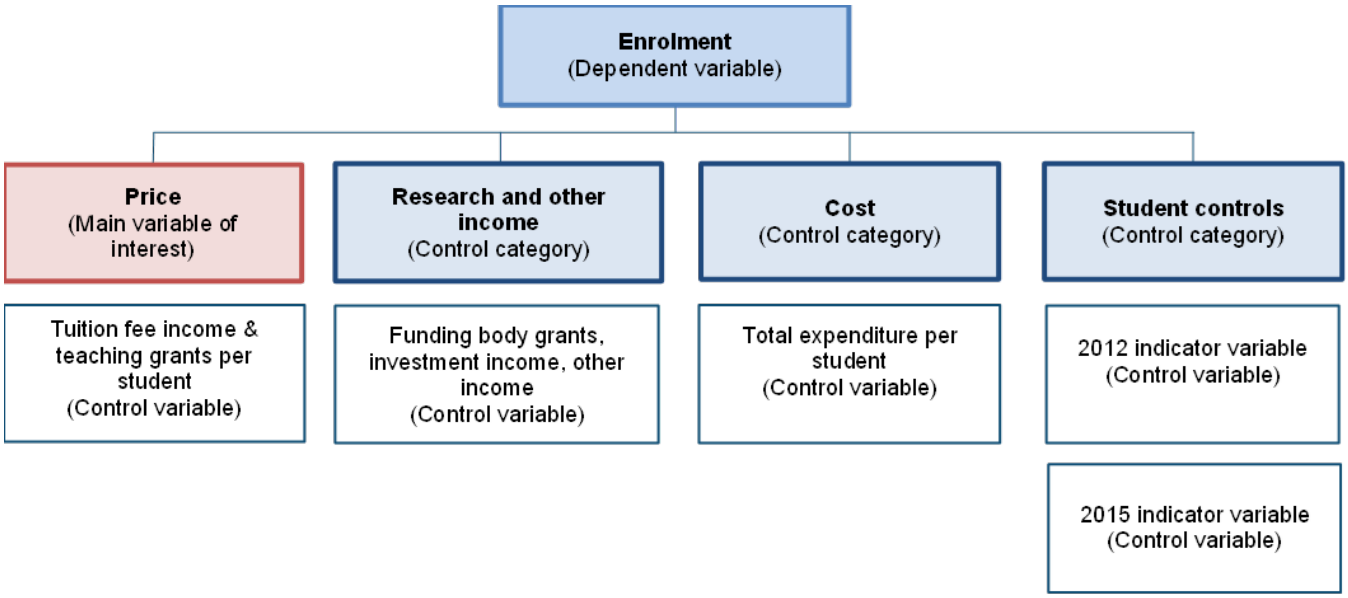
- Teaching funding: This is the direct grant funding HEPs receive for domestic and EU students (the latter until the UK's exit from the EU) and can be considered a tuition fee top-up.
- Research and other funding: This is included to capture the possibility that teaching and research are joint outputs of a common production process. HEPs use shared inputs—academic staff, laboratories, and infrastructure—for both activities simultaneously. Research funding may therefore affect the cost and capacity of teaching provision.

[43] KPMG (2014). A Review of the Cost of Postgraduate Taught Provision. Report to the Higher Education Funding Council for England.
[44] Although the supply equation and the price elasticity of supply may vary by HEP, it is practically difficult to estimate them with sufficient confidence. As shown in the findings section, identifying the supply curve across all HEPs is challenging; disaggregating the data by tier would be even more challenging and it will be difficult to assess whether any differences between are driven by genuine differences or data limitations and estimation challenges.

- Student number controls (student caps): Direct regulation of domestic undergraduate student numbers has periodically constrained supply independently of price and cost. Student number controls were first introduced in the early 1990s, relaxed in 2012 for students with AAB or higher A-level grades, and fully removed for most domestic undergraduates in 2015. The relaxation of student caps is captured using indicator variables.

A summary of the supply specification is illustrated below.[45]

**Figure 5: General supply specification**




Price is the total tuition fee income and teaching grants per student FTE—it reflects the average income per student.[46] Research and other income mainly capture research grants and contracts.[47] The cost variable captures total average expenditure per student and encompasses all types of regular HEP costs. [48]

[45] In equation format, the supply equation is: $\log(Enrolment_t) = \alpha + \beta_1 \log(Price_t) + \beta_2 \log(OtherInc_t) + \beta_3 \log(Cost_t) + \beta_4 (2012) + \beta_5(2015_t) + \varepsilon_t$; where: Enrolment: number of international students enrolled; Price: tuition fee income and teaching grants per student; OtherInc: Research and other funding; Cost: total expenditure per student; 2012: binary variable = 1 in 2012-2014; 0 otherwise; 2015: binary variable = 1 in 2015 onwards; ε: Idiosyncratic error term.

[46] Price is measured in local currency (British pounds), since this is the relevant metric for HEPs. Exchange rates, visa costs, and the immigration health surcharge—although part of students' overall costs—are excluded, as supply decisions by providers are based on the revenue received in British pounds.

[47] Income sources, as categorised in the HESA public data included in this analysis, comprise funding body grants, research grants and contracts, investment income, and other income. Donations and endowments are excluded from the analysis due to data incompleteness and their relatively small contribution.

[48] Types of cost included in this analysis: academic staff costs, other staff costs, other operating expenses, depreciation and amortisation, interest and other finance costs. Restructuring costs are not included.

The supply equation is estimated using cointegration methods. Cointegration is commonly used to model long-run relationships between variables that are non-stationary with the aim of estimating long-run relationships and avoiding the risk of spurious regression.[49] Unlike the demand equation, the supply equation is expected to reflect longer-term adjustments—it takes time for HEPs to adjust their supply following a shock, which are more appropriately captured within a cointegration framework.[50] Two alternative approaches are considered: Dynamic OLS (Stock and Watson, 1993) and Fully Modified OLS (Phillips and Hansen, 1990). Both methods adjust for the endogeneity and serial correlation that affect the conventional OLS estimator.[51]

[49] Cointegration refers to a statistical relationship between two or more non-stationary time series variables that move together over the long run. Although the individual series may drift over time, a linear combination of them is stationary, implying the existence of a stable long-run equilibrium relationship between the variables. A spurious regression occurs when two or more non-stationary time series are regressed on each other and appear to have a statistically significant relationship, even though no true underlying relationship exists. This typically happens when the variables share similar trending behaviour over time, which can produce high R-squared values and significant t-statistics despite the absence of any meaningful economic connection. The result is a misleading inference, as the apparent relationship is driven by common trends rather than genuine association. The existence of cointegration implies that relationships between non-stationary variables reflect genuine long-run links rather than spurious correlations.

[50] When we take the first-difference of a non-stationary series to make it stationary, long-run information embedded in the levels is removed. A model in first differences captures static effects. Adding lags in a first-difference specification can approximate some of the long-run dynamics, but it cannot recover the long-run equilibrium relationship.

[51] Dynamic OLS corrects for endogeneity and serial correlation by augmenting the cointegrating regression with leads and lags of the first differences of the regressors, effectively controlling for feedback effects between the dependent and independent variables. Fully Modified OLS, in contrast, applies non-parametric corrections to the conventional OLS estimator by adjusting for endogeneity and serial correlation through estimates of the long-run covariance matrix of the residuals. Both approaches are designed to produce super-consistent estimates of the long-run cointegrating parameters, making them particularly suitable for small- to medium-sample applications and providing robust inference in the presence of endogeneity and autocorrelation.

# 3. Data

Data on HE-specific variables, policy reforms, and macroeconomic variables between 2002 and 2023 were collected.[52] The main source of HE data is the Higher Education Statistics Agency (HESA), which provides information on student enrolment and HE finances, including tuition fee income. The primary source of macroeconomic variables is the World Bank. As the HE data are reported annually, all other variables are likewise compiled at an annual frequency.

This section summarises the key data and data sources, with further details provided in the Appendix.

## 3.1 Quantity measure

HE "quantity" is proxied by student enrolment at English HEPs, focusing on first-year entrants. Total enrolment captures students at all stages of their studies and can therefore be interpreted as reflecting cumulative demand over the duration of a degree programme. In contrast, first-year enrolment better reflects demand at a particular point in time and allows for a more direct assessment of how policy changes and prevailing market conditions influence demand. Enrolment data are available from and are disaggregated by student domicile region, level, and mode of study.

## 3.2 Tuition fees

A measure of average tuition fees is constructed using two data sources: HESA as the primary source and the Reddin Tuition Fee Survey (Reddin) as a supplementary source.[53] Because HESA does not report tuition fees directly, but instead provides each HEP's total tuition fee income, the average fee is estimated by dividing total tuition fee income by total enrolment.[54]

While the full set of breakdowns required for total enrolment—by region of student domicile, level, and mode of study—is consistently available over time from HESA, tuition fee income data are more limited and are not reported with consistent disaggregation across HEPs or over time, particularly in the earlier years. For example, between 2002/03 and 2015/16, tuition fee income from non-EU students

[52] There is a slight mismatch between the time periods for HE and macroeconomic variables. HE data are measured by academic year, starting in September, while macroeconomic variables are reported by calendar year.
[53] The Reddin Survey is a survey of UK university tuition fees compiled by Complete University Guide, which compiles typical annual tuition fees for full-time Home, EU, and international students for undergraduate and postgraduate courses. A similar approach was adopted by London Economics (2021).
[54] Enrolment is expressed in full-time equivalent (FTE) terms.

was not disaggregated by level of study. To address this gap, HESA data are combined with data from the Reddin Tuition Fee Survey. Specifically, (i) the average postgraduate and undergraduate tuition fees for non-EU students using Reddin data is calculated; (ii) the ratio of undergraduate to postgraduate fees is computed; (iii) the ratio of undergraduate to postgraduate tuition fee income is derived using the fee ratio and respective enrolment numbers; (iv) this ratio is applied to aggregate HESA tuition fee income data to derive level-specific tuition fees.

Moreover, HESA does not provide a breakdown of tuition fee income by entry cohort; tuition fee data are reported for all years of study, including both first-year and continuing students. Consequently, changes in tuition fee levels, which affect only new entrants, are not captured precisely. In other words, tuition fees calculated from HESA reflect average fees over the duration of a degree (e.g., from time *t–3* to *t*). To address this, adjustments were implemented to better align the estimated fee series with the timing of major fee reforms.[55] Further details on calculations and adjustments undertaken to address missing tuition fee information are provided in Appendix A.2.

## 3.3 Other variables

The following additional data were collected.

- **GDP per capita:** GDP per capita by country of domicile, expressed in real terms (constant 2015 USD), obtained from the World Bank Open Data. The weighted average GDP per capita was computed for the EU and non-EU regions using country-specific GDP per capita and student enrolment as weights. Accordingly, the EU GDP per capita represents the enrolment-weighted average across EU countries, while the non-EU GDP per capita represents the enrolment-weighted average across non-EU countries.
- **Exchange rates to GBP:** Market exchange rate of local currency to GBP by country of domicile, obtained from World Bank Open Data. Similar to GDP per capita, the exchange rates are converted into an EU index and a non-EU index, each of which represents the enrolment-weighted average of the exchange rates for EU and non-EU countries, respectively.
- **Relative living costs:** Ratio of purchasing power parity (PPP) conversion factor to the corresponding market exchange rate between the UK and a foreign country. The World Bank recommends this index to analyse changes over time in relative prices, analyse price convergence, and make spatial comparisons of the cost of living.

[55] To capture the large tuition fee increases in 2006/07 and 2012/13 for EU students, we assume that fees in 2006/07 and 2007/08 equal those in 2008/09, and that fees in 2012/13 and 2013/14 equal those in 2014/15.

- **Consumer Price Index:** Obtained from the World Bank Open Data and is used to deflate nominal variables (base year = 2010).
- **World university ranking:** Number of universities in the Top 100 universities worldwide obtained from QS World University Ranking. Alternative proxies were also used such as number of universities in Top 200 universities worldwide.
- **UK University Guide ranking:** Obtained from the Complete University Guide.
- **HEP costs by category:** Obtained from HESA, converted in real terms per full-time staff equivalent. The categories included in the dataset are: (i) academic staff costs; (ii) other staff costs; (iii) other operating expenses; (iv) depreciation and amortisation; and (v) interests and other financial costs.
- **HEP income by category outside tuition fees:** Obtained from HESA, expressed in real terms per full-time student equivalent. The categories included in the dataset are: (i) funding body grants, which include funding from OfS, Research England, and the DfE; (ii) research grants, which include all income in respect of externally sponsored research carried out by the HEP, including BEIS Research Councils; (iii) investment income; and (iv) other income.
- **Tuition fees in competitor countries:** Price index of real average tuition fees in key competitor countries (Australia, Canada, and the US) in real terms, converted to local currency of each domicile country (using World Bank Open Data). Tuition fees obtained from various national education providers (Statistics Canada, IPEDS (US), Australian Government).

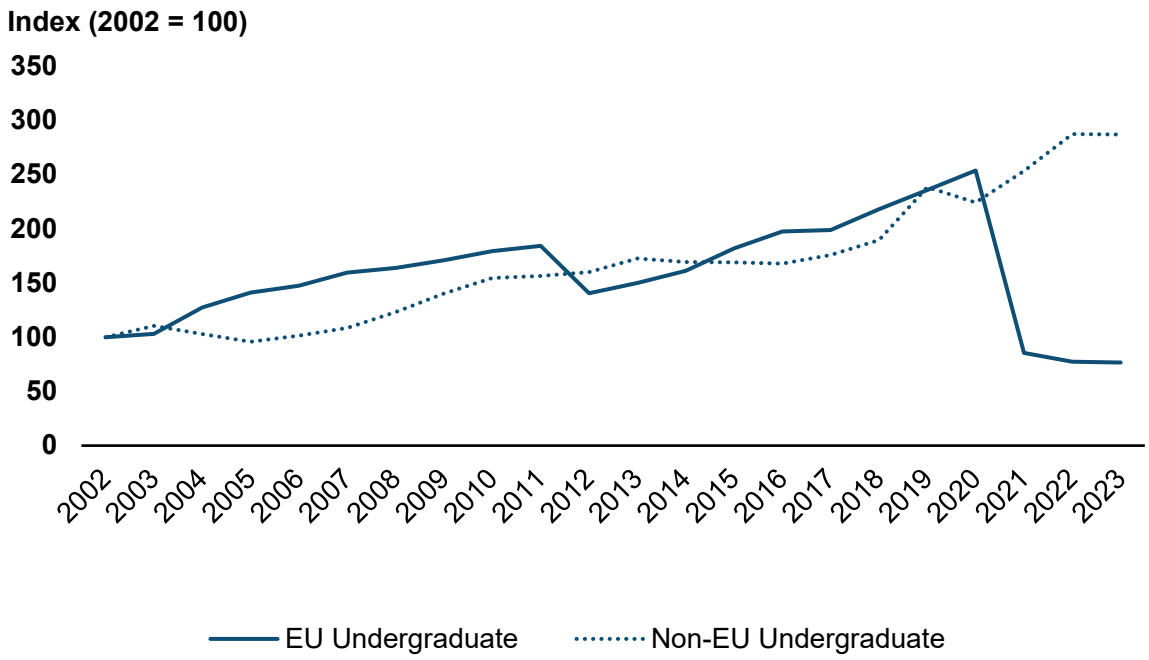
# 4. Descriptive analysis

This section presents a descriptive analysis using time-series plots to illustrate trends in HE prices and student enrolment, alongside the key policy events that drove changes over the period. Appendix A.3 sets out the main policy changes and provides useful context for interpreting the charts.

## 4.1 Full-time student trends

Figure 6 illustrates the trend in undergraduate student enrolment by region of domicile (EU and non-EU). Up to 2020, enrolment for both EU and non-EU students showed an upward trend, reaching approximately 2.5 times the 2002 level. As noted in the following section, this trend contrasts sharply with that for part-time students. For EU students, enrolment declined noticeably in 2012, likely reflecting the rise in tuition fees, and fell sharply in 2021, the year of EU exit.

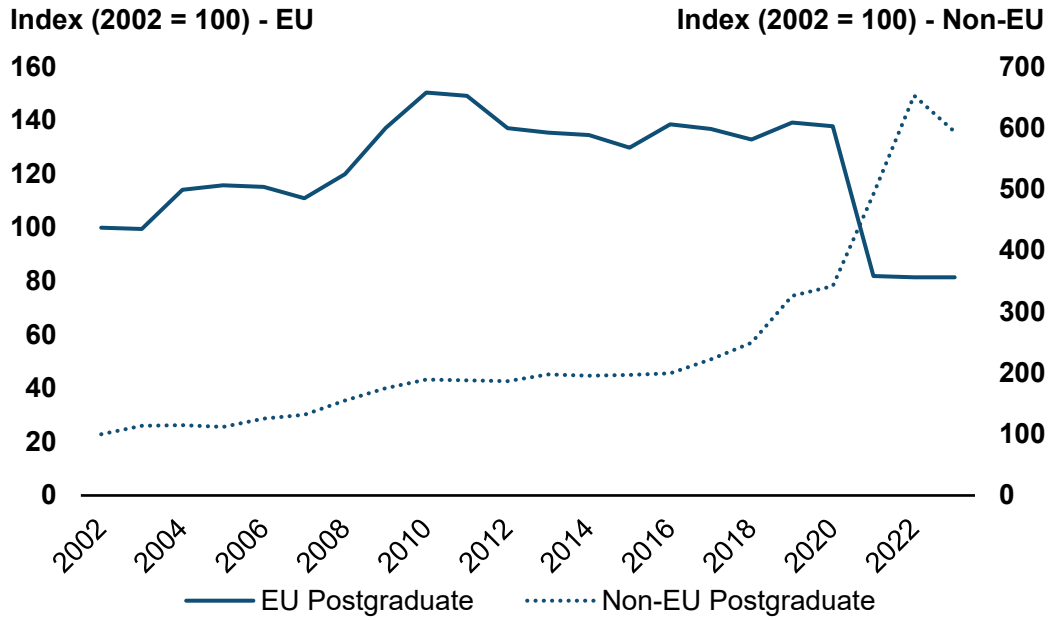
**Figure 6: Undergraduate student first-year enrolment trends (full-time)**




**Note:** Undergraduate refers to the number of first-year, full-time undergraduate students enrolled at English HE providers whose country of domicile is inside (EU) or outside the EU (non-EU); Source: HESA and Alma Economics analysis.

Figure 7 illustrates postgraduate enrolment trends, showing a distinct pattern. EU postgraduate enrolment (left-hand axis) grew until 2011, declined in 2012 and then remained relatively stable until 2021, when it experienced a sharp decline. In contrast, non-EU enrolment (right-hand axis) increased steadily until 2017, and then grew rapidly.

**Figure 7: Postgraduate student enrolment trends (full-time)**




**Note:** Postgraduate refers to the number of first-year, full-time postgraduate students enrolled at English HE providers whose country of domicile is inside (EU) or outside the EU (Non-EU); Source: HESA and Alma Economics analysis.

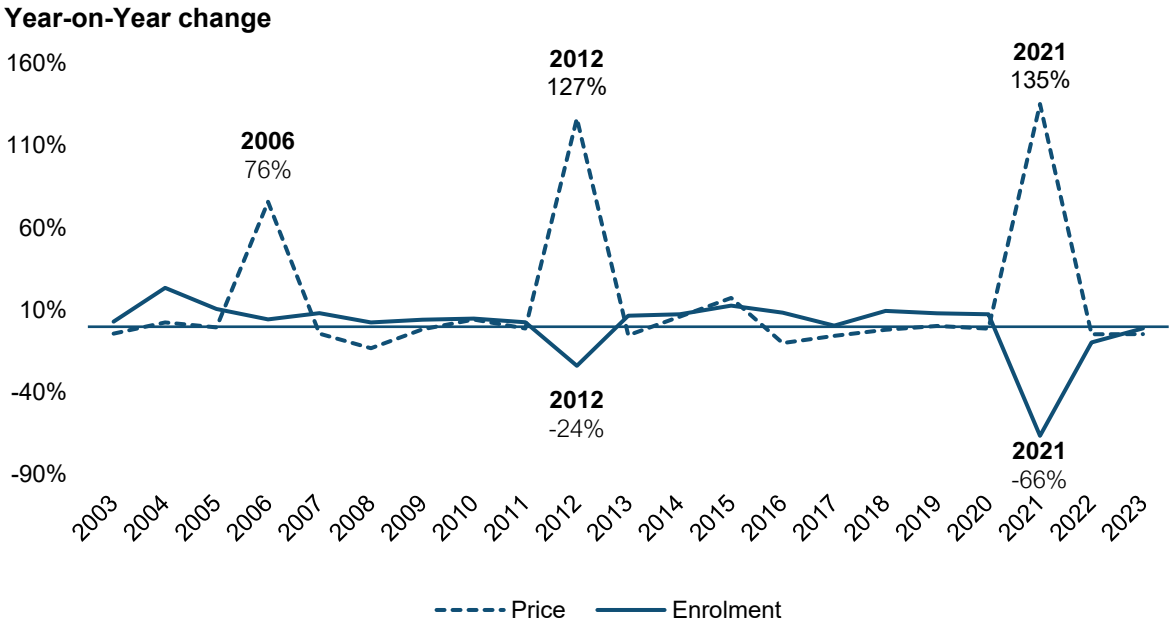
## 4.2 Full-time enrolment and price changes

### 4.2.1 EU students

Figure 8 depicts year-on-year growth rates in enrolment and prices for EU full-time undergraduate students. Three distinct events are visible—in 2006, 2012, and 2021—corresponding to the 2006 and 2012 fee reforms and EU exit. In each case, prices increased substantially, driven primarily by rises in tuition fees and accompanying changes in student finance terms.

With the exception of 2006, these events were accompanied by a significant reduction in student enrolment, with EU exit leading to a much larger decline (where enrolment declined by a larger percentage than the percentage price change), potentially reflecting not only the rise in tuition fees but also the loss of access to student finance and the right to work and study without a visa.

**Figure 8: EU undergraduate first-year enrolment and price (full-time)**

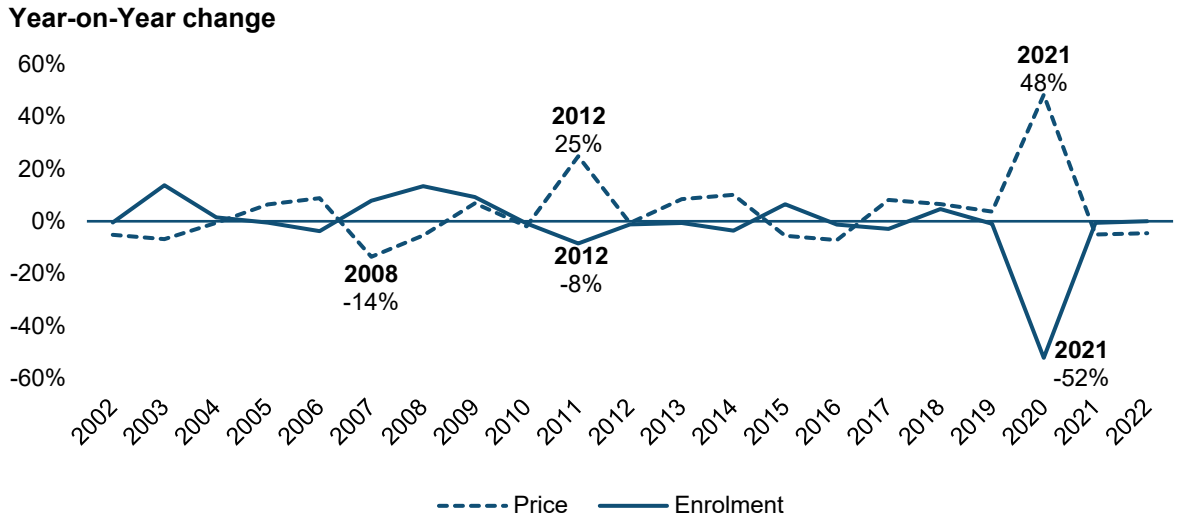



**Note:** Enrolment refers to the number of first-year, full-time undergraduate students enrolled at English HE providers whose country of domicile is inside the EU; price reflects tuition fees, exchange rates, and other factors as defined in the methodology section; Source: HESA and Alma Economics analysis.

Aside from these three events, the underlying series is relatively stable. It is clear that these three events are relatively dominant sources of variation in prices over the period that we study, and the key ways in which the price elasticity for undergraduate EU students can be identified. Since these represent largely exogenous shocks, it is reasonable to treat the EU undergraduate price as exogenous and estimate the model by OLS.

Figure 9 provides the same analysis for EU postgraduate students. Two notable increases in tuition fees are observed in 2012 and 2021. Although postgraduate fees are not formally regulated, they were likely influenced by the 2012 reform, as HEPs may have aimed to maintain a gap relative to undergraduate fees (the increase in postgraduate fees (25%) was significantly smaller than that for undergraduate fees (82%)). This makes the 2012 rise particularly noteworthy, as it can plausibly be considered the result of an exogenous policy shock, and can be used as an instrument for price to identify the price elasticity of EU postgraduates.

**Figure 9: EU postgraduate enrolment and price (full-time)**




**Note:** Enrolment refers to the number of first-year, full-time postgraduate students enrolled at English HE providers whose country of domicile is inside the EU; price reflects tuition fees, exchange rates, and other factors as defined in the methodology section; year-on-year change is calculated as the natural logarithmic change from t – 1 to t; Source: HESA and Alma Economics analysis.

Regarding EU exit, the cost of studying at an English HEPs for EU postgraduate students jumped by nearly 50% within a year. Enrolment responded sharply to the increase in tuition fees and other EU exit-related factors, declining by approximately 50%. Another notable price change occurred in 2008, when fees facing EU postgraduates (in their home currency) fell by 14%, primarily reflecting the depreciation of the British pound. This coincided with the onset of the global financial crisis, which was followed by recession across much of Europe in 2009–10.

This analysis provides a clearer understanding of the main sources of variation in the key variables and reveals that the three largest price changes (2008, 2012, and 2021) can largely be regarded as exogenous shocks. This, in turn, suggests that a simple identification strategy that treats price as exogenous may not yield substantially different results from one that models price as endogenous.

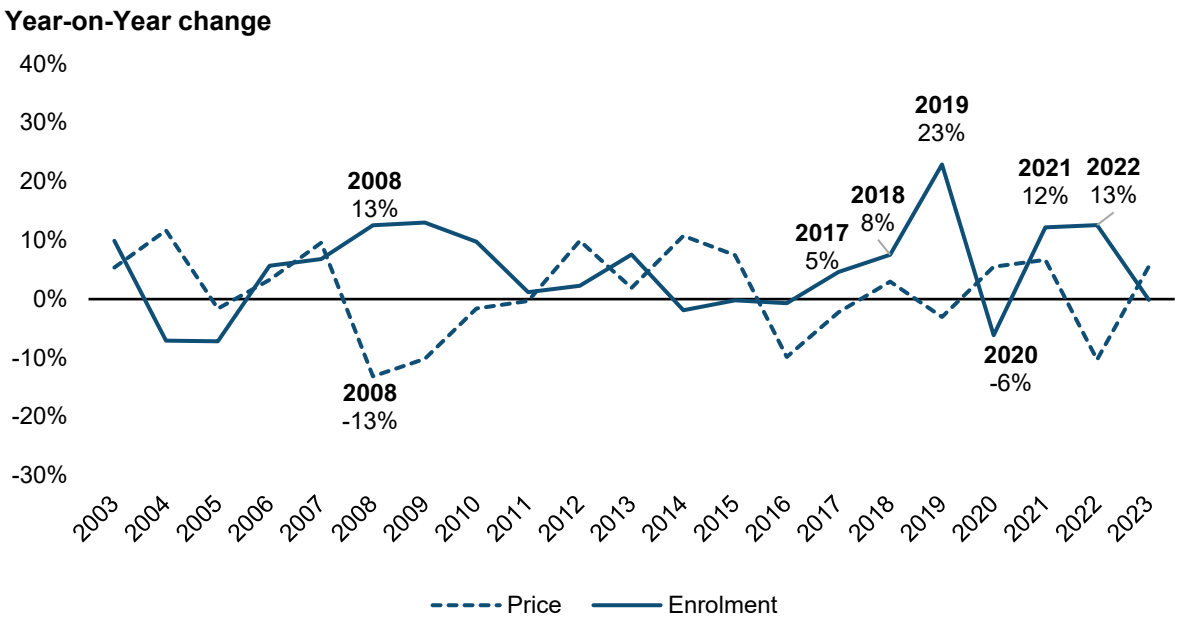
## 4.2.2 Non-EU students

Figures 10 and 11 depict enrolment and price for non-EU full-time undergraduate and postgraduate students, respectively. There are several notable observations.

- Between 2008 and 2011, prices for both undergraduate and postgraduate students declined, primarily reflecting the depreciation of the pound. During this period, enrolment increased.

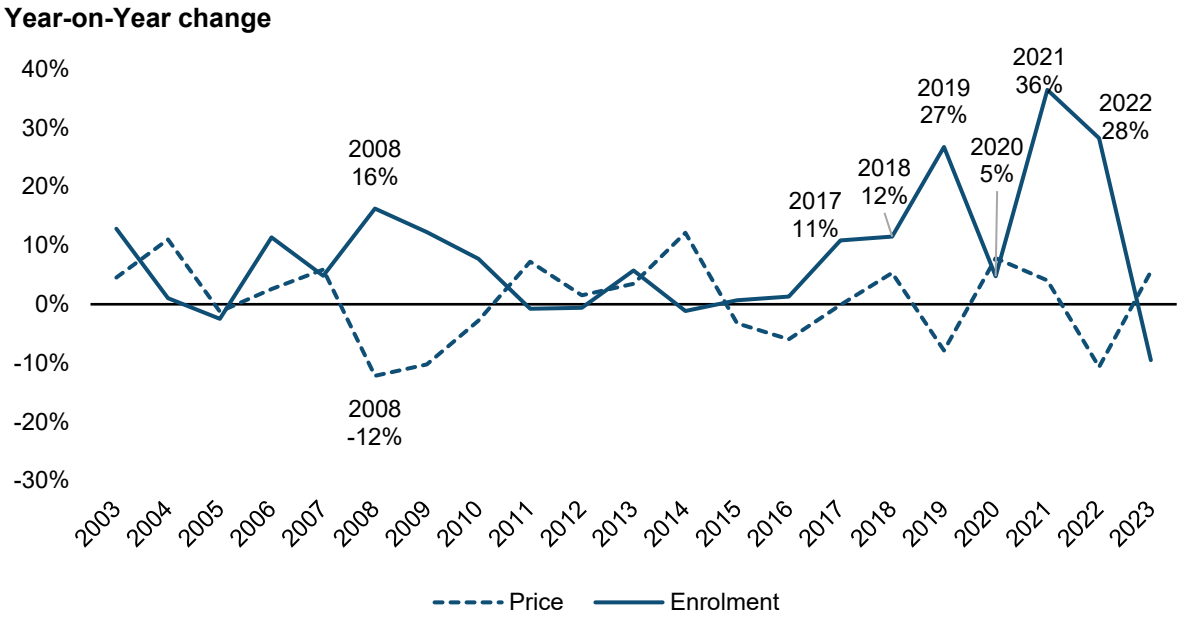
- Year-on-year changes in enrolment are positive in most years, reflecting the overall upward trend in non-EU student numbers during the last 20 years or so. This trend is particularly evident after 2015.
- In 2019, undergraduate enrolment increased by 23% and postgraduate enrolment by 27% - changes that cannot be attributed to tuition fees.
- In 2021 and 2022, growth rates were double-digit, at around 12% for undergraduates and over 28% for postgraduates, potentially reflecting the introduction of the Graduate Route visa, which allowed most overseas graduates to work in the UK for two or three years after completing their studies.

**Figure 10: Non-EU undergraduate first-year enrolment and price (full-time)**




**Note:** Enrolment refers to the number of first-year, full-time undergraduate students enrolled at English HE providers whose country of domicile is outside the EU; price reflects tuition fees, exchange rates, and other factors as defined in the methodology section; year-on-year change is calculated as the natural logarithmic change from t – 1 to t; Source: HESA and Alma Economics analysis.

**Figure 11: Non-EU postgraduate enrolment and price (full-time)**




**Note:** Enrolment refers to the number of first-year, full-time postgraduate students enrolled at English HE providers whose country of domicile is outside the EU; price reflects tuition fees, exchange rates, and other factors as defined in the methodology section; year-on-year change is calculated as the natural logarithmic change from t – 1 to t; Source: HESA and Alma Economics analysis.

The increase in enrolment in 2019 could be attributed to several factors.

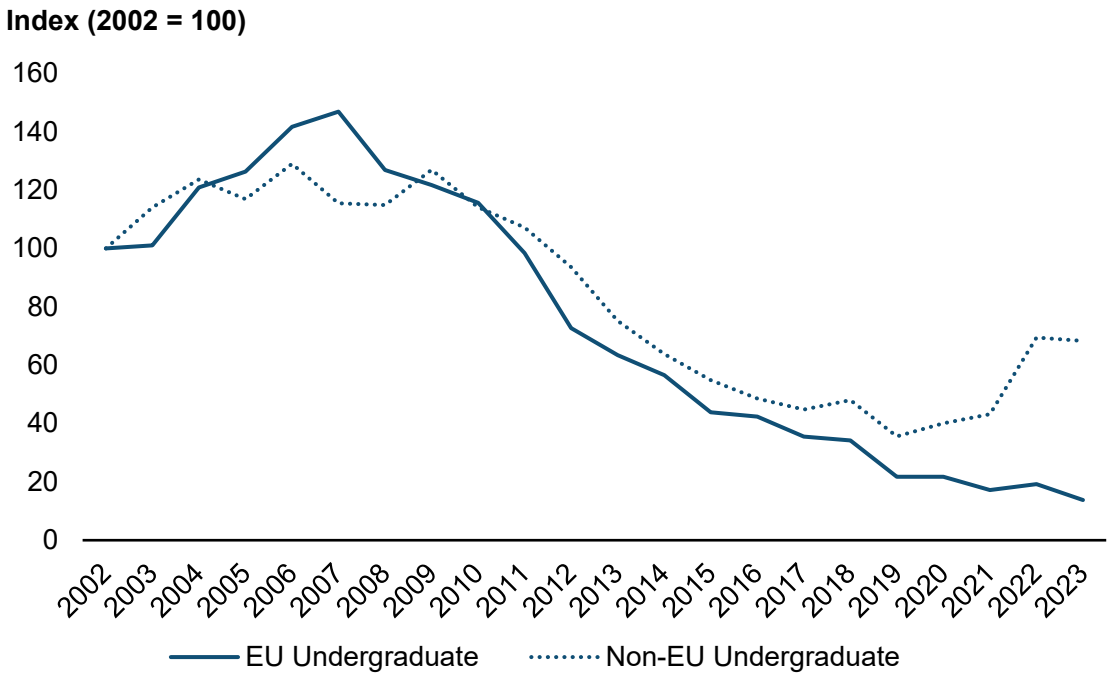
1. **Anticipation of UK Graduate Visa and other policy changes:** In December 2018, the UK government announced the return of the post-study visa, allowing overseas students to remain in the UK for two years after finishing their studies. At the same time, China was added to the UK's 'low risk' visa category in 2018, reducing documentary requirements for student visa applicants. This lower application barrier may have enhanced the UK's attractiveness as a HE destination.
2. **Tighter US immigration policies:** During the period 2018-2020, US visa applications faced increased scrutiny of foreign applicants and prolonged processing times. It was widely reported that prospective students expressed concerns about these developments (see, for example, the Higher Ed Dive report). Such policies may have weakened the relative appeal of US higher education and induced a substitution of demand toward alternative destinations such as the UK.
3. Increased non-EU marketing effort by HEPs: Anticipating a decline in EU enrolment after EU exit, HEPs intensified their recruitment efforts in non-EU markets, particularly in Asia and Africa.[56]

[56] The Migration Observatory (2025), Highman et al., (2025).

## 4.3 Part-time student trends

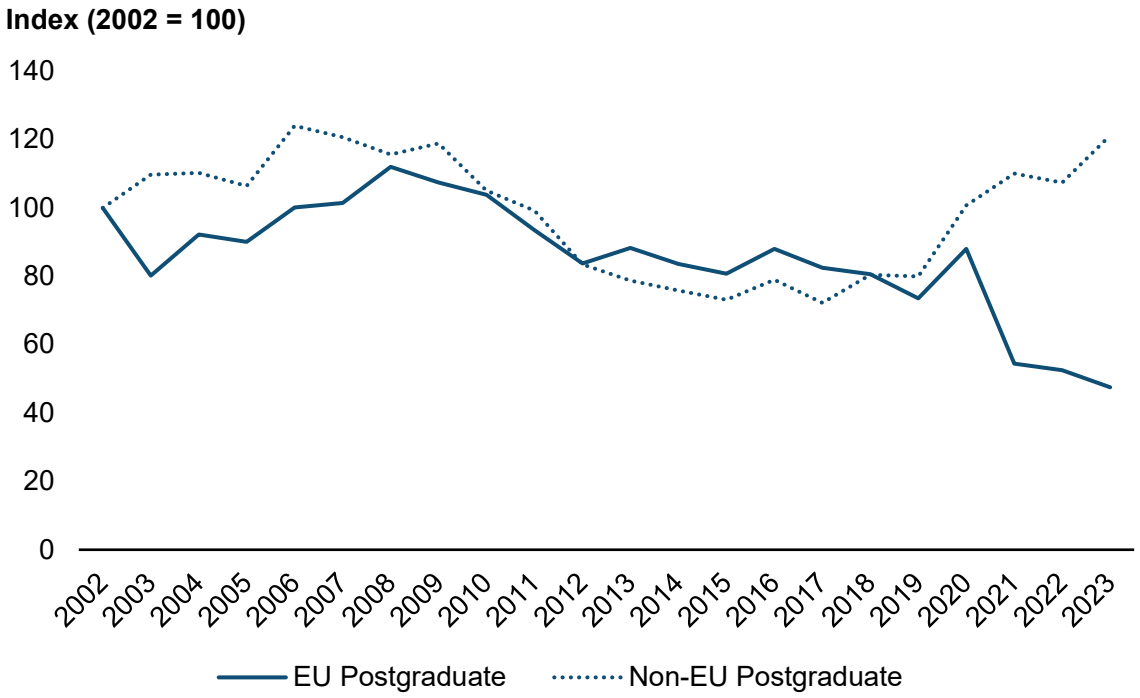
Figures 8 and 9 illustrate trends in part-time student enrolment for undergraduate and postgraduate programmes, respectively. For both groups and regions of domicile (EU and non-EU), enrolment remained relatively stable or grew slightly from 2002 until 2010, after which it steadily declined until 2019. After 2019, EU enrolment continued to decline, while non-EU enrolment experienced a strong rebound. This pattern contrasts with full-time enrolment trends and may indicate a shift in student preferences away from part-time study. This has important implications for the modelling strategy adopted, as it makes isolating the effects of price and other factors challenging. Indeed, the models used (not reported) failed to capture the variation in part-time student enrolment, with all key demand drivers, including price, being statistically insignificant.

**Figure 12: Undergraduate student trends (part-time)**




**Note:** Undergraduate refers to the number of first-year, part-time postgraduate students enrolled at English HE providers whose country of domicile is inside (EU) or outside the EU (non-EU); Source: HESA and Alma Economics analysis.

**Figure 13: Postgraduate student trends (part-time)**




**Note:** Postgraduate refers to the number of first-year, part-time postgraduate students enrolled at English HE providers whose country of domicile is inside (EU) or outside the EU (non-EU); Source: HESA and Alma Economics analysis.

# 5. Findings

This section presents the results of the econometric analysis and is organised into three sub-sections. The first two sub-sections focus on demand estimation for EU and non-EU students, respectively. The third concentrates on the supply equation. The analysis concentrates on full-time first-year students. Part-time students are excluded due to the challenges discussed in the previous section.

In both the demand and supply estimation, the focus is on price elasticities. For demand, a range of elasticity estimates is reported using both time-series and panel methods, as well as OLS and IV estimation methods. The panel-data IV approach is the preferred approach. As discussed in the methodology section, the panel-data method exploits a richer source of variation in the data, while the IV method addresses the potential endogeneity between demand and price. Therefore, this approach is considered the most reliable.

For the provider-tier analysis, only time-series models are estimated, as breaking down enrolment by both country of origin and provider tier results in cell sizes (tier/country/year) that are too small and noisy for reliable estimation.

The supply analysis is more straightforward. A single supply equation is estimated, covering all students—across both domestic and international students—as well as both undergraduate and postgraduate programmes, and is based on a relatively simple model specification. Specifically, the structure of this section is as follows.

*EU student demand*

- Section 5.1.1 presents the panel data analysis for full-time EU students.
- Section 5.1.2 presents the time-series analysis for full-time EU students.
- Section 5.1.3 presents the time-series analysis for full-time EU students by HEP tier.

*Non-EU student demand*

- Section 5.2.1 presents the panel data analysis for full-time non-EU students.
- Section 5.2.2 presents the **time-series analysis for full-time non-EU students**.
- Section 5.2.3 presents the **time-series** analysis for full-time non-EU students by HEP tier.

*Supply*

- Section 5.3 presents estimates of the **price elasticity of supply**.

## 5.1 Demand: Full-time EU students

### 5.1.1 Panel data analysis - Full-time EU students

Table 3 presents the coefficient estimates for the baseline demand equations for EU full-time undergraduate and postgraduate taught programmes using panel data analysis. The baseline specification is kept parsimonious, with living costs, English HEP rankings, and competitor tuition fees omitted but included in sensitivity checks—both to preserve degrees of freedom and because these variables show limited time variation (see Appendix A4).

As discussed in the methodology, the panel approach uses enrolment data by country and year, meaning that the analysis exploits variation in price and enrolment not only over time but also across countries, each of which may have its own demand determinants (e.g. macroeconomic conditions and exchange rates).

One set of results is reported for undergraduate students using OLS, and two sets are reported for postgraduate students using both OLS and IV estimation methods. Given the likely correlation between unobserved country-specific factors and the regressors, a fixed-effects specification is adopted.

**Table 3: Full-time EU demand estimates (panel data analysis)**

| | **Full-time undergraduate** | **Full-time postgraduate taught** | **Full-time postgraduate taught** |
|---|---|---|---|
| **Variables** | **OLS** | **OLS** | **IV** |
| ln(price) | 0.04 | −0.50*** | −0.45*** |
| ln(price) × 2012 reform | −0.38*** | | |
| ln(price) × EU exit (2021) | −1.32*** | −0.68*** | −0.73*** |
| Brexit referendum (2017) | −0.02 | −0.03 | −0.03* |
| ln(GDP per capita) | −0.78 | −0.53 | −0.54 |
| Lagged dependent variable | 0.13*** | 0.06 | 0.06 |
| **R-squared** | **0.57** | **0.50** | **0.51** |
| **Model diagnostics** | | | |
| Hansen J test | | | 0.46 |
| Kleibergen-Paap test | | | 0.01 |

**Note:** The dependent variable is the natural logarithm of first-year enrolment; the price variable reflects tuition fees, visa fees, and the immigration health surcharge, expressed in local currency; all variables are measured in first differences; price and GDP per capita are expressed in real terms; OLS: panel data fixed effects model; IV: Panel data fixed effects instrumental variable model; Sample size is: 220 (20 years across 11 countries); the Hansen J test is a test of the validity of the overidentifying restrictions (its null hypothesis is that the instruments are exogenous, i.e. uncorrelated with the error term and valid—rejecting the null provides evidence that at least one instrument is invalid; the Kleibergen–Paap test is used to assess instrument relevance in the presence of heteroskedasticity or clustering (its null hypothesis is that the model is under identified / instruments are weak—rejecting the null indicates that the instruments are relevant and the model is identified); both the Hansen J test and Kleibergen-Paap test values reported are p-values; (i) individual exchange rate (by country) to GBP (ii) Weighted average of all other countries to GBP exchange rate; statistical significance is assessed using cluster-robust standard errors; ***, **, and * indicate statistical significance at the 1%, 5%, and 10%.

## Price impacts

*Undergraduate EU students*

In the **undergraduate student model**, there are three price variables: the baseline price, the interaction between price and the 2012 reform dummy, and the interaction between price and the EU exit dummy. The baseline price coefficient captures the average elasticity over the sample period, excluding the price changes in 2012 and 2021. As discussed in the Methodology section, the price variable is interacted with the 2012 reform, which affected undergraduate students, and the EU exit, which affected both undergraduate and postgraduate students. This is because these events affected not only prices, but also other aspects of enrolment decisions, such as changes in student finance arrangements associated with the 2012 reform and the loss of access to student loans associated with the EU exit, which cannot be identified separately. As such, these price estimates should be interpreted with caution, as they do not capture pure price effects. The coefficients of the interaction terms should be interpreted relative to the baseline price, as they measure the additional effect (see Box 4).

The coefficient of the baseline price in the undergraduate student model is not statistically significant, which is not surprising given the relatively limited variation in price when excluding the 2012 reform and EU exit events—the baseline price cannot be estimated with reasonable accuracy due to a lack of price variation. In contrast, the coefficients of the two interaction terms are statistically significant. The price elasticity associated with the 2012 reform is −0.34 ((−0.38) + (0.04)), implying that a 10% increase in price corresponds to a 3.4% reduction in enrolment. Accounting for lagged effects (see Box 4), the long-run price elasticity is larger in absolute value, at −0.37, indicating that a 10% price increase linked to the 2012 reform resulted in a 3.7% decrease in demand.[57]

[57] The long-run elasticity is calculated by dividing the short-run elasticity (−0.34) by (1 − 0.13), where 0.13 is the coefficient on the lagged dependent variable.

This elasticity would likely be larger in absolute terms in the absence of student loans. The loans are income-contingent, meaning repayments only begin once graduates' earnings exceed a specified threshold, and any remaining balance is written off after a fixed period. As a result, the actual cost incurred by students may be lower than the stated tuition fee, in which case the estimated price elasticity might understate the true elasticity. To account for this, an adjustment is applied to the 2012 fee increase using the RAB charge (see Appendix A.8 for more details). This adjustment assumes that students can, on average, anticipate the proportion of their loan that will not be repaid and therefore assess the true cost of studying; it does so by adjusting tuition fees downward to reflect only the portion that is actually repaid.

When this adjustment is applied, the estimated long-run price elasticity increases in absolute terms from −0.37 to −0.57. If students understand the student finance system and can anticipate, on average, the share of their loan they will not repay, then −0.57 is the better approximation of the true elasticity. If, on the other hand, students do not understand the system and/or expect to repay their loan in full, then −0.37 is the more appropriate estimate. **For policy purposes, the price elasticity for EU undergraduates should be taken as lying between −0.37 and −0.57, with values closer to −0.37 if it is believed that students are unlikely to account for the probability of partial non-repayment, and values closer to −0.57 if it is believed that they are. These are the preferred estimates presented in the Executive Summary.**

The elasticity associated with EU exit is substantially larger. The short-run elasticity is −1.28 (−1.32 + 0.04) and the long-run elasticity is −1.47, both statistically significant at the 1% level, implying that a 10% increase in price associated with EU exit was accompanied by a 14.7% decrease in enrolment in the long run. This stronger effect likely reflects the loss of access to government student finance for EU students—meaning the fee change alone understates the effective increase in costs—as well as the introduction of visa requirements following EU exit. **For policy purposes, particularly when assessing the potential impact of a student levy on demand, this elasticity should not be used or used with care, as it captures other concurrent factors (loss of access to student loans and the right to study and work in the UK without a visa) that cannot be separately isolated.** The 2012 price variable also reflects changes in student finance introduced at the same time as the fee increase, although this confounding effect is likely to be less pronounced than that related to Brexit.

*Postgraduate EU students*

**The price specification for postgraduate students differs slightly.** A 2012 interaction term is not included, as the 2012 reform did not directly affect postgraduate

fees. Instead, an EU exit interaction term is included. The price elasticity captures the average elasticity over the sample period, while the EU exit interaction captures the additional effect (See Box 4 for the interpretation of the interaction term). Specifically, the price elasticity in the IV case is −0.45, and the elasticity associated with EU exit is −1.18 ((−0.45) + (−0.73)). The lagged dependent variable is not statistically significant; therefore, these elasticities capture the full impact of price changes—encompassing both short-run and long-run effects.

For policy purposes, the baseline elasticity of −0.45 would likely be more appropriate for assessing the impact of future price changes, as the EU exit elasticity captures not only price effects, but also other factors associated with EU exit. The OLS estimates are similar, but the IV estimates are preferred as they account for potential endogeneity between enrolment and price. **In short, the −0.45 elasticity is the preferred estimate for EU postgraduate demand, as it is based on the preferred approach (panel data IV). It is the figure reported in the Executive Summary**.

An alternative specification was estimated using an additive EU exit dummy rather than a multiplicative one. The estimated coefficient on the EU exit dummy is 0.39, indicating that the loss of access to student finance and the right to study and work in the UK without a visa is associated with a 39% decline in demand. This interpretation depends on the assumption that the price effect under EU exit is similar to that observed in earlier periods.

### Other variables

The coefficient on the Brexit referendum is small (around −0.03) and not statistically significant, suggesting no clear effect of the referendum on demand. GDP per capita is negative in both the undergraduate and postgraduate models, and in the postgraduate IV specification, it is statistically significant at the 10% level. This is somewhat unexpected, as standard income effects would predict a positive relationship between income and demand. The negative association between income and demand may be explained by the business cycle and conditions in the labour market. Demand for HE could be counter-cyclical: weaker labour market conditions may encourage individuals to delay entering employment or to take a break from the labour market to pursue HE. Notwithstanding these, the GDP per capita is not statistically significant, suggesting that demand is not materially affected by changes in income or business cycle.

### Model fit and diagnostics

The model fit is satisfactory, with an R-squared value of 0.57 for undergraduate students and around 0.50 for postgraduate students.

In panel data settings, it is typically uncommon to conduct diagnostic tests, as in time-series or cross-sectional contexts, either because they have lower power or are not available. Instead, researchers typically use cluster-robust standard errors, which are robust to heteroskedasticity and within-country serial correlation. This is the approach followed in this research. However, instrument diagnostics are performed for the IV model. The Hansen J test for instrument exogeneity and the Kleibergen–Paap test for instrument relevance are reported.

The Hansen J test fails to reject the null hypothesis that the instruments are exogenous, suggesting that the instruments are valid. In addition, the Kleibergen–Paap test rejects the null hypothesis that the instruments are weak, indicating that the instruments are sufficiently correlated with the endogenous regressor. Taken together, these diagnostics indicate that the instruments are reliable, being both relevant and exogenous.

### 5.1.2 Time-series analysis - Full-time EU students

Table 3 presents the coefficient estimates for the baseline demand equations of EU full-time undergraduate and postgraduate taught programmes using time-series data. As in the case of the panel data analysis, for undergraduate students, estimates are reported using OLS only, whereas for postgraduates, both OLS and IV estimates are presented.

#### Price impacts

The model specification is the same as that in the panel data analysis. There are three price variables: the baseline price, the interaction between price and the 2012 reform dummy, and the interaction between price and the EU exit dummy. The baseline price coefficient captures the average elasticity over the sample period, excluding the price changes in 2012 and 2021. The coefficients of the interaction terms should be interpreted relative to the baseline price, as they measure the additional effect (see Box 4).

**Table 4: Full-time EU demand estimates (time-series analysis)**

| | Full-time undergraduate | Full-time postgraduate taught | Full-time postgraduate taught |
|---|---|---|---|
| **Variables** | **OLS** | **OLS** | **IV** |
| ln(price) | −0.06 | −0.49*** | −0.43*** |
| ln(price) × 2012 reform | −0.34*** | | |
| ln(price) × EU exit (2021) | −1.37*** | −0.65*** | −0.70*** |
| Brexit referendum (2017) | −0.10* | −0.09 | −0.08* |
| ln(GDP per capita) | 0.79 | −0.07 | −0.11 |
| Lagged dependent variable | 0.16*** | 0.13 | 0.12* |
| Intercept | 0.06*** | 0.03** | 0.03*** |
| **R-squared** | **0.98** | **0.91** | **0.91** |
| Model diagnostics | | | |
| Breusch-Pagan test | 0.30 | 0.21 | |
| IM-test | 0.98 | 0.35 | |
| Breusch-Godfrey | 0.88 | 0.21 | |
| Sargan test | | | 0.63 |
| Wu-Hausman test | | | 0.46 |
| First stage | | | 21.0 |

**Note:** The dependent variable is the natural logarithm of first-year enrolment; the price variable reflects tuition fees, visa fees, and the immigration health surcharge, expressed in local currency; all variables are measured in first differences; price and GDP per capita are expressed in real terms; Sample size is: 20 (years); model diagnostics report p-values, except for the first-stage F-statistic. The Breusch–Pagan test is a test for heteroskedasticity; the IM test is the Cameron–Trivedi decomposition test for heteroskedasticity, skewness, and kurtosis; the Breusch–Godfrey test is a test for first-order serial correlation; the Sargan test is a test for the validity of overidentifying restrictions, determining if instruments are exogenous; the Wu–Hausman test evaluates whether price is endogenous; First stage F-statistic is the F-statistic from the first-stage IV and assesses the strength of the instruments; Instruments included in the IV: (i) 2012 reform dummy and (ii) EU/GBP exchange rate; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

*Undergraduate EU students*

In the **undergraduate student model**, the baseline price elasticity is not statistically significant. However, the coefficients of the two interaction terms are statistically significant. The price elasticity associated with the 2012 reform is −0.40 ((−0.34) + (−0.06)), implying that a 10% increase in price corresponds to a 4% reduction in enrolment.[58] Accounting for lagged effects (see Box 4), the long-run price elasticity is larger in absolute value, at −0.48, indicating that a 10% price increase linked to the 2012 reform resulted in a 4.8% decrease in demand.[59]

As in the panel data analysis, a RAB adjustment is applied to account for the possibility that students factor in the proportion of tuition fees that will not be repaid, given the income-contingent nature of the loans (see Appendix A.8 for more details). When this adjustment is applied, the long-run price elasticity for the 2012 reform increases from −0.48 to −0.74. **For policy purposes, the price elasticity for EU undergraduates should be taken as lying between −0.48 and −0.74, with values closer to −0.48 if students are unlikely to account for the probability of partial non-repayment, and values closer to −0.74 if they are. These estimates are very close to the panel estimates (−0.37 and −0.57), which are the preferred ones.**

The elasticity associated with EU exit is substantially larger. The short-run elasticity is −1.43 ((−1.37) + (−0.06)), and the long-run elasticity is −1.70 (both statistically significant at the 1% level), implying that a 10% increase in price associated with EU exit occurred alongside a 17% decrease in enrolment in the long run. This stronger effect likely reflects the loss of access to government-provided student finance for EU students—meaning this time that the fee change alone u*nderstates* the effective increase in costs for EU students—as well as the introduction of visa requirements following EU exit. **For policy purposes, particularly when assessing the potential impact of a student levy on demand, this elasticity should not be used or used with care, as it captures other concurrent factors (loss of access to student loans and the right to study and work in the UK without a visa) that cannot be separately isolated.** The 2012 price variable also reflects changes in student finance introduced at the same time as the fee increase, although this confounding effect is likely to be less pronounced than that related to Brexit.

[58] −0.06 is the baseline price coefficient, which captures the average elasticity over the sample period, excluding the price changes in 2012 and 2021. −0.34 is the coefficient on the 2012 interaction term, which captures the additional effect above the baseline effect, associated with the 2012 reform. See Box 4 for further details on how these coefficients should be interpreted.
[59] This is based on the formula discussed in Box 4: −0.40/(1−0.16) = −0.48.

*Postgraduate EU students*

The price specification for **postgraduate students** differs slightly. A 2012 interaction term is not included, as the 2012 reform did not directly affect postgraduate fees. Instead, an EU exit interaction term is included. The price elasticity captures the average elasticity over the sample period, while the EU exit interaction captures the additional effect. Specifically, the short-run price elasticity in the IV case is −0.43, and the elasticity associated with EU exit is −1.13 ((−0.43) + (−0.70)). Accounting for the lagged dependent variable, the baseline long-run price elasticity for postgraduate students is −0.49, and the long-run elasticity associated with EU exit is −1.28.[60] The OLS estimates are similar to the IV estimates. The baseline price elasticity is −0.49, and the elasticity associated with EU exit is −1.14 ((−0.49) + (−0.65)). The coefficient on the lagged dependent variable in the OLS model is not statistically significant; therefore, these OLS estimates represent the short-run and long-run price effects.

The price elasticity of demand for postgraduate students lies within a similar range to that estimated for undergraduate students. **For policy purposes, the baseline long-run elasticity of −0.49 would likely be more appropriate to use as a guide to the impacts of future price changes (IV and OLS estimates are both −0.49). This is because the EU exit-related price elasticity captures not only price effects, but also other factors associated with EU exit.**[61]

### Other variables

The Brexit referendum indicator variable is negative and statistically significant at the 10% level for both undergraduate and postgraduate students (IV model only). For undergraduates, the coefficient of −0.10 implies a reduction in enrolment of around 10% following the referendum. For postgraduates, a similar effect is found, with enrolment falling by around 8%. This is in contrast to the panel data model, where the estimated effect of the Brexit referendum is substantially smaller and not statistically significant.

For undergraduate students, GDP per capita in the EU has a positive coefficient that is close to one, whereas for postgraduate students, the coefficient is close to zero. However, in neither case is the coefficient statistically significant.

[60] These are calculated as follows: -0.43/(1-0.12) = -0.49; -1.13/(1-0.12) = -1.28.
[61] An alternative specification was estimated using an additive EU exit dummy rather than a multiplicative one. The estimated coefficient on the EU exit dummy is 0.31, indicating that the loss of access to student finance and the right to study and work in the EU without a visa is associated with a 31% decline in demand. This interpretation depends on the assumption that the price effect under EU exit is similar to that observed in earlier periods.

### Model fit and diagnostics

All three models exhibit a high degree of fit, with R-squared values above 0.90. This primarily reflects the presence of several large 'events' captured by the models, which explain much of the variation in enrolment (rather than model overfitting).[62]

A series of standard diagnostic tests for the OLS specifications was conducted. The Breusch–Pagan test and the Breusch–Godfrey test provide no evidence of heteroskedasticity or serial correlation, respectively. In addition, the Cameron–Trivedi IM test fails to reject the null hypothesis of correct model specification. Together, these results suggest that the OLS models are well specified.

For the postgraduate IV model, instrument relevance and validity are assessed. The first-stage F-statistic is 21.0, comfortably exceeding the conventional threshold of 10, indicating strong instrument relevance. The Sargan test fails to reject the null that the instruments are exogenous (overidentifying restrictions are valid). Taken together, these diagnostics indicate that the instruments are reliable (relevant and exogenous).

Interestingly, the Wu–Hausman test fails to reject the null hypothesis that price is exogenous. A possible explanation is that a substantial share of the observed price variation arises from exogenous sources, such as exchange rate fluctuations and the 2012 reform, thereby reducing the likelihood that the price is endogenously determined. This suggests that the OLS estimator is largely unaffected by endogeneity and can thus provide reliable estimates.[63]

## 5.1.3 Price elasticity by HEP ranking tier - Full-time EU students

Table 5 presents the long-run price elasticity of demand by HEP ranking tier. This is based on time-series analysis and not panel data analysis. This is due to data constraints, as splitting the sample by both country and provider tier results in small numbers of students by country and tier. The tier results, therefore, build on the aggregate EU time-series model. However, it is reassuring that the panel and time series analyses produce very similar results, where both approaches can be applied.

[62] The higher model fit relative to the panel data model reflects the fact that the time-series model pools countries together, reducing noise in the data, whereas the panel model relies on country-specific time series that are inherently noisier.
[63] If price is endogenous and this is not accounted for, for example through an instrumental variables approach, the estimated price elasticity may be considerably biased.

**Table 5: Full-time EU students: price elasticity of demand by HEP tier**

| **Undergraduate** | **Tier 1** | **Tier 2** | **Tier 3** | **Tier 4** |
|---|---|---|---|---|
| 2012 reform<br>(2012 reform - RAB adjusted) | −0.17*<br>(−0.26) | −0.19*<br>(−0.29) | −0.37**<br>(−0.57) | −0.70**<br>(−1.08) |
| EU exit (2021) | −0.74*** | −1.25*** | −1.70*** | −3.72*** |
| **Postgraduate taught** | **Tier 1** | **Tier 2** | **Tier 3** | **Tier 4** |
| Baseline | 0.07 | −0.50*** | −0.62** | −0.63*** |
| EU exit (2021) | −0.57*** | −1.20*** | −1.65*** | −2.83*** |

**Note:** Tier 1 represents the highest-ranking tier, and Tier 4 the lowest; the reported elasticities represent long-run values, incorporating the lagged dependent variable as well as the baseline and interaction terms; Price elasticity: 2012 reform – price elasticity of demand associated with the 2012 reform; Price elasticity: EU exit (2021) – price elasticity of demand associated with EU exit; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

In nearly all cases, there is a clear pattern: lower-tier HEPs tend to have higher price elasticity of demand. For undergraduate programmes, the 2012 price reform had a negative, though only weakly statistically significant, effect on demand for Tier 1 and Tier 2 HEPs. The estimated long-run elasticities are −0.17 for Tier 1 and −0.19 for Tier 2, implying that a 10% increase in price reduces demand by around 1.7% and 1.9%, respectively. By contrast, the effects are larger in absolute terms for Tiers 3 and 4, with long-run elasticities of −0.37 and −0.70, indicating that the same price increase reduced demand by 3.7% and 7.0%, respectively. RAB-adjusted elasticities are also presented; these are larger in absolute terms but follow a similar pattern.

A similar pattern is observed for the price elasticity associated with EU exit, although the effect is both material and statistically significant even for Tier 1 HEPs. The long-run elasticities are −0.74, −1.25, −1.70, and −3.72 for Tier 1, Tier 2, Tier 3, and Tier 4 HEPs, respectively. These figures indicate that a 10% EU exit -related increase in price reduced demand for undergraduate studies by 7.4% in Tier 1, 12.5% in Tier 2, 17.0% in Tier 3, and 37.2% in Tier 4 HEPs, highlighting substantially greater price sensitivity among lower-ranked institutions.

For postgraduate programmes, price elasticity again varies across tiers, although the differences are less stark. The baseline long-run elasticities of demand for Tier 1 are not statistically significant, and for Tier 2, Tier 3, and Tier 4 HEPs are −0.50, −0.62, and −0.70, respectively. In contrast, the long-term elasticity associated with EU exit shows a much clearer pattern, increasing from −0.57 for Tier 1 to −1.20 for Tier 2, −1.65 for Tier 3, and −2.83 for Tier 4. This indicates that EU exit-related tuition fee

changes had a disproportionately large impact on demand for postgraduate taught programmes, with lower-ranked HEPs experiencing the greatest reductions.

Variation in price elasticity across HEPs may reflect differences in the price sensitivity of their respective student pools: students at higher-ranked institutions may be less price-sensitive due to the stronger earnings potential associated with a degree from those institutions.

## 5.2 Demand: Full-time non-EU students

### 5.2.1 Panel data analysis - Full-time non-EU students

Table 6 presents the coefficient estimates for the baseline demand equations for non-EU full-time undergraduate and postgraduate taught programmes using panel data analysis. Two sets of estimates are reported using both OLS and IV methods. Similar to the EU models, the baseline specification omits living costs, English HEP rankings, and competitor tuition fees, both to preserve degrees of freedom and because these variables show limited variation over time. They are, however, included in the sensitivity checks presented in the Appendix.

#### Price impacts

In the undergraduate student model, the price coefficient is −0.28 in the OLS model and −0.32 in the IV model, and it is statistically significant at the 1% level in both cases. [64] When the statistically significant lagged dependent variable is considered, the implied long-run price elasticities are −0.33 for OLS and −0.37 for IV.[65] Hence, for the preferred IV estimate, the elasticity indicates that a 10% increase in price is associated with a 3.7% decrease in demand from non-EU undergraduate students.

In the postgraduate models, the price coefficient is −0.33 under OLS and −0.26 under IV, and both are statistically significant at the 5% level. The lagged dependent variable is also statistically significant, yielding long-run price elasticities of −0.52 (OLS) and −0.42 (IV). For the preferred IV estimate, the elasticity indicates that a 10% increase in price is associated with a 4.2% decrease in demand from non-EU postgraduate taught students. The preferred estimates for non-EU students are −0.32 for undergraduates and −0.42 for postgraduates, both derived from the panel IV analysis, which is the preferred approach. These are the elasticities reported in the Executive Summary.

**Table 6: Full-time non-EU demand estimates (panel data analysis)**

[64] Unlike in the EU model, the price variable is not interacted with indicator variables, since there were no distinct events that directly influenced the non-EU student market.
[65] −0.28/(1-0.13) = 0.33; −0.32/(1-0.13) = 0.37;

| | Full-time undergraduate | Full-time undergraduate | Full-time postgraduate taught | Full-time postgraduate taught |
|---|---|---|---|---|
| **Variables** | **OLS** | **IV** | **OLS** | **IV** |
| ln(price) | −0.28** | −0.32*** | −0.33** | −0.26** |
| 2019 dummy | 0.34* | 0.34*** | 0.15 | 0.15* |
| Graduate Visa | 0.08** | 0.08*** | 0.08*** | 0.08*** |
| ln(GDP per capita) | 0.49 | 0.49 | −0.75 | −0.74* |
| Lagged dependent variable | 0.13** | 0.13*** | 0.36*** | 0.36*** |
| **R-squared** | **0.15** | **0.14** | **0.23** | **0.23** |
| **Model diagnostics** | | | | |
| Hansen J test | | 0.59 | | 0.25 |
| Kleibergen–Paap test | | 0.04 | | 0.03 |

**Note:** The dependent variable is the natural logarithm of first-year enrolment; the price variable reflects tuition fees, visa fees, and the immigration health surcharge, expressed in local currency; all variables are measured in first differences; price and GDP per capita are expressed in real terms; OLS: panel data fixed effects model; IV: Panel data fixed effects instrumental variable model; Sample size is: 220 (20 years across 11 countries); the Hansen J test is a test of the validity of the overidentifying restrictions (its null hypothesis is that the instruments are exogenous, i.e. uncorrelated with the error term and valid—rejecting the null provides evidence that at least one instrument is invalid; the Kleibergen–Paap test is used to assess instrument relevance in the presence of heteroskedasticity or clustering (its null hypothesis is that the model is under identified / instruments are weak—rejecting the null indicates that the instruments are relevant and the model is identified); both the Hansen J test and Kleibergen-Paap test values reported are p-values; Instruments included in the undergraduate IV: (i) individual exchange rate (by country) to GBP (ii) weighted average of all other countries to GBP exchange rate; statistical significance is assessed using cluster-robust standard errors. ***, **, and * indicate statistical significance at the 1%, 5%, and 10%.

### Other variables

For both undergraduate and postgraduate taught programs, a year dummy for 2019 is included, which captures the significant increase in enrolments that could not be explained by other variables.[66] As noted in the Descriptive Analysis section, this could be explained by factors such as the announcement of the UK Graduate Visa, which took effect in 2021, and more restrictive US immigration policies. For undergraduate students, the 2019 dummy coefficient suggests an increase in demand of around

[66] We identified a large model residual in 2019, indicating that price and other factors could not explain the increase in enrolment.

34%. For postgraduate students, the increase is smaller, at around 15%, and is statistically significant only in the IV specification at the 10% level.

The graduate visa indicator, which reflects the year in which changes to the graduate visa came into effect, is economically and statistically significant in both the undergraduate and postgraduate models across both estimation methods. It is also remarkably consistent across all four levels of study and estimation approaches, with a coefficient of 0.08. This implies that each additional (or fewer) year of post-study work rights is associated with approximately a 8% increase (or decrease) in demand for undergraduate and postgraduate taught programmes. However, the visa policy coefficient decreases in magnitude and is no longer statistically significant when the 2021 visa policy change is excluded. Given this, along with the challenges of confounding effects associated with COVID-19 and the EU exit in 2021, it is difficult to be confident about the impacts of visa policies alone.

The GDP per capita coefficient is 0.49 in the undergraduate models and approximately −0.75 in the postgraduate models, and it is statistically significant at the 10% level in the IV case.

#### Model fit and diagnostics

Model fit ranges from 0.14 to 0.23, which is lower than in the EU models. This is because the EU models featured several large enrolment shifts, most notably those associated with the 2012 reform and the EU exit, which were well captured by the model and thereby inflated the model fit. The Hansen J test fails to reject the null hypothesis that the instruments are exogenous in both the undergraduate and postgraduate models, suggesting that the instruments are valid. In addition, the Kleibergen–Paap test rejects the null hypothesis of weak instruments in both cases, indicating that the instruments are sufficiently correlated with the endogenous regressor. Taken together, these diagnostics suggest that the instruments are reliable, being both relevant and exogenous.

### 5.2.2 Time-series analysis - Full-time non-EU students

Table 7 reports the coefficient estimates from the baseline demand equations for non-EU full-time undergraduate and postgraduate taught programmes using time-series data. For each level of study, two sets of estimates are presented corresponding to the OLS and IV models.

**Table 7: Full-time non-EU demand estimates (time-series analysis)**

| | Full-time undergraduate | Full-time undergraduate | Full-time postgraduate taught | Full-time postgraduate taught |
|---|---|---|---|---|
| **Variables** | ***OLS*** | ***IV*** | ***OLS*** | ***IV*** |
| ln(price) | −0.48** | −0.56*** | −0.62* | −0.55* |
| 2019 dummy | 0.18** | 0.17*** | 0.15 | 0.16* |
| Graduate Visa | 0.01 | 0.01 | 0.06 | 0.06** |
| ln(GDP per capita) | 0.82 | 0.92 | 1.31 | 1.25 |
| Lagged dependent variable | 0.08 | 0.09 | 0.22 | 0.22 |
| Intercept | 0.02 | 0.02 | 0.02 | 0.02 |
| **R-squared** | **0.52** | **0.51** | **0.52** | **0.52** |
| **Model diagnostics** | | | | |
| Breusch-Pagan test | 0.79 | | 0.77 | |
| IM-test | 0.39 | | 0.12 | |
| Breusch-Godfrey | 0.22 | | 0.52 | |
| Sargan test | | 0.74 | | 0.60 |
| Wu-Hausman test | | 0.48 | | 0.72 |
| First stage | | 15.1 | | 21.3 |

**Note:** The dependent variable is the natural logarithm of first-year enrolment; the price variable reflects tuition fees, visa fees, and the immigration health surcharge, expressed in local currency; all variables are measured in first differences; price and GDP per capita are expressed in real terms; Sample size is: 20 (years); Model diagnostics report p-values, except for the first-stage F-statistic. The Breusch–Pagan test examines heteroskedasticity; the IM test is the Cameron-Trivedi decomposition test for heteroskedasticity, skewness, and kurtosis; the Breusch-Godfrey test examines serial correlation; the Sargan test assesses overidentifying restrictions; and the Wu–Hausman test evaluates endogeneity. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively; Instruments included in the undergraduate IV: (i) 2012 reform dummy and 2017 Brexit referendum dummy reflecting demand shifter from “other” countries, and (ii) non-EU exchange rate; Instruments included in the postgraduate IV: (i) 2017 Brexit referendum dummy reflecting demand shifter from “other countries”; and (ii) non-EU exchange rate.

### Price impacts

For undergraduate students, the results indicate a price elasticity of −0.48 under OLS and −0.56 under IV. Although the estimates are broadly comparable, the IV elasticity is preferred. The IV elasticity implies that a 10% increase in price is associated with a 5.6% reduction in enrolment. The coefficient of the lagged dependent variable is not statistically significant, indicating that the reported coefficient represents the full price effect.[67]

For postgraduate students, the results suggest a similar price elasticity of −0.62 under OLS and −0.55 under IV. The preferred IV estimate implies that a 10% increase in price is associated with a 5.5% reduction in enrolment. Similar to the undergraduate student demand, the lagged dependent variable is not statistically significant, implying that the price coefficients reflect the full price elasticity of demand.

### Other variables

The coefficient on the 2019-year dummy suggests an approximate 17% increase in demand for undergraduate programmes in 2019, and around 16% for postgraduate taught programmes. As discussed in the previous section, this may reflect factors such as the announcement of the UK Graduate Visa, which took effect in 2021, and more restrictive US immigration policies, which increased demand by international students.

The graduate visa indicator, which reflects the year in which changes to the graduate visa came into effect, is economically small and statistically insignificant in the undergraduate model. By contrast, it is both an economically and statistically significant driver of postgraduate demand in the IV specification. The estimated coefficient indicates that each additional year of post-study work rights is associated with roughly a 6% increase in demand for postgraduate taught programmes. However, similar to the panel data model, the changes to visa policy in 2021 appear to have been key to this result. If the 2021 policy is excluded, the graduate visa indicator is no longer statistically significant. Given that the 2021 visa changes coincided with other major events, including COVID-19 and the EU exit, these findings should be interpreted with caution.

The GDP per capita variable is not statistically significant. However, the coefficient is positive and has a magnitude close to one, implying an elasticity of approximately one—that is, a 1% increase in GDP per capita in non-EU countries is associated with a roughly 1% increase in enrolment. That said, the lack of statistical significance means we cannot rule out that the true effect is zero. Overall, the findings provided in this report suggest that GDP per capita is not a key driver of demand for HE in England.

[67] This is not very different from the panel data models or EU models, where the lagged dependent variable is statistically significant but small in magnitude, suggesting that most of the effects materialise at time $t$.

### Model fit and diagnostics

All four models exhibit a high degree of fit, with R-squared values above 0.50, and pass all diagnostic tests. The Breusch-Pagan test, Breusch-Godfrey test, and Cameron-Trivedi IM test indicate no heteroskedasticity, serial correlation, or misspecification in the OLS model. The first-stage F-statistic exceeds the conventional threshold of 10 in both the undergraduate and postgraduate IV models, whereas the Sargan test fails to reject the null hypothesis that the instruments are exogenous. Interestingly, as in the case of the EU IV model, the Wu-Hausman test fails to reject the null hypothesis that price is exogenous in both the undergraduate and postgraduate non-EU models, indicating that the risk of endogeneity is low.

## 5.2.3 Price elasticity by ranking tier - Full-time non-EU students

Table 8 presents the price elasticity of demand for non-EU students by HEP ranking tier. Similar to the case of EU student demand, there is a strong indication that lower-ranking HEPs experience higher price elasticity of demand.

**Table 8: Full-time non-EU students: price elasticity of demand by tier**

| | Tier 1 | Tier 2 | Tier 3 | Tier 4 |
|---|---|---|---|---|
| **Undergraduate** | −0.10 | −0.35* | −0.36 | −1.03*** |
| **Postgraduate taught** | −0.02 | −0.39*** | −0.65* | −2.13*** |

**Note:** Tier 1 represents the highest-ranking tier, and Tier 4 the lowest; the reported elasticities reflect long-run elasticities, accounting for the lagged dependent variable; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

For undergraduate programmes, the long-run elasticities are −0.10, −0.35, −0.36, and −1.03 for Tiers 1, 2, 3, and 4, respectively. The Tier 1 and Tier 3 coefficients are not statistically significant at conventional levels, although the Tier 3 result may reflect data limitations. These estimates imply that a 10% price increase would reduce enrolment by around 3.5% in Tier 2 and Tier 3 HEPs, and by 10.3% in Tier 4 HEPs.

For postgraduate programmes, price elasticities again increase with tier. The long-run elasticities are −0.02, −0.39, −0.65, and −2.13 for Tiers 1, 2, 3, and 4, respectively. The Tier 1 coefficient is not statistically significant. A 10% percentage increase in price would thus reduce enrolment by around 3.9% in Tier 2 HEPs, 6.5% in Tier 3 HEPs, and 21.3% in Tier 4 HEPs—over seven times the reduction observed in Tier 2 and three times the reduction observed in Tier 3.

## 5.2 Supply

This section discusses the estimates of the supply equation. As outlined in the methodology section, a relatively simple specification is used, in which supply—across both domestic and international students— is a function of price and costs, and it is estimated using cointegration methods. The price variable is defined as tuition fee income and teaching funding per student FTE, representing the average income per student.

Two sets of estimates are presented using the Dynamic OLS approach (Stock and Watson, 1993) and the Fully Modified OLS approach (Phillips and Hansen, 1990). The sensitivity of the results is also examined by incorporating additional supply-side drivers, including student caps and other sources of income. Finally, while the baseline estimates use all domestic and international students enrolled in English HEPs, reflecting the uncertainty around the extent to which supply to each segment is determined independently, sensitivity checks are also conducted using international students only.

Table 9 reports the baseline supply equation estimates. The price elasticity of supply is 0.81 in the Fully Modified OLS model and is statistically significant. The dynamic OLS model returns a similar estimate, at 0.70, although this is statistically significant only at the 10% level. These estimates suggest that a 10% increase in price is associated with roughly a 7% to 8% increase in the supply of student places. Sensitivity checks provide estimates ranging from 0.41 to 0.99. The cost variable is negative, as expected, although not statistically significant in either model.

**Table 9: Supply equation**

| | Fully Modified OLS | Dynamic OLS |
|---|---|---|
| **Price (log)** | 0.81*** | 0.70* |
| **Average cost per student (log)** | -0.40 | -0.43 |

**Note:** The dependent variable is the natural logarithm of first-year enrolment across students from all countries of origin and both postgraduate and undergraduate programmes. The price variable reflects tuition and non-tuition fee income expressed in British pounds; Both price and cost are expressed in real terms; Dynamic OLS is based on the cointegration regression approach of Stock and Watson (1993), while Fully Modified OLS follows the approach of Phillips and Hansen (1990); Sample size is: 20 (years); ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 10 provides a note of caution. It reports cointegration tests using two alternative methods: the Engle–Granger and Phillips–Ouliaris approaches. We report two versions of each test. In all four cases, the null hypothesis of no cointegration cannot

be rejected, implying that the above estimates cannot be interpreted as valid long-run relationships.

**Table 10: Cointegration tests**

| Test | Value | P-value |
|---|---|---|
| Engle-Granger tau-statistic | -1.75 | 0.83 |
| Engle-Granger z-statistic | -5.91 | 0.82 |
| Phillips-Ouliaris tau-statistic | -1.96 | 0.75 |
| Phillips-Ouliaris z-statistic | -7.16 | 0.73 |

**Note:** The null hypothesis is the underlying series are cointegrated; p-values greater than 0.05 reject the null hypothesis at 5% level; cointegration is tested between enrolment, price and average costs per student; enrolment is the natural logarithm of first-year enrolment across students from all countries of origin and both postgraduate and undergraduate programmes; the price variable reflects tuition and non-tuition fee income expressed in British pounds; both price and cost are expressed in real terms.

The relative difficulty of obtaining a robust estimate of the supply equation may be explained by limitations in the data and in the cointegration tests. Cointegration tests are well known to have low power—they often fail to detect cointegration even when it exists. This issue is particularly pertinent in small samples (such as the one used in this study). Therefore, the results should not be dismissed, and to anchor policy simulations to reasonable assumptions, we will use a range of supply elasticities similar to those reported in Table 9. However, the precise magnitude of the supply elasticity is subject to more uncertainty than the demand elasticities that are at the centre of most of this report.

# Appendix

## A.1 Unit root tests

The tables below show the results of the Augmented Dickey-Fuller (ADF) tests for both the levels and first differences of the three key series. The tests were conducted separately for EU and non-EU full-time undergraduate and postgraduate taught programmes. The results indicate that the null hypothesis of a unit root cannot be rejected for the levels but is rejected for the first differences, suggesting that these series are integrated of order one (I(1)).[68] The ADF tests were performed with one lagged difference, although the results are generally consistent across different lag specifications.

**Table 11: Unit root tests: levels**

| | EU Undergraduate | EU Postgraduate taught | Non-EU Undergraduate | Non-EU Postgraduate taught |
|---|---|---|---|---|
| **Enrolment** | −1.63 | −0.93 | −0.17 | −0.38 |
| **Price** | −0.67 | −0.67 | −2.23 | −2.77* |
| **GDP per capita** | −0.30 | −0.30 | −1.58 | −1.58 |

**Note:** The table reports the Dickey–Fuller Z-statistic from the ADF regression with one lagged difference; ***, **, and * denote rejection of the unit root hypothesis at the 1%, 5%, and 10% significance levels, respectively. Source: Alma Economics analysis.

[68] The only exception is the price series for non-EU postgraduate taught, which marginally rejects the null of unit root at 5% significance level. However, this result is not robust to alternative lag specifications: re-estimating the ADF test with lag lengths of 0, 2, 3, and 4 fails to reject the null hypothesis of unit root.

**Table 12: Unit root tests: first difference**

| | EU Undergraduate | EU Postgraduate taught | Non-EU Undergraduate | Non-EU Postgraduate taught |
|---|---|---|---|---|
| **Enrolment** | −3.05** | −3.23*** | −3.20** | −2.61* |
| **Price** | −3.84*** | −3.48*** | −3.67*** | −4.13*** |
| **GDP per capita** | −3.53*** | −3.53*** | −4.12*** | −4.12*** |

**Note:** The table reports the Dickey–Fuller Z-statistic from the ADF regression with one lagged difference; ***, **, and * denote rejection of the unit root hypothesis at the 1%, 5%, and 10% significance levels, respectively. Source: Alma Economics analysis.

## A.2 Detailed adjustments to tuition fee income series

This section details the adjustments made to the tuition fee income series. First, we removed any obvious outliers and excluded any individual HEP data points where the tuition fee income data was missing.[69] The table below summarises adjustments made.

**Table 13: Limitations on the tuition fee income data and adjustments**

| Period affected | Data limitation | Adjustment |
|---|---|---|
| 2002 – 2023 | **All course group:** Tuition fee income from first-year and continuing students is not reported separately. As a result, fee changes are only gradually reflected in the income data, since continuing students remain on their original fee levels. This is a major limitation when there are large tuition fee changes like those | To capture the tuition fee increases in 2006/07 and 2012/13 for EU students, it is assumed that fees for undergraduate courses in 2006/07 and 2007/08 equal those in 2008/09, and that fees in 2012/13 and 2013/14 equal those in 2014/15. |

[69] This includes the outlier in 2020/21 for non-EU postgraduate taught students, where an abnormally low levels of tuition fee income was recorded due to COVID. We adjust by interpolating between 2019/20 and 2021/22. Other excluded outliers were individual HEP-level observations that were clearly invalid, such as tuition fee income values recorded as negative.

| | | |
|---|---|---|
| | occurred in 2006/07 and 2012/13 academic years. | |
| 2002 – 2015 | **Non-EU** undergraduate and non-EU postgraduate: Tuition fee income from non-EU students is reported without a breakdown by level and mode of study. | The steps below were followed to generate fees by level and model of study:<br><br>Use the Reddin Tuition Fee Survey (2006/07–2021/22) to estimate England-wide average undergraduate and postgraduate tuition fees by year.<br><br>Compute the postgraduate-to-undergraduate tuition fee ratio by year using the Reddin estimates.<br><br>Using detailed breakdown data from HESA available for 2016/17–2018/19, compute the median tuition fee ratios across mode and level of study within undergraduate and postgraduate programmes for non-EU students.<br><br>Apply the Reddin-based ratio from Step 2 to split total non-EU tuition fee income into undergraduate and postgraduate components, then apply the median ratios from Step 3 to further disaggregate by mode and detailed level of study.<br><br>Effectively, it is assumed that the relative tuition fee structure across levels and modes of study for non-EU students remained stable over the earlier period. |

| | | |
|---|---|---|
| 2022 – 2023 | **All course group:** Following the EU exit, EU students face international tuition fees. From 2022/23 onward, tuition fee income for EU and non-EU students is reported jointly under a "non-UK" domicile group. Pooling continuing EU students (who retain home-fee status) with international-fee students would understate the estimated tuition fee. | We estimate a linear trend in non-EU tuition fees using historical data up to 2019/20 and project this trend forward to 2022/23 and 2023/24. The projected tuition fees are subsequently applied to EU students. |
| 2002–2015 | **EU undergraduate** and **EU postgraduate:** Tuition fee income for EU undergraduate and postgraduate students from 2002/03 to 2015/16 is reported together with UK undergraduate income. | This is not an issue for undergraduate fees, as UK and EU students face the same tuition rates. This means that the tuition fee estimates can be obtained by dividing the tuition fee income from EU and UK students by the total enrolment of EU and UK students.<br><br>For postgraduate students, we infer the split using more recent data in which tuition fee income is reported separately for UK and EU students, following a procedure similar to that described above for non-EU students. Specifically, we apply the UK–EU tuition fee ratio observed in later years to estimate the tuition fee income in the earlier years. |
| 2002–2007 | **EU postgraduate:** tuition fee income is not available separately for taught and research programmes. | The steps below were followed:<br><br>Estimate the total postgraduate tuition fee for 2002–2007.<br><br>Using detailed breakdown data from HESA available for 2008/09–2010/11, calculate the median tuition fee ratio across EU post-graduate taught and research programmes. |

| | | |
|---|---|---|
| | | Apply the ratio from Step 2 to the total post-graduate tuition fee income from Step 1 to disaggregate the tuition fees for research and taught programmes.<br><br>Effectively, this procedure implicitly relies on the assumption that the ratio of postgraduate taught-to-research tuition fee income in 2002/03–2007/08 is comparable to that in 2008/09–2010/11.<br><br>The postgraduate taught/research ratio for 2002-2007 is assumed to be 5:1 for EU; 10:1 for non-EU, taking the 2008-2010 average value. This ratio is fairly stable between 2008-2018, so it should provide a good proxy. |

## A.3 Policy variables

A number of indicator variables were generated to capture policy and other market changes. For EU students, the primary focus is to capture policy reforms and the EU exit. For non-EU students, the primary focus is to capture changes in the work visa policies.

**EU student policies captured by indicator variables**

- **2012 Tuition Fee Reform:** Raised the undergraduate home student fee cap to £9,000. Also, the terms of the student loan changed.
- **Brexit Referendum:** The UK voted to leave the EU in 2016.[70]
- **Postgraduate student loan eligibility:** Postgraduate master's student loans were introduced in 2016/17. This is relevant because EU postgraduate students were eligible for these loans from 2016/17 until the UK's exit from the EU in 2021.
- **EU exit:** With the EU exit in 2021, EU students faced higher tuition fees, lost access to UK student loans, and no longer had the automatic right to work and

[70] Since the referendum took place in June 2016 which was only a few months away from the start of the 2016/17 academic year, we assume the impact of the referendum started in the 2017/18 academic year.

study in the UK without a visa.

**Non-EU student policies captured by indicator variables**

- **2004 Science and Engineering Graduates Scheme (SEGS):** Non-EU STEM graduates were allowed to stay and work for 12 months after graduation.
- **2007 International Graduate Scheme (IGS)**: In 2007, the SEGS was replaced by the IGS, where graduates who have completed a recognised UK degree, Master's degree, PhD, or postgraduate certificate or diploma in any subject on or after 1 May 2007 are eligible to work in the UK for up to 12 months.
- **2008 Post-Study Work visa**: In 2008, the IGS was replaced by the Tier 1 visa, allowing most international graduates to work in the UK for up to two years without sponsorship.
- **2012 closure of Post-study Work visa**: The Post-Study Work visa was cancelled, and international graduates were no longer permitted to remain and work in the UK without a sponsored Tier 2 work visa. This policy was used alongside others to construct the visa policy variable—see below.
- **2018 expansion of Tier 4 "low-risk" status to China**: From 2018, Chinese nationals applying for a Tier 4 (student) visa were included under the UK's "differentiation arrangements" (also informally known as "low-risk" status), meaning they were no longer routinely required to provide evidence of maintenance funds, academic qualifications, or English language ability.
- **2019 announcement of Graduate route**: On 11 September 2019, the UK government announced plans to reintroduce a two- to three-year post-study work visa for international students, under a new Graduate route.
- **2021 introduction of Graduate route**: The Graduate route was launched in 2021, allowing most graduates to work in the UK for up to two years after completing their studies, and three years for PhD graduates.

To effectively capture the combined impact of changes in these work visa policies over time, a composite work visa policy index was constructed. This index is primarily based on the number of years[71] graduates are permitted to remain in the country and work before securing an alternative route to stay (e.g., obtaining a Tier 2 work visa). The index offers a more parsimonious way to account for changes in visa policies by consolidating the information into a single measure, rather than including four or five separate variables in the model. Changes in student visa fees and the immigration

[71] To account for the 2004–2007 policy, which applied only to STEM graduates, we scaled the number of eligible post-study work years by the share of STEM subjects in total enrolment.

health surcharge are reflected in the price variable, as discussed in the Methodology section.

## A.4 Additional descriptive analysis

This section presents a descriptive analysis of the control variables, including university ranking, relative living costs, and the average real tuition fee in key competitor countries.

### A.4.1 University ranking

Figure 14 shows the ratio of English universities to EU universities ranked in the Top 100 of the QS World University Rankings. The figure also presents this ratio for the Top 200 rankings. The data are expressed as an index with 2004 being the base year.

**Figure 14: Ratio of English to EU universities in Top 100 and Top 200 (3-year moving average)**

Source: QS World University Rankings and Alma Economics calculations.

We use a three-year moving average because the actual series is quite noisy. This approach is motivated by the fact that large fluctuations are more likely to reflect measurement issues than genuine changes in reputation. The Top 200 index exhibits very limited variation over time. Although the Top 100 index shows greater movement and an upward trend, short-run variation may still be due to the small number of universities ranked in the Top 100 and thus may reflect measurement challenges rather than genuine changes in the reputation of English universities.

Figure 15 shows the evolution of the English-to-non-EU ratio among universities ranked in the Top 100 and Top 200 of the QS World University Rankings, exhibiting a pattern similar to that observed for the English–EU ratio.

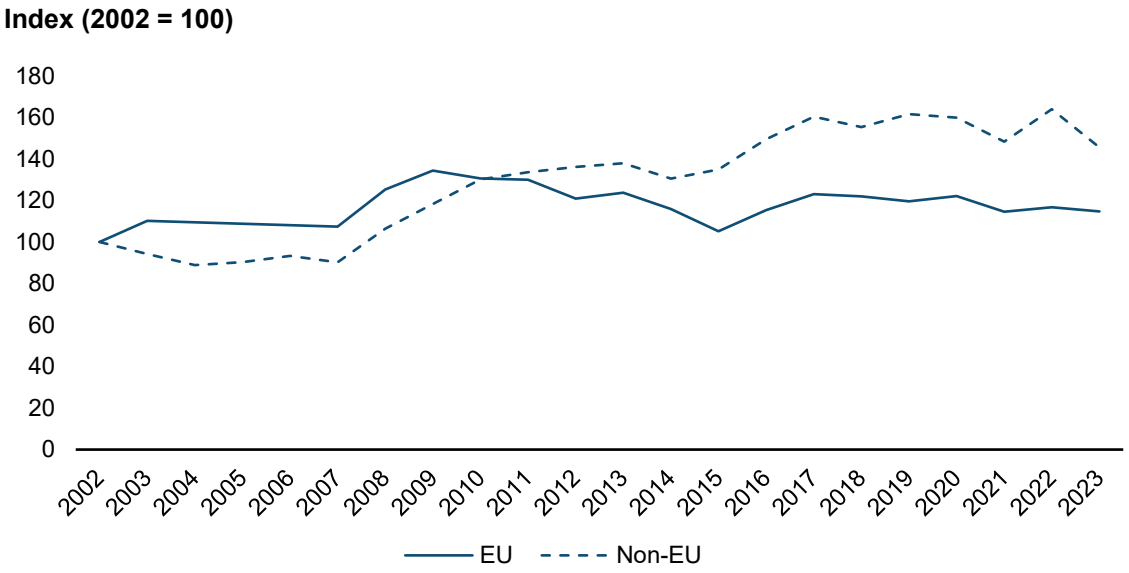
**Figure 15: Ratio of English to non-EU universities in Top 100 and Top 200 (3-year moving average)**

Source: QS World University Rankings and Alma Economics calculations.

## A.4.2 Relative living costs

Figure 16 presents the evolution of the EU-to-UK and non-EU-to-UK purchasing power parity (PPP) ratios, indexed to 2002. According to the World Bank, these ratios can be used to approximate relative living costs across countries. The non-EU-to-UK PPP ratio exhibits a sustained upward trend from the late 2000s onwards, which may reflect stronger income growth relative to the UK in several major developed and developing countries. The EU-to-UK cost-of-living ratio also increased over the sample period, but it displays significant short-run variability.

**Figure 16: Purchasing power parity index of EU and non-EU countries relative to the UK**

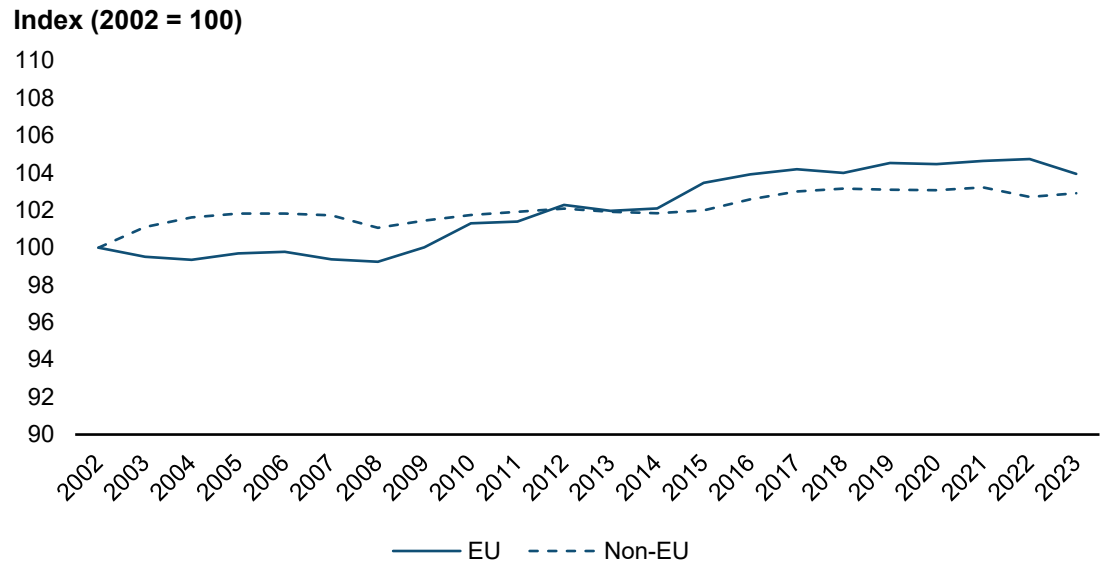



Source: World Bank and Alma Economics calculations.

## A.4.3 Average tuition fee in key competitor countries

The figure below presents the evolution of the price index for real average tuition fees in key competitor countries over the period 2002–2023, expressed in local currency (EU or non-EU). The competitor countries included are Australia, Canada, and the United States. For both EU and non-EU students, tuition fees exhibit very little variation over time. Consequently, it is unlikely that these variables drove material changes in demand or that the models would be able to quantify their impact.

**Figure 17: Real average tuition fee in local currency**



## A.5 Sensitivity Checks: Additional control variables

### A.5.1 Full-time EU students

Table 14 reports the price elasticity estimates with additional control variables for full-time EU students. In each alternative model, only one additional control variable was added to prevent over-saturating the model and inflating standard errors through multicollinearity.

**Table 14: Full-time EU students: price elasticity of demand across alternative model specifications**

| Undergraduate | Baseline (preferred) model | Competitor Fees | Top 100 | Top 200 | Living Cost |
|---|---|---|---|---|---|
| 2012 reform | −0.37*** | − 0.36* | −0.39* | −0.40** | −0.42** |
| EU exit (2021) | −1.47*** | −1.45*** | −1.47*** | −1.48*** | −1.49*** |
| **Postgraduate taught** | **Baseline (preferred) model** | **Competitor Fees** | **Top 100** | **Top 200** | **Living Cost** |
| Baseline Price | −0.45*** | −0.45** | −0.47*** | −0.47*** | −0.46* |
| Brexit (2021) | −1.18*** | −1.25*** | −1.25*** | −1.30*** | −1.25*** |

**Note:** Each column reports the long-term price elasticities obtained from estimating the baseline panel OLS model with the addition of one control variable. The Competitor Fees model includes the natural logarithm of the weighted average price of tuition fees in real local currency for international students in Australia, Canada, and the US. The Top 100 model includes the ratio of the number of English to EU universities in the Top 100 in the QS World University Ranking. The Top 200 model includes the same ratio but with Top 200 in the ranking instead. The Living Cost model includes the PPP variable; Price elasticity: 2012 reform – price elasticity of demand associated with the 2012 reform; Price elasticity: EU exit (2021) – price elasticity of demand associated with EU exit price change; no RAB adjustment has been applied; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

All figures reported in Table 14 are the respective long-term price elasticities. These elasticities appear considerably stable across model specifications.

## A.5.1 Full-time non-EU students

Table 15 reports the price elasticity estimates with additional control variables for full-time non-EU students. Similar to above, in each alternative model, only one additional control variable was added to prevent over-saturating the model.

**Table 15: Full-time non-EU students: price elasticity of demand across alternative model specifications**

| | Baseline (preferred) model | Competitor Fees | Top 100 | Top 200 | Living Cost |
|---|---|---|---|---|---|
| **Undergraduate** | −0.32*** | −0.41*** | −0.31* | −0.29* | −0.55** |
| **Postgraduate taught** | −0.42** | −0.36* | −0.44** | −0.41* | −0.64 |

**Note:** Each column reports the long-term price elasticities obtained from estimating the baseline panel OLS model with the addition of one control variable. The Competitor Fees model includes the natural logarithm of the weighted average price of tuition fees in real local currency for international students for each respective course in Australia, Canada, and the US. The Top 100 model includes the ratio of the number of English to non-EU universities in the Top 100 in the QS World University Ranking. The Top 200 model includes the same ratio but with Top 200 in the ranking instead. The Living Cost model includes the PPP variable. The reported elasticities reflect long-run elasticities, accounting for the lagged dependent variable; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

All figures reported in Table 15 are the respective long-term price elasticities. In the baseline panel-data analysis in Section 5.2.1, the price elasticity estimates are −0.32 and −0.42 for undergraduate and postgraduate taught programmes, respectively. Similar to the EU results in Table 14, the non-EU estimates remain negative and broadly similar in magnitude across specifications, suggesting that the baseline findings are robust to the inclusion of additional controls. While some variation is present, the main conclusions are unchanged. The largest deviation occurs for postgraduate taught programmes in the Living Cost specification.

## A.6 Sensitivity Checks: TRAC Peer Group-based Analysis

This section presents price elasticity estimates by TRAC group. In the TRAC taxonomy, the groupings are defined as follows.

- **Group A:** Institutions with a medical school and research income equal to at least 20% of total income.
- **Group B:** All other institutions with research income of at least 15%.
- **Group C:** Institutions with research income between 5% and 15%.
- **Group D:** Institutions with research income below 5% and total income above £150 million.
- **Group E:** Institutions with research income below 5% and total income of £150 million or less.
- **Group F:** Specialist music and arts teaching institutions.

For the purposes of this analysis, however, the University of Cambridge, the University of Oxford and Imperial College London are excluded from the standard grouping and reported separately as the “Top 3”. HEPs with missing tuition fee income data are excluded from the analysis.[72]

The tables below present estimates of the price elasticity of demand by HEP TRAC peer groupings for EU and non-EU students, respectively. There is considerable variation in elasticities across groups, and several coefficients are not statistically significant. This could be explained by the small sample size—there are six TRAC groups, which inevitably reduces the number of HEPs and students within each group—and potentially by the fact that the HEPs within each group are not fully comparable, at least in terms of reputation, unlike the CUG groups. As such, these results should be interpreted with caution.

[72] Where tuition fee income is unavailable for a given HEP in a particular year, that HEP-year observation is excluded from the analysis, while the HEP is retained for all other years in which valid data exist. This ensures that the tier-level tuition fee measure is calculated correctly: for each tier, course group, and year, tuition fee income is aggregated only across HEPs with complete data and divided by the corresponding student numbers.

**Table 16: Full-time EU students: price elasticity of demand by TRAC peer groups**

| | Top 3 | Group A | Group B | Group C | Group D | Group E | Group F |
|---|---|---|---|---|---|---|---|
| **Undergraduate** | | | | | | | |
| 2012 reform | −0.17* | −0.34* | −0.27*** | −0.57*** | −0.53** | −0.67*** | −0.24* |
| EU exit (2021) | −0.74*** | −1.49*** | −1.15*** | −2.41*** | −2.89*** | −4.47*** | −1.21*** |
| **Postgraduate taught** | | | | | | | |
| Baseline | 0.07 | −0.50*** | −0.27 | −0.76* | −0.74*** | −0.25 | −0.37** |
| EU exit (2021) | −0.57*** | −1.02*** | −1.27*** | −1.28*** | −2.51*** | −3.18*** | −1.14*** |

**Note:** The reported elasticities reflect long-run values, accounting for the lagged dependent variable and are estimated using time-series approach; Price elasticity: 2012 reform – price elasticity of demand associated with the 2012 reform; Price elasticity: EU exit (2021) – price elasticity of demand associated with EU exit; no RAB adjustment has been applied; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

**Table 17: Full-time non-EU students: price elasticity of demand by TRAC peer groups**

| | Top 3 | Group A | Group B | Group C | Group D | Group E | Group F |
|---|---|---|---|---|---|---|---|
| **Undergraduate** | −0.10 | −0.67** | −0.61** | −1.00** | −0.71 | −0.76* | −0.23 |
| **Postgraduate taught** | −0.02 | −0.75*** | −0.57* | −0.44 | −0.46 | −0.64 | −0.28 |

**Note:** The reported elasticities reflect long-run elasticities, accounting for the lagged dependent variable and are estimated using a time-series approach; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

## A.7 Higher Education providers within scope

The following lists show the HEPs included in the CUG tier-based analysis. Tier 1 includes three providers: Imperial College London, University of Cambridge, and University of Oxford.

**Lists of HEPs included in the CUG tier-based analysis**

### Tier 2

- University of Bath
- University of Birmingham
- University of Bristol
- University of Durham
- University of East Anglia
- University of Exeter
- King's College London
- University of Lancaster
- University of Leeds
- London School of Economics and Political Science
- Loughborough University
- University of Manchester
- University of Nottingham
- University of Southampton
- University College London
- University of Warwick
- University of York

## Tier 3

- Aston University
- Arts University Bournemouth
- Brunel University of London
- City St George's University of London
- Coventry University
- Edge Hill University
- University of Essex
- Goldsmiths College
- Harper Adams University
- University of Huddersfield
- Keele University
- University of Kent
- University of Leicester
- University of Lincoln
- University of Liverpool
- University of the Arts London
- Manchester Metropolitan University
- Newcastle University
- Northumbria University
- Nottingham Trent University
- Oxford Brookes University
- Queen Mary University of London
- University of Reading
- Royal Holloway University of London
- SOAS University of London
- University of Sheffield
- University of Surrey
- University of Sussex
- University of the West of England

## Tier 4

- Anglia Ruskin University
- Bath Spa University
- University of Bedfordshire
- Birmingham City University
- University College Birmingham
- Birmingham Newman University
- Lincoln Bishop University
- University of Greater Manchester
- Bournemouth University
- University of Bradford
- University of Brighton
- Buckinghamshire New University
- Canterbury Christ Church University
- University of Lancashire
- University of Chester
- University of Chichester
- University for the Creative Arts
- University of Cumbria
- De Montfort University
- University of Derby
- University of East London
- Falmouth University
- University of Gloucestershire
- University of Greenwich
- University of Hertfordshire
- University of Hull
- Kingston University
- Leeds Beckett University

- Leeds Trinity University
- Liverpool Hope University
- Liverpool John Moores University
- London Metropolitan University
- London South Bank University
- Middlesex University
- University of Northampton
- Norwich University of the Arts
- University of Plymouth
- University of Portsmouth
- Ravensbourne University London
- Roehampton University
- Royal Agricultural University
- St Mary's University, Twickenham
- University of Salford
- Sheffield Hallam University
- Solent University
- University of Staffordshire
- Plymouth Marjon University
- University of Suffolk
- University of Sunderland
- Teesside University
- University of West London
- University of Westminster
- University of Winchester
- University of Wolverhampton
- University of Worcester
- York St John University

The following list shows the English HEPs included in the analysis but excluded from the tier-based analysis. These are mainly smaller, more specialist HE providers without university status.

**List of English HEPs excluded from the CUG tier-based analysis**

| HEP excluded from CUG tier-based analysis |
| --- |
| • ACM Guildford Limited |
| • AECC University College |
| • Amity Global Education |
| • Arden University |
| • BIMM University |
| • British Academy of Jewellery Limited |
| • Birkbeck University of London |
| • Bloomsbury Institute |
| • Institute of Cancer Research |
| • Cambridge Arts and Sciences Limited |
| • Courtauld Institute of Art |
| • Cranfield University |
| • Central School of Ballet |
| • Cliff College |
| • Central Film School London |
| • Court Theatre Training Company |
| • College of Health |
| • Escape Studios |
| • National Film and Television School |
| • Queen's Foundation for Ecumenical Theological Education |
| • Futureworks |
| • University College of Estate Management |
| • Guildhall School of Music and Drama |
| • Institute of Contemporary Music Performance |

- Hartpury University
- Leeds Arts University
- Institute of Art London Limited
- INTO University Partnerships Limited
- Liverpool Institute for Performing Arts
- Kaplan International Colleges UK Limited
- Kaplan Open Learning (Essex)
- London Business School
- Leeds Conservatoire
- LAMDA Limited
- London School of Management Education
- London School of Theology
- College of Legal Practice Limited
- Academy of Live Technology
- St Mellitus College
- LIBF Limited
- Moorlands College
- Nazarene Theological College
- Luther King House Educational Trust
- London Film School Limited
- Missio Dei
- Metanoia Institute
- Open University
- Arts University Plymouth
- The London Interdisciplinary School
- Northeastern University London
- Regent College London
- Rose Bruford College of Theatre and Performance
- Royal Academy of Music

- Royal College of Art
- Royal College of Music
- Point Blank Music School
- Royal Central School of Speech and Drama
- National Centre for Circus Arts
- Royal Northern College of Music
- The Royal Veterinary College
- Northern School of Contemporary Dance
- London Contemporary Dance School
- Royal Academy of Dramatic Art
- Rambert School
- Trinity Laban Conservatoire of Music and Dance
- University of Law
- Waverley Abbey College
- SP Jain London School of Management Limited
- Engineering and Design Institute London
- University Centre Peterborough
- Think Space Education Limited

## A.8 Resource Accounting and Budgeting charge adjustment

This section outlines the methodology used to adjust the 2012 price elasticity obtained from the EU undergraduate models.

The nature of the student loan system means that a considerable number of loans are never fully repaid. In particular, the loans are income-contingent, meaning that repayments only begin once graduates' income exceeds a specified threshold. Any remaining balance is eventually written off after a fixed period—25 or 30 years (before 2023)—resulting in a proportion of the total student lending that is not recovered. This implies that the actual cost incurred by students may be lower than the stated tuition fee. To account for this, an adjustment is applied to the 2012 elasticity using the Resource Accounting and Budgeting (RAB) charge.

The RAB charge captures the share of student loans that is not expected to be repaid. For full-time Plan 2 loans relevant to the sample period within scope, the RAB charge ranges from 45% to 53%[73], meaning that, on average, around half of undergraduate student loans will not be repaid.[74] Assuming that students have a reasonable estimate of the portion of the loan they will not repay, the effective cost of HE is therefore approximately 50% lower than the listed tuition fee for those who take a student loan. Combining a RAB charge with the average loan uptake among undergraduate EU students, which is between 65% and 73%, implies that, on average, EU students faced an effective price that is around 35% lower than the listed tuition fee.

In other words, when a government student loan system is in place, part of the tuition fee is effectively subsidised through non-repayment and therefore does not represent the full economic cost to students—the sticker price exceeds the expected cost to students by 35% based on the above analysis.

The table below sets out the long-run price elasticities obtained from the time-series and panel data analysis (Unadjusted) alongside the RAB adjusted elasticities.

**Table 18: 2012 price elasticity with and without RAB adjustment**

| | Unadjusted | RAB adjusted |
|---|---|---|
| **Time-series estimates** | −0.48 | −0.74 |
| **Panel estimates** | −0.37 | −0.57 |

[73] These estimates cover both UK and EU student loans, as separate data for EU students are not available.
[74] The RAB charge is calculated by projecting repayments for income-contingent loans and discounting them back to the period in which the loan is issued

The adjusted figures are calculated by assuming that prices do not increase by, for example, 10%, but by 10% × (1 − 35%) = 6.5%. The resulting elasticity is −4.8% ÷ 6.5% = −0.74 and −4.0% ÷ 6.5% = −0.62.

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