

DISCUSSION PAPER SERIES

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ABSTRACT

International Student Migration: Did Brexit Close the Door to EU Students?*

This paper examines the effect of the Brexit process on international student migration from the European Union (EU) to the United Kingdom (UK). Using administrative data on higher education students in the UK, we employ a dynamic and a synthetic difference-in-differences estimator to compare EU to non-EU students. We show that the Brexit referendum itself and the introduction of visa requirements did not affect EU student migration. However, the introduction of higher tuition fees led to a large reduction in EU student applications to UK universities and colleges, and, subsequently, a decline in place offers, student acceptances, and enrolments. The effect ranges from 48% to 64%. Our findings suggest that increased tuition fees acted as a deterrent for EU students wanting to study in the UK.

JEL Classification: J61, C21, O15, I28

Keywords: Brexit, European Union, international student mobility, synthetic difference-in-differences, United Kingdom, higher education

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1 Introduction

On June 23, 2016, the United Kingdom (UK) population voted to leave the European Union (EU). The result came as a shock and set off a long period of uncertainty. Brexit represented an unprecedented change in the relationship between the EU and the UK. Both the referendum and the subsequent exit have had substantial economic, political, and social implications on both sides of the Channel (Ahmad et al., 2023; Born et al., 2019; Breinlich et al., 2020; Carr et al., 2020; Geiger & Güntner, 2023; Oberhofer & Pfaffermayr, 2021). One of the main concerns after the referendum was how Brexit would affect international migration between the EU and the UK. The UK lost its appeal as a destination country for EU migrants, while some natives and migrants previously settled in the UK left the country (Auer & Tetlow, 2023; Clifton-Sprigg et al., 2023; Di Iasio & Wahba, 2023; Portes, 2021, 2022).

Besides affecting the long-term migration plans of Europeans, Brexit also disrupted international student mobility. New legal and financial requirements were phased in to equalise the terms of access to UK higher education for EU applicants with those of non-EU applicants. Immediately after the referendum (Phase 1), the future of the right of free movement and residency, which made the UK a major destination for EU students wishing to study abroad, was unclear. However, no practical changes took place. As of the academic year 2020/21 (Phase 2), EU students were subject to additional administrative requirements since they needed to obtain (pre-)settled status or a student visa. As a final step (Phase 3), in the autumn of 2021, tuition fees were drastically increased (as EU students moved from home to overseas tuition status), and newly enrolling students lost access to the UK loan scheme (see Section 2). As a result, the UK became a much less attractive destination for EU students. Understanding how Brexit impacted student mobility is crucial. As the second-largest host of international students worldwide (Migration Advisory Committee, 2018), the

UK has long relied on the various positive economic benefits they bring.¹ However, Brexit restricted the UK's ability to recruit international students and enjoy the associated benefits.

To this end, we examine how the UK's unexpected decision to leave the EU and the subsequent institutional changes faced by prospective EU students affected the inflow of EU students into the UK. We consider how the various phases of Brexit – immediately post-referendum (Phase 1), Brexit itself (Phase 2), and the tuition fee increase (Phase 3) – impacted EU student applications to UK higher education institutions (HEIs) and the consequent place offers, acceptances and enrolments. We use data from the Universities and Colleges Admissions Service (UCAS) (academic years 2006/07 to 2022/23) and the Higher Education Statistics Agency (HESA) (academic years 2009/10 to 2022/23). In a dynamic and synthetic difference-in-differences (DD) setting, we compare an array of outcomes for EU students (treated units) and non-EU students from high and upper-middle-income countries (control units) in the UK. We find no impact on EU students' mobility to the UK after the referendum or in the first year after Brexit. Only when EU students become subject to higher tuition fees, in 2021/22 and 2022/23, we find that student applications drop sharply (–56%), resulting in a decline in offers (–56%) and acceptances (–64%). The ultimate impact on student enrolments is –48%. Offer rates from HEIs increase slightly and students' acceptance rates decrease. The heterogeneity analysis shows a larger impact on Northern or Central and Eastern European students. We do not find strong differences in other demographic student characteristics or administrative HEI characteristics, such as students' sex, age, or university classification. The impact is larger for students originating from countries with weaker economies and labour markets.

Furthermore, we consider the special case of Croatia, a new EU member starting in 2013. Croatia offers an additional policy discontinuity in terms of student mobility, as we also observe the introduction of free movement and home tuition fees for Croatian students in the UK. We

¹ Previous research highlights that the strong recruitment of international students in the UK resulted in various positive economic benefits, including creative spillovers and innovation, as well as cross-subsidising the education of domestic students (Migration Advisory Committee, 2018) and generating important revenues for local economies and public universities (Vickers and Bekhradni, 2007; Bound et al. 2020).

demonstrate that the introduction of these preferential policies had effects that were opposite but symmetrical to those observed upon their removal, following Brexit. The results are robust to placebo tests, alternative sample specifications, and alternative control group compositions. We ensure that our results are not driven by violations of the parallel trends assumption, using Rambachan and Roth's (2023) approach, or by violations of the SUTVA assumption, using alternative counterfactual scenarios. We also perform several checks on the confounding effect of Covid-19, by showing that our results hold when excluding students from countries with strong mobility restrictions (imposed by their own government or by the UK) or many Covid-19 cases.

Our findings suggest that the uncertainty related to the status of EU students in the UK and the introduction of EU visa requirements were not considerable enough barriers. Potential students remained motivated to study in the UK up until tuition fees were increased, illustrating that finances are a primary determinant in students' decision to study abroad. To further illustrate the economic impact of Brexit, we estimate the potential monetary losses associated with the decrease in EU students. We show that the significant loss of tuition fees due to the reduced student inflow can be outweighed by the increased tuition fee for remaining EU students. However, when accounting for students' spending on accommodation and general day-to-day expenditures, we find a large financial loss due to Brexit.

Our study contributes to the growing literature on the implications of Brexit for international student migration. The closest work to ours is that by Amuedo-Dorantes and Romiti (2024), which analyses how the referendum (Phase 1) changed students' willingness to study in the UK. Using UCAS data from 2013 to 2019 and a DD estimator, they find a 7% reduction in the growth rate of EU applications compared with those from non-EU countries, resulting in a decline in the growth of student enrolments. This result differs from our findings, which can be explained by methodological differences in our approaches. Amuedo-Dorantes and Romiti (2024) have more detailed data on the studied subjects and chosen institutions by applicants, while we use more comparable origin countries and a synthetic DD. The impact is larger for students applying for STEM subjects and, similar

to us, they find larger responses among students originating from countries with weaker economies and employment prospects. The authors do not examine whether the changing growth rate translates into changing levels of EU students in the UK. They also do not examine the actual Brexit and its associated introduction of visa requirements (Phase 2) and increased tuition fees (Phase 3). Falkingham et al. (2021) examine the effect of triggering Article 50 (the official start of Brexit negotiations) on international students' return intentions. Using the Survey of Graduating International Students, they distinguish between graduate and postgraduate final-year students from EU and non-EU countries. Using a DD approach, they find that EU students are more likely to plan on leaving the UK after graduation than non-EU students. However, the decision of students who had already decided to stay did not change. Di Iasio and Wahba (2023) use a similar strategy to estimate the referendum's effect on overall migration flows between the UK and the EU, using the Long-Term International Migration estimates and Labour Force Survey. They find a large impact on work-motivated migration flows. When focussing particularly on movements motivated by study, they find no significant effect on the flow of EU students entering the UK or British students leaving their country. Finally, Davies and Specht (2024) predict the long-term impact of Brexit using a structural gravity model. Using aggregate bilateral data on inbound foreign student stocks from 2003 to 2015, they employ a general equilibrium approach. They model different counterfactual scenarios in which Brexit represents an additional cost for students migrating between the EU and the UK. They do not make the distinction between different potential mechanisms or policy changes. The authors predict a large drop in EU students in the UK (-20 to -40%) and a decline in British students studying abroad.²

In addition, our study relates to the broader literature on the determinants of student mobility (Beine et al., 2014; Kahanec & Králiková, 2011; Rosenzweig, 2008), particularly on the role

² Other survey-based research has also shown how changes in visa requirements or tuition fees impacted students' decisions to study in the UK after Brexit (Acar et al., 2018). There also exists further descriptive discussion on the repercussions of Brexit on student mobility (Mayhew, 2017; Fowler et al., 2018; Mayhew 2022; Corbett and Hantrais, 2023; Dias Lopes, Mateos- Gonzalez, and Wakeling, 2024). Some authors have focused on specific topics, such as the consequences on the Erasmus programme (Cardwell, 2021; Brooks and Waters, 2023).

of policy and institutional factors. Studies on the role of visa regulation and administrative requirements focus mainly on visa restrictions after graduation (i.e., labour market openness) (Kato & Sparber, 2013; Shih, 2015). The literature on the role of credit constraints is richer and relies mainly on tuition and grant reforms (Dwenger et al., 2012; Nielsen et al., 2010; Van der Klaauw, 2002), loan accessibility cut-offs (Solis, 2017), or experimental settings (Burland et al., 2023; Dynarski, 2003). Most studies find that credit constraints play an important role; only a few remain ambiguous on the role of education fees in the decision to study (Beine et al., 2014; Wakeling & Jefferies, 2013). For the UK, most notably, Dearden et al. (2014) find that the re-introduction of maintenance grants for low-income students had a positive effect on attendance rates at HEIs (a 3.95 pp increase in attendance for a £1,000 increase in aid). Considering a tuition fee reform in England, Sá (2019) finds that the fee increase negatively affected applications (price elasticity of -0.11) and attendance rates (a 0.23 pp increase for a £1,000 increase in tuition). These studies, however, only consider domestic students.

Our contribution is fourfold. First, we study the effect of the complete Brexit process (from the referendum (Phase 1) to the changing visa requirements (Phase 2) and increased tuition fees (Phase 3)) on the inflow of EU students into the UK. This allows us to consider separately and in conjunction the role that increased legal requirements and tuition fees played in the decline in post-Brexit international students at UK HEIs. We bridge various strands of literature on student mobility, which typically consider one factor at a time. Second, we provide new insights into the determinants of migrants' study choices. By exploiting the various policy changes throughout the Brexit process, we show that tuition fees are a primary determinant of EU student mobility. To our knowledge, we are the first to show that financial constraints rather than visa restrictions are the main drivers of the Brexit effect. Third, using Croatia's accession to the EU prior to Brexit, we show that the effects of lifting and introducing access restrictions to UK HEIs were relatively symmetric. Fourth, we illustrate the importance of international recruitment by estimating the monetary losses associated with the Brexit-induced reduction in international students.

The paper is structured as follows. Section 2 provides background information on the relevant regulations for international students in the UK and the policy implications of Brexit. Section 3 presents the data and descriptive statistics. Section 4 discusses the empirical strategy, followed by the empirical results in Section 5. Section 6 shows that our results hold throughout a set of robustness checks and in Section 7, we calculate the monetary loss due to the decreased inflow of EU students. Section 8 concludes the paper with a brief discussion.

2 Studying in the UK for EU and non-EU students

2.1 Before the referendum (Phase 0)

Prior to Brexit, students from the EU, European Economic Area (EEA), and Switzerland (hereinafter referred to as EU students) benefited from freedom of movement and were entitled to study at any UK university or college under the same conditions as home students. Non-EU students, on the other hand, were subject to several additional regulations and requirements. This had several consequences.

First, EU and non-EU students were subject to varying tuition fees, as HEIs differentiated between overseas and home tuition fees. At the undergraduate level, home fees have long been capped. While universities can charge below the tuition fee cap, most of them charge the maximum (Hubble & Bolton, 2018). Caps on home fees for full-time undergraduate courses range between £1,820 to £9,250, depending on the UK country. Additionally, home students in Wales can receive grants to cover their costs and home students in Scotland can have their tuition fees paid for by the Student Award Agency Scotland, resulting in free higher education (Hubble & Bolton, 2018; Lewis, 2023a, 2023b, 2024). Overseas fees for non-EU undergraduate students have never been capped and are determined by providers. Fees vary from £11,400 - £38,000, with an estimated average cost of around £22,200 per year (British Council, 2023). At the postgraduate level, there is no cap and fees vary widely. Home fees are on average around £11,000 per year (UCAS, 2023c) while international

tuition fees tend to be higher, with an average estimated around £17,109 per year (British Council, 2023). Further information on UK tuition fees is provided in Appendix A1.1.

Second, as a result of the lower, subsidised tuition fees, HEIs have over time been restricted in the number of home fee (i.e., UK students and pre-Brexit EU students) undergraduate students they could recruit. An admission cap was first introduced in the 1990s in England. Between the academic years 2012/13 and 2014/15, this restriction was relaxed, until the cap was abolished in 2015/16. In the following years, UK universities were free to recruit as many UK and EU-domiciled students as they wanted to. Non-EU students were never under any quota control as they were subject to higher overseas fees (Hillman, 2020). After Brexit, limiting student admissions from both EU and non-EU origin countries became a topic of debate. Admission caps have been proposed with the aim of stabilising student admissions, dampening competition between universities, or bringing down net migration. However, at the time of writing, no cap has been formally introduced. Further information on UK admission caps is provided in Appendix A1.2.

Finally, EU and non-EU students had differing visa regulations before Brexit. EU students were free to study in the UK without any passport or visa requirements, while non-EU students had to apply for a Tier 4 Student or Tier 5 Short-term Study visa (Gower, 2018). To obtain the study visa, students had to provide a 'Confirmation of Acceptance for Studies' from a recognised education institution, hold a valid passport, prove they could support themselves financially, show sufficient knowledge of English, and pay an application fee (UK Home Office, 2023a). Students had restrictions on how long they could stay in the UK, whether they were allowed to bring dependents, and how much they were permitted to work outside of their studies. Over time, these UK policies on non-EU student mobility have only slightly changed. Only minor adaptations to the Tier 4 student visa were introduced, which generally facilitated the applications. In 2020, at the time of Brexit, the various Visa Tiers were replaced by visa routes. These routes would supposedly simplify the visa regime and, although this included reforms in certain areas, nothing much changed regarding student visas. The only main difference is that now both EU and non-EU citizens fell under the visa regulations (UK Home

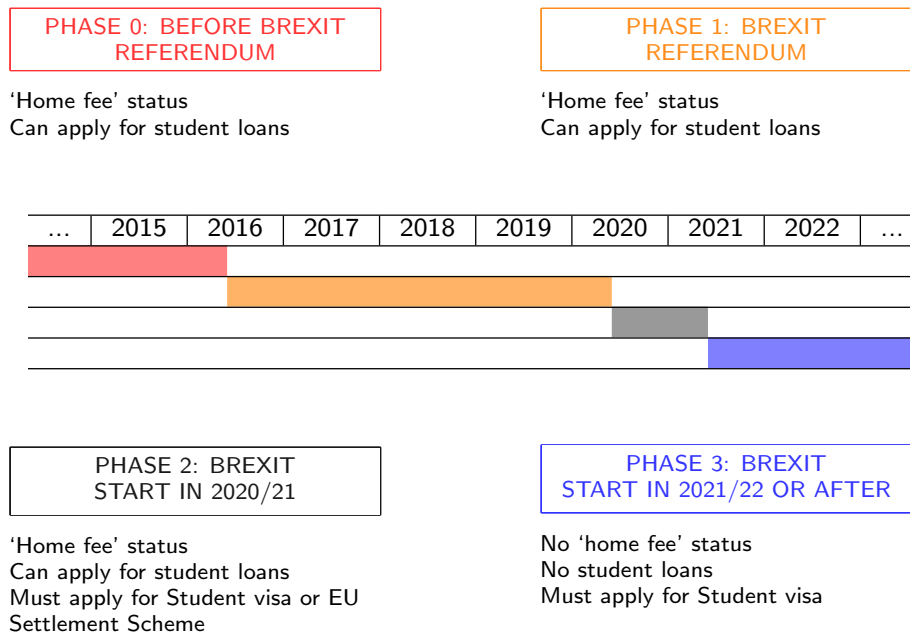
Office, 2023a). Appendix A2 provides a more detailed summary of relevant policy changes for foreign students in the UK.

2.2 Brexit referendum and Brexit process (Phases 1 to 3)

The UK referendum on EU membership, i.e., the Brexit referendum, was held in the UK on June 23, 2016, to determine whether the country should remain an EU member state. The Conservative Party had pledged to hold such a referendum in their 2015 election campaign, and the first plans were made after their victory in the General Election of May 2015. The official campaign period began in February 2016 and highlighted various issues such as sovereignty, immigration, and trade opportunities. The Leave campaign particularly emphasised the need to take control over the UK's borders and limit free movement within the EU (Joppke, 2020). The referendum had a high turnout (72.2%) and ended with an unexpected result; nearly 52% of voters elected to leave the EU. The Leave campaign won by a margin of approximately 1.3 million votes. In March 2017, the UK triggered Article 50. This gave formal notification of the UK's intention to leave the EU and officially initiated the withdrawal process. The long and difficult negotiations began. After postponing the withdrawal deadline several times, a Withdrawal Agreement was finally reached near the end of 2019. The UK officially left the EU on January 31, 2020, which was followed by a transition period until December 31, 2020 (Walker, 2021).

After the transition period, the freedom of movement between the EU and the UK ended and entry requirements for EU citizens changed. Figure 1 provides a schematic overview of the changing requirements faced by EU students in the UK. We describe each phase of the Brexit process in turn below.

Figure 1: Changing requirements for EU students



Notes: Composed by the authors based on British Council (2021); Citizens Information (2021); Universities UK (2021).

Phase 1 (post-referendum)

The referendum did not change any entry requirements (British Council, 2021; Universities UK, 2021). EU students were able to study in the UK under the same conditions as UK students. However, the referendum did cause uncertainty about EU students' future in the UK and may have caused migrants to perceive the UK as a less welcoming place.

Phase 2 (Legal requirements)

Students who started their degree in the academic year 2020/21 were part of the second phase. During this period, nothing changed concerning tuition fees. EU students could still enjoy the home tuition status and remained eligible for the other benefits. Students of this cohort, however, had additional administrative requirements. Those who arrived in the UK before December 31, 2020, could apply for the EU Settlement Scheme. The EU Settlement Scheme is a UK government programme designed to allow EU citizens and their family members to continue living and working

in the UK after Brexit. Under the Settlement Scheme, eligible EU citizens who were UK residents before the end of the transition period (December 31, 2020) were able to apply for settled or pre-settled status. The settled status grants the right to stay in the UK indefinitely, while pre-settled status allows EU citizens to stay in the UK for up to five years, after which they can apply for settled status. This means that EU students could stay in the UK for their studies without the need to apply for a visa after the transition period (Universities UK, 2021). Those that arrived after December 31, 2020, could no longer apply for the EU Settlement Scheme. Similar to non-EU students, they needed to acquire a student visa and were eligible to apply for the Graduate route. This Graduate visa makes it possible for EU and non-EU students to study in the UK and stay for two years after graduation. If they find employment upon graduation, they can switch to the work route (Universities UK, 2021).

Phase 3 (Higher tuition fees)

In the last phase, the favourable requirements for EU students had completely faded. All EU students who started in the academic year of 2021/22 or later were subject to the same higher overseas tuition fees and stricter visa and immigration requirements as non-EU students. Additionally, they were no longer eligible for student loans (British Council, 2021, 2023; Universities UK, 2021).

To summarise, the Brexit process may have affected international student mobility in several ways. First, the referendum may have made EU students perceive the UK as a less welcoming place to study as a result of both the anti-EU sentiments reflected during the campaigns and the increased uncertainty. The status of students and their families would be insecure during their studies and after graduation. Second, after Brexit, EU students faced increased administrative procedures and legal requirements. Lastly, they suffered negative economic consequences through increased tuition fees and loss of access to student loans (Falkingham et al., 2021). Overall, this likely made EU students more hesitant to study in the UK.

3 Data and Descriptive Statistics

3.1 Data description

First, we use publicly available administrative data from UCAS, running from the academic years 2006/07 to 2022/23. As the managing institution of applications to undergraduate courses, the UCAS publishes data on student applications, admissions, and acceptances to HEIs in the UK. The data provide information on all full-time undergraduate UK and non-UK students in England, Northern Ireland, and Wales. The data focuses on first-degree³ and only some sub-degree courses; most sub-degree courses are not processed by UCAS. For Scotland, applications for colleges providing school-level qualifications, university entrance qualifications, or more vocational courses are not included, which encompasses around one-third of undergraduates. The UCAS data include information on students' personal characteristics (origin country, age, and sex) and time of applying. The data do not include any information on the specific courses or universities (UCAS, 2022, 2023a, 2023d, 2023e). We obtain five outcome variables from this source: international student applications to UK higher education providers, offers to international students, offer rates (share of offers compared to total applications from a given origin country), international students' acceptances, and acceptance rates (share of accepted offers compared to total applicants from a given origin country).⁴

Second, we obtain statistics on enrolment into HEIs from HESA. HESA provides annual data on the registration of non-UK-domiciled students at universities, colleges, and other higher education providers, from the academic years 2009/10 to 2022/23. We do not use data from earlier years, as these have incomplete information on students' origin country. The administrative dataset contains

³ First-degrees are more commonly known as bachelor's degrees and take three years to complete. Non-first-degree (sub-degree) courses are usually shorter courses that can stand alone as qualifications. This includes foundation degrees, higher national diplomas, certificates of higher education, national vocational qualifications, institutional undergraduate credit, and other higher education qualifications of less than degree standard. This type of degree is much less common (HESA, 2023a).

⁴ Students can submit up to five applications and may thus receive up to five offers. After receiving applications, universities and colleges can make a conditional or unconditional offer to students they wish to admit. Students can then accept one offer. In case of a conditional offer, they may also accept an 'insurance' offer (UCAS, 2023a). When accepting an offer, students agree to a contract with their chosen institution. Students can still attempt to change their accepted offer through a detailed administrative process or withdraw their entire application when deciding not to attend any undergraduate programmes that year (UCAS, 2023a).

information on students' country of origin, level of study (undergraduate/postgraduate), mode of study (full-time/part-time), and detailed information on the HEIs. Compared to the UCAS data, the enrolment data are more comprehensive in the sense that they also include part-time students, postgraduate students, and students who applied directly to the institutions. The data, however, only include numbers from publicly funded higher education providers (HESA, 2023c, 2024).⁵

3.2 Descriptive statistics

Table 1 summarises the composition of international students in the UK before the referendum. It provides the yearly mean outcome variables, by the various regions of origin of migrant students. It only includes students from origin countries in our specific sample (see Section 4 for further information). Most students come from Asia, with yearly 104,350 applications and 93,807 enrolments on average. Within this group, China is the most frequent origin country. Besides Asia, many international students originate from within the EU, with the majority coming from Southern (yearly 42,885 undergraduate applications and 28,209 total enrolments) and Western Europe (yearly 39,586 undergraduate applications and 25,376 total enrolments). The remaining students most commonly arrive from North America or the Middle East and North Africa. Interestingly, we find the largest offer rate and consequent acceptance rate for students originating from Asian and other European non-EU countries, likely indicating stronger self-selection from these origins. These summary statistics are in line with the composition of all international students in the UK (see for example HESA (2023a)).

⁵ Private higher education in the UK is subject to little regulation and its student body remains largely unknown. However, estimates suggest around 800 providers, with around half principally offering programmes at sub-degree level (Hunt and Boliver, 2023). Most privately funded HE providers cater only for a small number of students; the majority has less than 250 registered students (Hughes et al., 2023).

Table 1: Descriptive statistics on student outcomes in the UK by origin region

	(1) Applications mean	(2) Offers mean	(3) Offer rate (%) mean	(4) Acceptances mean	(5) Acceptance rate (%) mean	(6) Enrolments mean
Northern Europe	24023	13302	55.5	3256	59.0	9486
Central and Eastern Europe	32820	20877	62.8	4835	65.9	15197
Southern Europe	42885	24653	57.0	6153	66.2	28209
Western Europe	39586	22064	56.0	6241	63.4	25376
Other EEA and Schengen	11008	6960	62.9	1703	65.8	5366
Other Europe and Central Asia	9833	6516	66.1	1354	64.5	7154
Asia	104350	69544	66.8	16167	71.1	93807
Oceania and Pacific Islands	1935	829	43.1	204	39.4	1614
Middle East and North Africa	13969	7462	53.5	1886	60.0	15053
Sub-Saharan Africa	4417	2548	57.5	569	55.8	2339
North America	18653	9007	48.3	2398	48.2	15850
Latin America and Caribbean	5244	2687	51.4	630	51.4	5492

Notes: Authors' estimations based on UCAS (2006/07 – 2015/16) and HESA (2009/10 – 2015/16) data. The table shows the yearly mean per origin region for each outcome variable for the pre-referendum period.

Table 2: Descriptive statistics on EU and non-EU student outcomes in the UK

		(1) Before referendum mean sd		(2) Referendum - Brexit mean sd		(3) After Brexit mean sd		(4) Diff. (2)-(1)	(5) Diff. (3)-(2)
Applications	EU	5183	4863	7264	6358	4713	5107	2081**	-2551**
	non-EU	1864	5441	2677	8409	3663	14366	813	986
Offers	EU	3029	2949	4756	4212	3082	3403	1726***	-1674**
	non-EU	1160	3657	1749	5794	2224	8957	589	475
Offer rate (%)	EU	55	12	62	13	63	11	7***	1
	non-EU	42	26	48	25	47	24	6***	-1
Acceptances	EU	765	743	1066	908	649	756	301**	-416***
	non-EU	273	882	353	1219	457	1917	80	104
Acceptance rate (%)	EU	57	14	58	13	51	14	1	-8***
	non-EU	32	28	32	26	30	25	-0	-1
Enrolments (undergr.)	EU	2662	2412	3286	2854	2893	2755	624*	-393
	non-EU	1226	4444	1517	5873	1722	1226	4444	1517
Enrolments (postgr.)	EU	1392	1764	1360	1806	1064	1383	-32	-295
	non-EU	1127	4755	1396	7346	1664	1127	4755	1396

Notes: Authors' estimations based on UCAS (2006/07 – 2022/23) and HESA (2009/10 – 2022/23) data. The table shows the yearly mean per origin country and standard deviation of each outcome variable. The table compares the period before the referendum (2006/07 – 2015/16), between the referendum and Brexit (2016/17-2019/20), and after Brexit (2020/21-2022/23). Differences in means are tested using a t-test for unequal variances, *** p<0.01, ** p<0.05, * p<0.1. The mean number of applications and offers is much higher than the acceptances, as students can have up to 5 applications. The mean number of enrolments is higher than the acceptances, as these include postgraduate courses, part-time students, and students who applied directly to institutions.

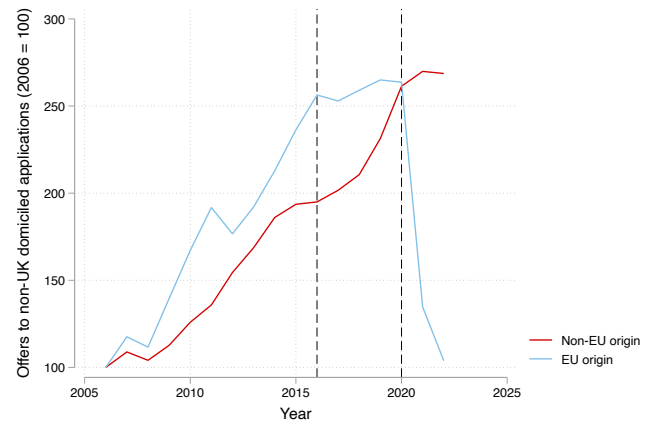
Next, Table 2 reports summary statistics (yearly mean per origin country) of the outcome variables before the referendum (Phase 0, 2006/07 to 2015/16), in between the referendum and Brexit (Phase 1, 2016/17 to 2019/20), and after Brexit (Phases 2 and 3, 2020/21 to 2022/23). The outcomes are reported separately for EU and non-EU countries. Before the referendum, the majority of higher education applications came from EU students. Consequently, an average EU country accounts for more offers, acceptances, and enrolments. The offer and acceptance rates are also higher for EU students. After the Brexit vote, both EU and non-EU outcomes increased, although only significantly for EU students. This upward trend for both EU and non-EU students has been documented before and is in line with other sources (Migration Observatory, 2022). After Brexit, we observe a clear break in existing trends as EU numbers decrease while numbers for non-EU students remain relatively stable.

Figure 2 visualises the applications, offers, acceptances, and enrolments over time. The outcomes are normalised to 100 in the first year, to account for differences in levels. Before Brexit, both EU and non-EU student numbers were increasing. We observe a small short-lived decline in the EU outcomes after 2012, the year tuition fees for UK and EU students were increased in England (Hubble & Bolton, 2018). Around 2015, non-EU outcomes slowed down slightly, perhaps as a result of the Home Secretary's proposals to toughen student visa rules or due to the introduction of the Immigration Health Surcharge (Cook, 2015; Gil, 2015). For the student applications, offers, and acceptances, these movements over time are rather small and the upward trends are relatively steady. After the referendum, the number of EU students seemed to stabilise slightly. For student enrolments, the EU and non-EU trends are diverging already before the referendum, with non-EU enrolments increasing faster. For all outcomes, Brexit is followed by a noticeable drop. The decrease is especially distinct in the academic year 2021/22, when tuition fees increased.

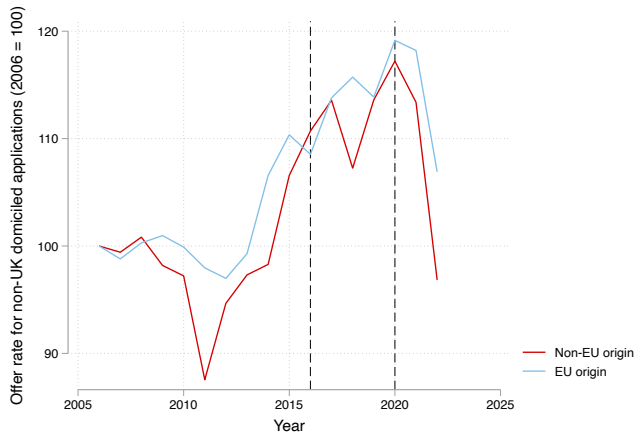
Figure 2: EU and non-EU student outcomes in the UK



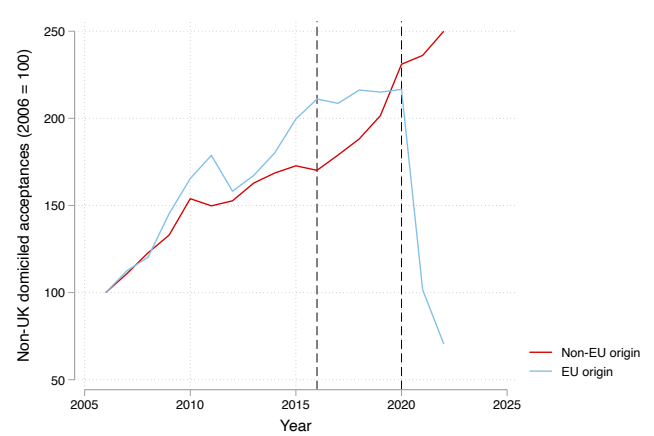
a. Applications



b. Offers



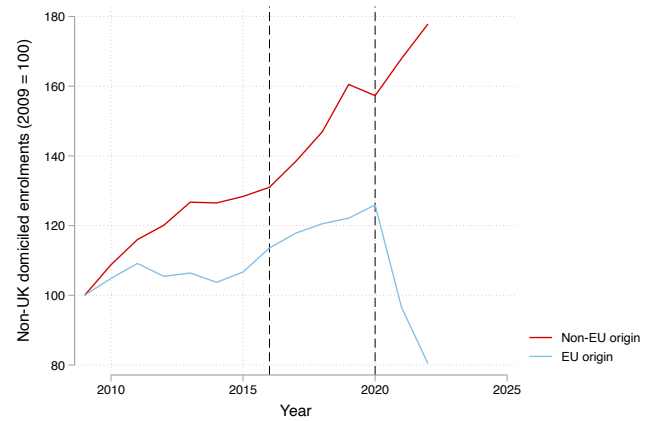
c. Offer rate



d. Acceptances



e. Acceptance rate



f. Enrolments

Notes: Authors' estimations based on UCAS (2006/07 – 2022/23) and HESA (2009/10 – 2022/23) data. The figure shows the total outcomes of all sample countries over time. The dotted lines indicate the years of the referendum and Brexit. Quarterly outcome variables by origin country were first aggregated by EU and non-EU region.

4 Empirical strategy

We employ a DD strategy and consider six outcome variables: international student applications to UK HEIs, institutions' offers to international students, offer rate (%), international students' acceptances, acceptance rate (%), and international student enrolments. We use academic years as time units. An academic year usually runs from early September to mid- or late August in the following year. We use the years from 2006/07 or 2009/10 to 2022/23, depending on data availability. The unit of analysis is the origin country of the international students, where we compare EU students (treated units) with non-EU students (control units) in the UK. By using non-EU origin countries as a control group, we isolate the impact of the Brexit-induced change in regulations for international students. We exclude other possible time-varying confounders, such as the negative economic impact or increased political tensions following the referendum, as we expect both groups to be equally affected by this.

To compare similar types of international students driven by similar confounders, we only include high and upper-middle-income countries⁶ as control units. We exclude Ireland and Croatia from the main analysis. Irish students could continue studying in the UK under the same conditions after Brexit due to the Common Travel Area. Croatia, a new EU member starting in 2013, has an additional policy discontinuity in terms of student mobility, which we examine as a separate case study. Countries that are part of the European Economic Area or Schengen Area experienced the same Brexit-induced change in visa requirements and tuition fees as EU students and are therefore considered as treated. As a result, the treated group consists of 29 EU-origin countries⁷ and the control group consists of 85 non-EU-origin countries.⁸

⁶ We limit the control group to non-EU high and upper-middle-income countries, following the World Bank's classification of 2016. Countries that were re-classified as lower-middle-income economies (Mongolia, Algeria, and Iran), became unclassified (Venezuela), or were in conflict (Iraq) between the referendum and Brexit are excluded (The World Bank, 2023). As a robustness check, we also consider all non-EU countries available in the data as control units.

⁷ Northern Europe: Denmark, Estonia, Finland, Latvia, Lithuania, Norway, Iceland, Sweden. Central and Eastern Europe: Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia. Southern Europe: Cyprus, Greece, Italy, Malta, Portugal, Spain. Western Europe: Austria, Belgium, France, Germany, Liechtenstein, Luxembourg, Netherlands, Switzerland.

⁸ Other Europe and Central Asia: Albania, Azerbaijan, Belarus, Bosnia and Herzegovina, Kazakhstan, Macedonia, Montenegro, Russia, Serbia, Turkey, Turkmenistan. Asia: Brunei, China, Hong Kong, Japan, Malaysia, Maldives, Singapore, South Korea, Taiwan, Thailand. Oceania and Pacific Islands: American Samoa, Australia, Fiji, French Polynesia, Guam,

First, we estimate the log-linear dynamic DD model shown in Equation (1):

$$\ln_Student_{it} = \alpha_0 + \sum_{2006}^{2022} \alpha_t EU_i * YEAR_t + \delta_i + \gamma_t + \varepsilon_{it} \quad (1)$$

The outcome variable $\ln_Student_{it}$ captures the logarithmic⁹ number of students in the UK from an origin country i during the academic year t . The dummy variable EU_i indicates the origin countries that were impacted by Brexit. The variable $YEAR_t$ indicates the academic year. We use 2015/16 as the baseline period, the last year before the Brexit referendum. The coefficient α_t captures the average treatment effect on the treated (ATT) of Brexit for each period and models any anticipation towards it. We include origin-fixed effects, represented by δ_i , and year-fixed effects, represented by γ_t . Standard errors are clustered at the origin-country level.

Additionally, we estimate a similar DD model, capturing the main events and policy changes during the Brexit process: the referendum (Phase 1), the introduction of visa restrictions (Phase 2), and the introduction of increased tuition fees (Phase 3). This is captured in Equation (2):

$$\begin{aligned} \ln_Student_{it} = & \alpha_0 + \alpha_1 EU_i * REFERENDUM_t + \alpha_2 EU_i * VISA_t \\ & + \alpha_3 EU_i * TUITION_t + \delta_i + \gamma_t + \varepsilon_{it} \end{aligned} \quad (2)$$

The dummy variable $REFERENDUM_t$ marks the post-referendum period, starting 2016/17. $VISA_t$ is a dummy variable equal to one starting 2020/21 and $TUITION_t$ is a dummy variable equal to one from 2021/22 onwards. The remainder of the equation is specified similarly as before.

Marshall Islands, Nauru, New Caledonia, New Zealand, Northern Mariana Islands, Palau, Tonga, Tuvalu. Latin America and Caribbean: Antigua and Barbuda, Argentina, Aruba, the Bahamas, Barbados, Belize, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Curacao, Dominica, Dominican Republic, Ecuador, Grenada, Guyana, Jamaica, Mexico, Panama, Paraguay, Peru, Puerto Rico, St. Kitts and Nevis, St. Lucia, St. Vincent and The Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay, US Virgin Islands. Middle East and North Africa: Bahrain, Kuwait, Lebanon, Libya, Oman, Qatar, Saudi Arabia, United Arab Emirates. Sub-Saharan Africa: Botswana, Equatorial Guinea, Gabon, Mauritius, Namibia, Seychelles, South Africa. North America: Bermuda, Canada, United States.

⁹ By using logarithmic outcome variables, we lose origin countries with zero values. This is not an issue, as these origin countries experienced little variation over time and are not very informative. Additionally, Table A6.1 reports a regression using inverse hyperbolic sine transformed outcome variables and a Poisson regression using untransformed outcome variables. This does not change our results.

We complement the analysis using a synthetic DD estimator. The synthetic DD re-weights units to align pre-treatment trends. The estimator constructs two types of optimal weights. Unit weights are designed to make the average treated outcome parallel to the weighted average control outcome before the adoption of the treatment, while allowing for a constant difference between treated and control units and over time. Unit weights thus aim to make units follow parallel pre-trends, not identical pre-trends. Time weights aim to balance pre- and post-treatment periods by making the average post-treatment outcome differ by a constant from the weighted average pre-treatment outcomes for each control unit. Essentially, this puts more weight on the pre-treatment periods which are more similar to post-treatment periods. In the main analysis, estimates are not conditioned on any covariates. The variance is estimated using a block bootstrap with 200 replications, which offers the best properties for inference with panel data and is suitable as the number of treated units is large enough (Arkhangelsky et al., 2021; Clarke et al., 2023).

We implement the synthetic DD to create event-study-type graphs on the treatment effect of the Brexit referendum. The synthetic DD works slightly differently as it does not estimate treatment effects relative to one chosen baseline period. Instead, the baseline is simply the pre-treatment aggregates, as determined by the optimal pre-treatment time weights. The synthetic event-study coefficients then capture how the differences between treated units and synthetic controls (as re-weighted by the unit weights) have changed when compared to baseline differences (Arkhangelsky et al., 2021; Clarke et al., 2023).

Additionally, we focus on the actual exit in 2020 and summarise the Brexit effect in one coefficient by implementing the synthetic DD on Equation (3):

$$\ln_Student_{it} = \alpha_0 + \alpha_1 EU_i * BREXIT_t + \delta_i + \gamma_t + \varepsilon_{it} \quad (3)$$

The variable EU_i indicates the treated units and the dummy variable $BREXIT_t$ equals one for the academic year in which or after which the transition period has ended (the academic year 2020/21 and onwards). As discussed previously, visa requirements changed in the academic year 2020/21 and tuition fee regulations changed for the academic year 2021/22. The coefficient α_1 captures the ATT,

the impact experienced by EU students exposed to the changing requirements due to Brexit. To exclude any potential anticipation effect, the period between the referendum and Brexit (2016/17 to 2019/20) is removed.

By using non-EU origin countries as a control group, we make some important implicit assumptions. First, the condition of parallel trends must be satisfied. We assume that had Brexit not occurred, the difference between the treated and untreated outcome would have been constant over time and EU and non-EU student migration to the UK would have continued to follow parallel paths. To credibly make this assumption, the requirements for non-EU students, before and after Brexit, cannot have changed. As discussed in Section 2.1 and further elaborated in Appendix A2, there are only a few changes in UK policies on non-EU student mobility over time. Overall, these policy adaptations did not seem to impact the outcome variables for our sample (see descriptive evidence in Section 3.2). Additionally, by re-weighting units with the synthetic DD, we weaken the reliance on this parallel trend assumption. Any remaining concerns are addressed in the robustness checks, where we perform several placebo tests (Section 6.1) and follow Rambachan and Roth's (2023) "credible approach" to parallel trends (Section 6.2).

Second, we assume that non-EU students were unaffected by the change in EU students' behaviour following Brexit, i.e., that there were no spillover effects (Stable Unit Treatment Value Assumption or SUTVA). Universities and colleges have generally set firm limits on the number of home fee students (UK students and EU students pre-Brexit) they admit, either independently or due to restrictions from the UK government. Non-EU students, on the other hand, were never subject to any quota control as they were subject to higher overseas fees, unaffected by Brexit. These students have always been actively recruited by institutions to maintain financial stability. Offers are generally made to all applicants who can demonstrate the needed academic potential (Hillman, 2020; Universities UK International & IDP Connect, 2021; University of Bristol, 2011). As a result, changes in the number of EU students should not affect students from outside the EU and we should not expect any substitution. Nonetheless, we perform further checks to evaluate how potential changes

in HEIs' recruitment behaviour may affect our results (Section 6.3). We replicate our analysis using alternative counterfactual scenarios in which we assume that the non-EU inflow either continued growing at the same rate as before the referendum or experienced zero growth. These results dispel concerns about spillover effects.

Overall, to strengthen the validity of our empirical approach, we perform further robustness checks. We use alternative specifications (i.e., we include origin country control variables, use an inverse hyperbolic sine transformation, or employ the Poisson estimator on the outcome variables in levels) and alternative control group compositions (i.e., we exclude Asian-origin countries or use all available non-EU countries as control units). We also perform several checks on the confounding effect of Covid-19, by showing that our results hold when excluding students from countries with strong mobility restrictions (imposed by their own government or by the UK) or many Covid-19 cases. The series of robustness checks listed above adds to the credibility of our results

5 Estimation results

5.1 Dynamic DD results

Table 3 reports the results of the dynamic DD specification from Equation 1 for all outcome variables. The corresponding event study plots can be found in Figure A3. 1 in the Appendix. We observe parallel trends before the Brexit referendum, except for EU enrolments, which had been diverging already. We find no significant changes in the years following the vote. It seems that the Brexit-induced policy uncertainty and the psychological effect of the growing anti-EU sentiments during the referendum did not significantly impact students' behaviour. There also does not seem to be any anticipation effect awaiting the changing regulations. In the first year of Brexit, 2020/21, there are no significant changes in any of the outcome variables despite the changing visa requirements for EU students. Only starting the academic year of 2021/22, we observe a significant negative on applications, offers, acceptances, and enrolments from EU students. The decreases become even larger in 2022/23, with around 64.3% fewer applications, 63.6% fewer offers, 69.6% fewer

acceptances, and 53.7% fewer enrolments. The offer rate increased slightly and the acceptance rate declined, which means the decrease in students' offers (acceptances) was relatively smaller (larger) than the decrease in total applications.

Table 3: Dynamic DD estimates

	(1) Applications	(2) Offers	(3) Offer rate	(4) Acceptances	(5) Acceptance rate	(6) Enrolments
Pre-referendum (Phase 0)						
...						
2012	0.06 (0.08)	0.01 (0.09)	-0.04 (0.03)	0.00 (0.07)	-0.02 (0.03)	-0.25*** (0.09)
2013	0.04 (0.07)	0.01 (0.08)	-0.03 (0.03)	0.01 (0.07)	-0.01 (0.03)	-0.28*** (0.07)
2014	0.02 (0.06)	-0.01 (0.06)	0.01 (0.03)	-0.00 (0.05)	0.04 (0.03)	0.03 (0.05)
2015						
Referendum (Phase 1)						
2016	-0.09 (0.08)	-0.07 (0.08)	-0.02 (0.03)	0.08* (0.04)	0.02 (0.02)	0.02 (0.05)
2017	-0.02 (0.06)	-0.03 (0.07)	-0.03 (0.03)	0.05 (0.05)	0.01 (0.02)	0.04 (0.07)
2018	0.06 (0.07)	0.03 (0.08)	0.01 (0.03)	0.10 (0.07)	0.03 (0.03)	0.07 (0.07)
2019	-0.06 (0.08)	-0.02 (0.08)	-0.00 (0.03)	0.05 (0.08)	0.04 (0.03)	0.01 (0.09)
Settlement Scheme / visa requirements (Phase 2)						
2020	-0.04 (0.08)	-0.04 (0.09)	-0.00 (0.02)	0.04 (0.08)	0.03 (0.03)	0.16 (0.10)
Increased tuition fees (Phase 3)						
2021	-0.71*** (0.10)	-0.69*** (0.11)	0.02 (0.03)	-0.81*** (0.14)	-0.18*** (0.04)	-0.21** (0.10)
2022	-1.03*** (0.12)	-1.01*** (0.13)	0.06* (0.03)	-1.19*** (0.14)	-0.11*** (0.03)	-0.77*** (0.10)
Observations	1,767	1,725	1,611	1,592	1,350	1,393
R-squared	0.33	0.34	0.17	0.29	0.31	0.16
Origin countries	111	109	103	108	92	112
EU 2015 mean	6991	4350	0.61	999.8	0.57	4182
EU 2019 mean	7313	4878	0.62	1077	0.58	4787

Notes: Dynamic DD estimations of the log-linear model based on UCAS (2006/07 – 2022/23) (columns 1 to 5) and HESA (2009/10 – 2022/23) (column 6) data. Cluster robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The model includes time fixed effects and country fixed effects. The exact percentage changes can be calculated using the following formula: $\exp(\beta) - 1$.

Table 4: DD estimates on Brexit phases

	(1) Applications	(2) Offers	(3) Offer rate	(4) Acceptances	(5) Acceptance rate	(6) Enrolments
Brexit referendum (phase 1)	-0.05 (0.08)	-0.01 (0.09)	0.02 (0.02)	0.09 (0.09)	0.06*** (0.02)	0.24*** (0.09)
Settlement/visa requirements (phase 2)	-0.01 (0.05)	-0.01 (0.05)	0.01 (0.02)	-0.03 (0.04)	0.01 (0.02)	0.13** (0.06)
Tuition fees increased (phase 3)	-0.83*** (0.10)	-0.81*** (0.10)	0.04* (0.02)	-1.04*** (0.10)	-0.18*** (0.02)	-0.66*** (0.07)
Observations	1,767	1,725	1,611	1,592	1,350	1,393
R-squared	0.21	0.23	0.10	0.20	0.17	0.06
Origin countries	111	109	103	108	92	112
Pre-Brexit EU mean	7313	4878	0.62	1077	0.58	4787
% change (phase 3)	-56.29	-55.65	4.382	-64.49	-16.07	-48.29

Notes: DD estimations of the log-linear model based on UCAS (2006/07 – 2022/23) (columns 1 to 5) and HESA (2009/10 – 2022/23) (column 6) data. Three dummy variables (that stay on) capture the relevant events during the Brexit process. Cluster robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The model includes time fixed effects and country fixed effects. The exact percentage changes can be calculated using the following formula: $\exp(\beta) - 1$. The table also reports the mean outcome for EU origin countries in 2019 and the exact percentage change for phase 3 coefficients.

To capture the different policy changes during the Brexit process, Table 4 reports the results of the DD specification from Equation 2. These results are broadly aligned with those from the year-on-year analysis. In Phase 1, indicating the post-referendum period, we find no effect on applications, offers, acceptances, or the offer rate. We find a small positive effect on the acceptance rate and enrolments, likely driven by diverging trends before Brexit. There is no evidence of a change in the outcomes following the introduction of visa requirements (Phase 2), except in the case of enrolments. The increase in enrolments in the last year prior to tuition fee introduction may be a sign of anticipatory behaviour on students' behalf. Finally, there is clear evidence of a negative effect of the tuition fee increase on applications (-56.3%), offers (-55.7%), acceptances (-64.5%) and enrolments (-48.3%), as well as an impact on the offer (4%) and acceptance rates (-16%).

Based on the estimated impact of the tuition fee increase, we estimate price elasticities to assess the degree of responsiveness to the change. Before Brexit, EU students benefited from capped home tuition fees of a maximum of £9,250 in England, and even lower in other parts of the UK. After Brexit, overseas undergraduate degrees cost on average £22,200 per year, although overseas fees are set individually by institutions and can vary. EU students thus experienced a price increase of at

most +140%, leading to a decrease in applications of –56.3% in the two years of increased fees after Brexit (2021/22-2022/23). This implies a price elasticity of demand of applications (i.e., demand for UK higher education) of –0.40.¹⁰ This is larger than previous estimates on the price elasticity of demand for higher education. Particularly for the UK, Sá (2019) found a –0.11 price elasticity in applications from domestic English students, affected by the 2012 increase in home tuition fees.¹¹ On the one hand, this may suggest that foreign students are more price-sensitive towards UK education, as they are highly mobile and have more alternatives available. On the other hand, the tuition increase for EU students after Brexit was, in absolute terms, much larger than previous tuition fee reforms in the UK.

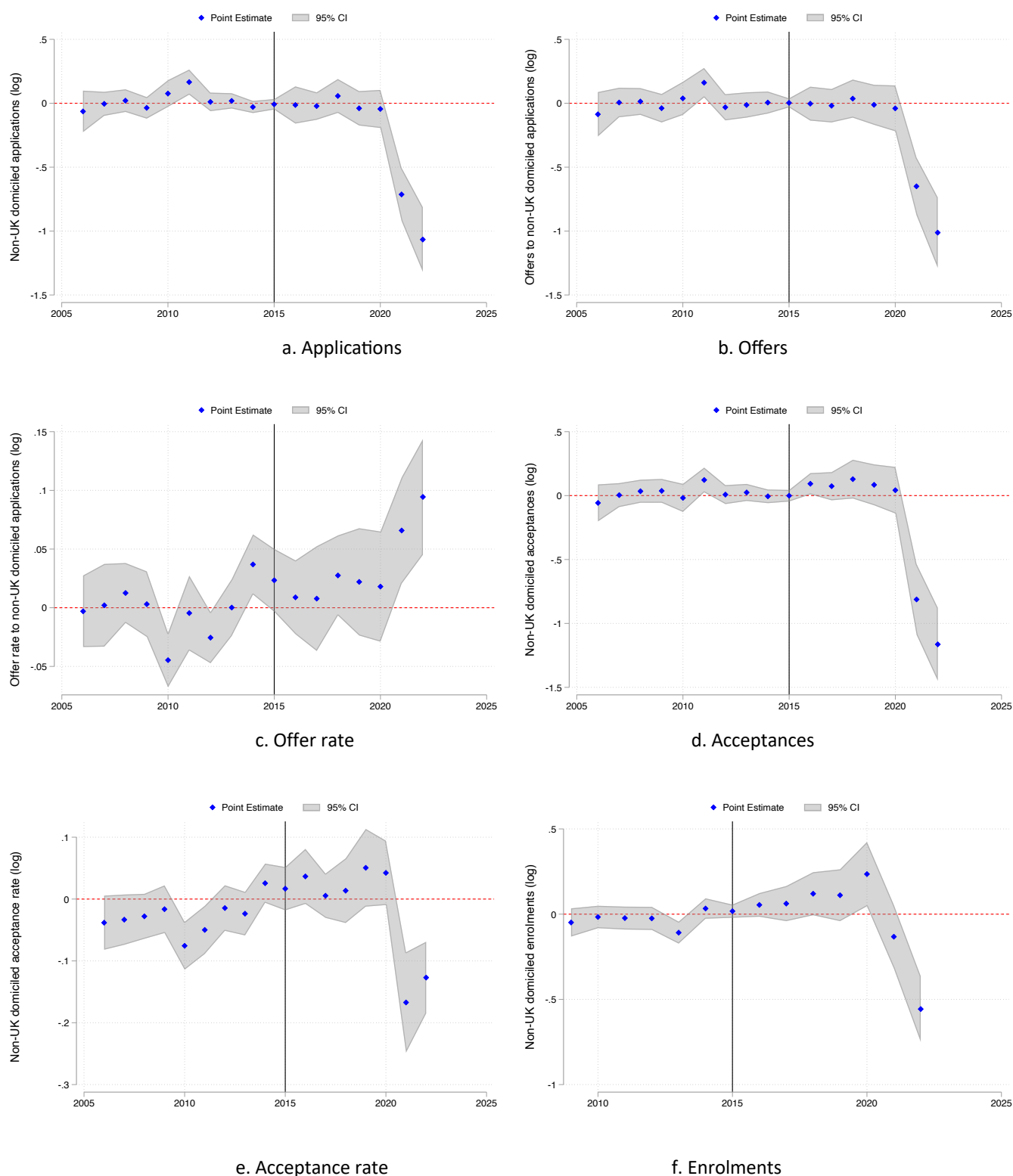
5.2 Synthetic DD results

To strengthen our conclusions, Figure 3 plots the coefficients of the synthetic DD. The period before the referendum is the baseline period. The event study figures show the difference between the treated outcomes and re-weighted untreated outcomes. We observe parallel trends before the referendum, indicated by the coefficients very close to zero, for EU applications, offers, acceptances, and enrolments. The impact remains insignificant in the years after the vote, highlighting the absence of a referendum effect or Brexit anticipation effect. In the first year of Brexit (Phase 2), we only observe a small significant increase in EU enrolments, likely in anticipation of the rising tuition fees. Starting 2021/22 (Phase 3), student applications, offers, acceptances, and enrolments are significantly negatively affected by the increased tuition fees.

¹⁰ We estimate the elasticity of applications, as this is commonly referred to in the literature. The elasticities can also be estimated for the other outcome variables. We find elasticities of -0.40 (offers), -0.46 (acceptances), and -0.34 (enrolments).

¹¹ Sá (2019) finds a demand elasticity of -0.36, for domestic students in England and Scotland using a log-log regression over the period from 1998 to 2015. When focussing on the 2012 reform in English tuition fees and comparing English applications to untreated Scottish applications in a DD setting (offering a causal interpretation), the estimated elasticity equals -0.11.

Figure 3: Synthetic DD, referendum as treatment



Notes: Synthetic DD estimations based on UCAS (2006/07 – 2022/23) (figures a to e) and HESA (2009/10 – 2022/23) (figure f) data. Confidence intervals are calculated using 200 bootstrap replications.

We find a small significant increase in the offer rate. On the one hand, this may indicate that universities and colleges tried to offset the decline in applications by increasing their offers. As EU students paid full tuition fees after Brexit, HEIs may have had more incentive to recruit them. On the other hand, this may simply reflect that students who continue to apply self-select and show higher potential. We cannot distinguish between the two possibilities. We, again, find a significant decrease in students' acceptance rate, illustrating that some EU students declined offers despite having gone through the entire application process. For both the offer and acceptance rates, our conclusions are more indicative, as we observe that pre-trends are not perfectly parallel.

To summarise the Brexit effect, in Table 5, we perform a synthetic DD with only the Brexit period as treated (see Equation 3). We calculate the overall change in the outcomes due to Brexit (Phase 2 and 3). Unit and time weights are reported in the Appendix, in Figure A4.1, Figure A4.2, and Table A4.1. Although we find no significant effect of the Brexit referendum in the previous analysis, we exclude the period between the referendum and Brexit to be cautious and exclude any possible anticipation effect. We find that Brexit reduced the number of student applications from an average EU country by 45.6%. Consequently, we find a significant reduction in average university and college offers (43.1%) and students' acceptances (47.8%). The offer rate increased by 6.7% and the acceptance rate decreased by 7.3%. We find a reduction in enrolments of 14.8% due to Brexit. This is smaller than the impact on other outcome variables, partly because the increased enrolments in the first year of Brexit (in anticipation of the higher tuition fees) offset the decrease in 2021/22. Additionally, this may reflect differences in data, as the numbers on enrolments are more comprehensive (e.g., the data also include post-graduates and part-time students).

Table 5: Synthetic DD, Brexit as treatment

	(1) Applications	(2) Offers	(3) Offer rate	(4) Acceptances	(5) Acceptance rate	(6) Enrolments
ATT	-0.61*** (0.10)	-0.56*** (0.10)	0.07*** (0.02)	-0.65*** (0.10)	-0.08** (0.03)	-0.16* (0.10)
Observations	1,209	1,170	1,079	1,066	923	890
Origin countries	93	90	83	82	71	89
Pre-Brexit EU mean	7313	4878	0.62	1077	0.58	4787
% change	-45.61	-43.14	6.72	-47.79	-7.32	-14.78

Notes: Synthetic DD estimations of the log-linear model based on UCAS (2006/07 – 2022/23) (columns 1 to 5) and HESA (2009/10 – 2022/23) (column 6) data. The period between the referendum and Brexit (2016/17 – 2019/20) is excluded. The table reports the average treatment effect on the treated, the mean outcome for EU origin countries in 2019, and the treatment effect as a percentage change. Bootstrapped standard errors (200 replications) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Percentage change is calculated using the following formula: $\exp(\beta) - 1$.

5.3 Heterogeneous results

To uncover if Brexit affected distinct types of students differently, we separate our outcome variables by students' socio-demographic and origin country characteristics or HEIs' administrative characteristics and employ the same synthetic DD as previously. In the Appendix, Table A5.1 reports the main results for different categories of student applications. The heterogeneity analyses for offers and acceptances are reported in Tables A5.2 and A5.3. Table A5.4 reports the results on various categories of student enrolments. Although the coefficients are generally not significantly different from each other, we observe some interesting distinctions. Event-study figures for each outcome are reported in the Appendix (Figures A5.1 to A5.4), and do not show anything noteworthy unless discussed otherwise below.

Applications

We find that the decrease in applications is relatively stable by age category, although slightly larger for students above 30. We find no differences between female and male students. The impact is slightly larger for applications for the January deadline.¹² When examining students' origin country,

¹² Generally, the deadline to apply is at the end of January of the year when the course starts. Students can still apply after this date until June of the same year, but applications are not guaranteed to be considered. After June, all applications received are entered into Clearing, the specific process by which universities and colleges fill any remaining places after the normal application window. The application deadline may be earlier. For Oxford, Cambridge and most programmes in medicine, dentistry, and veterinary science, applications should arrive by October, one year before classes begin.

we find a larger impact for Northern or Central and Eastern European students. Northern European countries have been increasingly offering English-taught programmes (Airey et al., 2017), providing students the opportunity to obtain high-quality degrees in their home country. Students from Central and Eastern Europe likely have a higher sensitivity to tuition fees, the availability of student loans, and uncertainties around post-study work opportunities, likely due to lower income levels in these regions. Despite previously demonstrating strong demand for UK degrees, these students may now choose universities closer to home that offer subsidised degrees (Universities UK International, 2022).

To examine whether origin countries' economy and labour market characteristics played a role, we estimate the impact of Brexit separately for students from countries with above or below median GDP per capita and unemployment rates. We find that the decrease is more pronounced for origin countries with a lower GDP per capita and higher unemployment rate. This suggests that students from countries with lower employment opportunities, thus facing greater credit constraints but with the most to gain from studying in the UK (higher expected returns), were impacted most by Brexit. Students from countries with stronger economies and tighter labour markets were impacted less by Brexit. This may suggest that the tuition-related income effect is a more important channel than students' concerns about employment prospects or feeling unwelcome in the UK.

Offers and acceptances

The impact of Brexit on university and colleges' offers and students' acceptances follows a very similar pattern, except for the age differences. The decrease in acceptances is driven by those aged 19 to 20, a common higher education enrolment age in many European countries. Older students, likely pursuing a second degree or already holding work experience, seemed to have adapted their behaviour earlier in the process compared to younger students.

Enrolments

For students' enrolments into higher education, the effect is concentrated among first-degree undergraduate and taught postgraduate courses.¹³ We find no significant effect for students enrolled in research-oriented postgraduate degrees, possibly because the increase in respective fees was not as substantial and because research students often secure scholarships to pursue their degrees. Therefore, they face different financial constraints. As before, the decrease is most pronounced for Northern European students. We find a decrease for students studying in Scotland and an increase for institutions located in Wales, due to diverging trends before Brexit. We do not find any significant impact when restricting our sample to enrolments into universities,¹⁴ universities belonging to the Russell group¹⁵, or other education institutions. This suggests that the selectivity of HEIs did not dampen the impact of Brexit.

Finally, the overall decrease in enrolments is slightly more pronounced for students from countries with a high GDP per capita and low unemployment rate. However, the coefficients are weakly significant and may be partially explained by anticipation effects. Specifically, in Figure A5.4, we see that enrolments of students from countries with a lower GDP and higher unemployment rate increased slightly after the referendum and in the first year of Brexit, in anticipation of the increased tuition fees. After the tuition fee increase, student enrolments among this group dropped sharply. This sharp reaction is offset by the anticipation. Enrolments of students from countries with a high GDP and lower unemployment rate did not experience this anticipation. These results highlight the role that students' home economy and labour market play in educational decisions.

¹³ We also observe a decrease in non-first-degree courses. This decrease is the direct result of the diverging trends from before Brexit. Therefore, we do not attach much importance to this result.

¹⁴ HEIs with the right to use the university title can be found for each jurisdiction at <https://www.officeforstudents.org.uk/advice-and-guidance/the-register/the-ofs-register/#/>, <https://www.economy-ni.gov.uk/articles/higher-education-policy>, <https://www.gov.scot/policies/universities/>, and <https://www.gov.uk/check-university-award-degree/recognised-bodies-wales>. Universities are recognised educational organisations, required to meet certain education qualities, that provide study programmes for (first-degree) undergraduate and postgraduate degrees. Colleges offer further education courses, often more vocational, leading to specific degrees or qualifications (UCAS, 2023d).

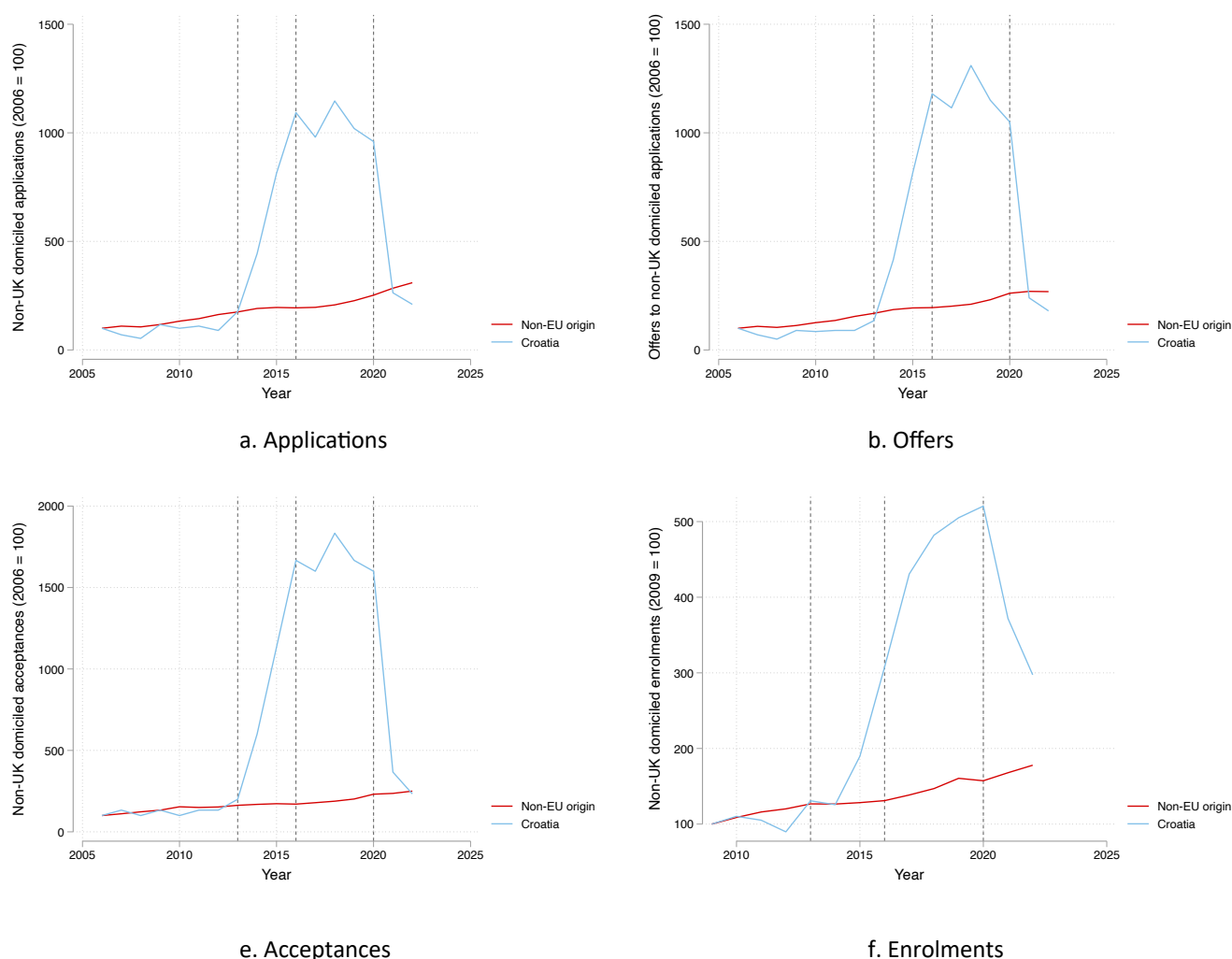
¹⁵ The Russell Group is an organisation of 24 universities that have a shared focus on research and a reputation for academic achievement. Universities of the Russell Group can be found at <https://www.theuniguide.co.uk/advice/choosing-a-course/what-is-the-russell-group>.

5.4 Case study on Croatia

As the most recent member of the EU, Croatia lends itself to a natural extension of our research design by offering an additional policy discontinuity in terms of student mobility. The country became an official EU member on July 1, 2013, following a rigorous accession process that spanned several years. Following the accession, member states were allowed to implement transitional arrangements to limit the access of citizens from the new member country to their labour markets. The UK, along with several other EU countries, chose to exercise this option and imposed a seven-year transitional period during which Croatian nationals faced restrictions when seeking employment in the UK (UK Home Office, 2012). There were, however, no transitional restrictions related to students in higher education. Croatian students immediately had access to all the benefits associated with being an EU member; they were now subject to lower (capped) tuition fees and were exempt from visa requirements. Croatian students benefited from this preferential treatment for several academic years, up until 2020. After Brexit, freedom of movement was restricted again and, as for all EU nationals, it became more challenging for Croatians to migrate and study in the UK.

Figure 4 visualises the applications, offers, acceptances, and enrolments of Croatian and non-EU students over time. The outcomes are normalised to 100 in the first year. Before 2013, the inflow of Croatian students in the UK followed a similar trend as the inflow of non-EU students. After Croatia's accession, student numbers increased strongly up until a few years later, when the inflow stabilised again. Between the referendum and Brexit, the number of applications, offers, and acceptances of Croatian and non-EU students seem to follow parallel trends again. For enrolments, this stabilisation is less visible, although the increase also slowed down. In 2021/22, all Croatian student outcomes declined almost back to pre-2013 levels.

Figure 4: Croatian and non-EU student outcomes in the UK



Notes: Authors' estimations based on UCAS (2006/07 – 2022/23) and HESA (2009/10 – 2022/23) data. The figure shows the total outcomes of Croatia and all non-EU sample countries over time. The dotted lines indicate the years of the Croatian accession, the referendum, and Brexit.

Table 6 implements the synthetic DD estimator, using the same set of non-EU control countries as in the main specification, on the two separate treatments experienced by Croatia: the EU accession (using data from 2006/07 to 2015/16) and Brexit (using data from 2015/16 to 2022/23). After becoming an EU member state, Croatian student applications, offers, and acceptances more than tripled while enrolments more than doubled. After Brexit, the applications, offers, acceptances, and enrolments decreased again by between 35.8% to 70.1%. This means that outcomes returned almost entirely back to pre-2013 levels.

Table 6: Synthetic DD, EU accession and Brexit as treatment for Croatia

	Applications		Offers		Acceptances		Enrolments	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Accession	1.24*** (0.33)		1.22*** (0.29)		1.31*** (0.26)		0.76* (0.44)	
Brexit		-1.03*** (0.26)		-1.21*** (0.24)		-1.18*** (0.22)		-0.44* (0.23)
Observations	660	511	630	483	570	420	441	434
Origin countries	66	73	63	69	57	60	63	62
2012 value	135		90		20		175	
2019 value		1530		1150		250		985
% change	244.9	-64.15	237.7	-70.06	269.7	-69.19	113.7	-35.81

Notes: Synthetic DD estimations of the log-linear model based on UCAS (2006/07 – 2015/16 for columns 1, 3, and 5; 2016/17–2022/23 for columns 2, 4, and 6) and HESA (2009/10 – 2015/16 for column 7; 2016/17 – 2022/23 for column 8) data. The table reports the average treatment effect on the treated (Croatia), the outcome for Croatia in 2012 and 2019, and the treatment effect as a percentage change. Placebo standard errors (200 replications) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Percentage change is calculated using the following formula: $\exp(\beta) - 1$.

Besides illustrating the enormous impact that being an EU member has on student mobility, our results also suggest that the effects of entering and leaving the agreement are relatively symmetric. By entering the EU, Croatian students were incentivised to study in the UK and as this academic study path became more widespread, awareness of its benefits likely increased. It is possible this allowed the UK to build a lasting reputation. However, our results indicate that despite having more experience with studying in the UK, Croatian students were strongly discouraged by the higher tuition fees after Brexit.

6 Robustness checks

6.1 Alternative specifications and control groups

The robustness checks are reported in Appendix A6. Table A6.1 summarises a series of robustness checks on the synthetic DD results. First, in panels A and B, we test for the impact of a hypothetical event prior to the referendum. As nothing changed, we should observe no significant changes. We find some significant coefficients for the offer and acceptance rate, and we observe some anticipation in the enrolment of EU students. As mentioned previously, pre-referendum trends

for these outcomes were not perfectly parallel and results should be interpreted with caution. Apart from this, we find no significant impact of the placebo events.

Panel C includes a set of yearly origin control variables in our main specification: GDP (current US\$) unemployment rate, and population. The variables are assigned to academic years based on their start year (e.g., a control variable from 2016 is assigned to the academic year 2016/17) and are thus slightly lagged. The control variables are used following the ‘projected’ procedure specified by Kranz (2022). The synthetic control is calculated on the residuals of all units after a regression adjustment based on parameters estimated only in control units. These parameters are obtained from a baseline fixed effects regression of the outcomes on the covariates (only for untreated units) and projected on all units. This procedure essentially removes the impact of the covariates on the outcome variables before implementing the synthetic DD. Similar to before, we find a significant negative impact on EU student applications, offers, acceptances, and the acceptance rate. We, again, find a significant positive impact on the offer rate and no significant change in EU enrolments. Panel D includes the same set of yearly control variables but for the UK, to capture changes in the UK economy as a whole. These variables affect both EU and non-EU students in the same manner and thus do not affect the estimates.

Next, we exclude Asian-origin countries from the control units, as these students may not be sufficiently comparable to EU students. On the one hand, UK universities have become increasingly reliant on Asian students over the past decades. The majority of non-EU students originate from China (around one-third of newly enrolled students); Malaysia and Hong Kong are popular sending countries as well (Migration Observatory, 2022). Numbers have been increasing for a long time and the UK’s reliance on these students is a frequent topic of discussion in the media (Adams, 2014, 2020). At the same time, these students have been exposed to other confounders over time. In 2020, students may have been discouraged by the increased racial hate crimes against East Asians as a result of Covid-19 (Carr et al., 2022). In early 2021, the recruitment of Hong Kong students was

facilitated by the introduction of a new British National (Overseas) Citizen visa (Migration Observatory, 2020). Panel E finds that these origin countries are not driving our results.

In Panel F, we replicate our analysis including all the non-EU countries and independent territories available in the data. This check ensures that the results are not driven by the selected control units. Our conclusions remain the same with this alternative sample.

Next, we restrict the period of analysis further. In panel G, we estimate the synthetic DD while only including the three years before the referendum as the pre-period. In doing so, we focus on obtaining parallel trends in the more relevant periods, closely before the referendum. In panel H, we exclude the year 2015/16 (in addition to the anticipation period between the referendum and Brexit). Descriptive evidence shows a one-time decline in non-EU student migration that academic year. The estimates do not change in magnitude and our conclusions stay the same. We only observe a slight increase in the standard errors as the number of observations has been reduced.

Finally, in panel I, we apply an inverse hyperbolic sine transformation to our outcome variables. This allows for a similar interpretation as the logarithmic outcomes while retaining zero-valued observations. Given the recent concerns on log-like transformations (Chen & Roth, 2023; Mullahy & Norton, 2022), panel J replicates the analysis using a Poisson estimator on the outcome variables in levels. When outcome variables can equal zero, the Poisson regression offers an alternative approach to obtain unit-free ATTs expressed as a percentage and avoid placing arbitrary weights on the extensive margin (Chen & Roth, 2023). We obtain similar relative treatment effects as in the main analysis.

6.2 Credible approach to parallel trends

The validity of our identification strategy depends on the parallel trends assumption, stating that in the absence of treatment, the difference between the treated and untreated outcome is constant over time. The dynamic DD from above already illustrates the credibility of this condition by inspecting whether trends are parallel pre-referendum. The synthetic DD further weakens the reliance of our results on the assumption by manufacturing pre-trends to be parallel. In this section,

to further inspect the robustness of our results, we perform a sensitivity analysis following Rambachan and Roth's (2023) credible approach to parallel trends.

Rambachan and Roth (2023) exploit the fact that the pre-treatment differences observed in the data are informative about the counterfactual differences in the post-treatment period. They impose that the counterfactual difference in trends cannot be 'too different' from the pre-trend differences. By varying the size of the counterfactual differences, we can create confidence bounds for the treatment effect under different violations of the parallel trends assumption. Thus, instead of assuming a common trend (i.e., a zero difference between counterfactual treated and observed untreated outcomes), we relax this assumption. The approach lends itself naturally to sensitivity analysis. By relaxing the assumption up to a varying degree, we find a cut-off point up to which the treatment effect is still significant.

Rambachan and Roth (2023) specify different types of restrictions that formalise the relationship between the pre- and post-treatment differences. The most suitable approach in our setting is to impose so-called bounds on relative magnitudes, denoted by $\Delta^{\text{RM}}(M)$. This restriction allows for differential economic shocks and assumes that shocks after the referendum cannot be much larger in magnitude than those before. In particular, the possible violations of parallel trends are bounded by M times the maximum pre-treatment violation. Imposing bounds of $M = 1$ thus restricts the post-treatment violations to be no larger than the maximal observed pre-treatment violation of parallel trends. Likewise, imposing bounds of $M = 2$ implies that the post-treatment violation cannot be larger than twice the maximal violation in the pre-period.

As our dynamic DD estimator finds large significant coefficients for the academic years 2021/22 and 2022/23, we implement the credible approach to parallel trends on the average of these two ATTs. We restrict violations relative to the maximal violation observed in the six years before the referendum. The resulting bounds for the treatment effect of each outcome variable are shown in Figure A6.1 (a) to (f). For the negative treatment effect on applications, offers, and acceptances, we find cut-off values around $M = 2$ or higher. This means that we can reject a null effect even when

allowing for violations of parallel trends up to twice the magnitude of the maximum pre-treatment violation. This illustrates that the results are insensitive to violations in parallel trends, reassuring the robustness of our findings. The positive impact on the offer rate was insignificant in the dynamic DD. The negative impact on the acceptance rate was relatively small and we find a cut-off point at $M = 0.8$. The treatment effect on student enrolments was small, leading to a cut-off value $M = 0.8$. As soon as we allow for rather small violations of the parallel trends assumption, we are unable to reject a null effect anymore, indicating this result is sensitive to the parallel trends assumption.

6.3 Addressing potential spillover effects

To exclude that our results are driven by a violation of the SUTVA assumption, we use alternative counterfactual scenarios. We follow the same approach as Di Iasio and Wahba (2023) and Amuedo-Dorantes and Romiti (2024) when analysing the impact of the referendum on labour migration and student migration, respectively. Table A6.2 shows the results for our baseline synthetic DD (panel A) and the results using two alternative counterfactual scenarios for the (control) non-EU student inflow. In the first scenario (panel B), we assume that in the absence of Brexit, the inflow of non-EU students would have continued to evolve at the same growth rate as before the referendum. We thus assume that the inflow from non-EU countries between 2016/17-2022/23 continues at the same trajectory as the country's pre-referendum growth rate. If spillover effects had occurred (i.e., if non-EU students applied and enrolled more due to the reduced number of EU students), our baseline estimates would be larger than this scenario and overstate the Brexit impact. In the second scenario (panel C), we assume that the inflow of non-EU students experienced no growth and remained stable at its pre-referendum value, as measured in 2015/16. Results for this scenario can be interpreted as a lower bound of the true effect, as it is unlikely that non-EU inflow completely stopped growing in the true counterfactual. We find that our baseline estimates lie in between both scenarios. This suggests that we find conservative estimates of the Brexit effect, likely close to the true impact, and that spillover effects were limited.

6.4 Coincidence with Covid-19

Finally, we inspect how the Covid-19 crisis coincided with Brexit. The pandemic decreased international student mobility and shifted mobility flows. Our identification strategy only partly controls for this, as the pandemic was distributed unevenly across the world and thus affected student flows differently (Mok et al., 2021). Generally, we expect mobility to be more constrained for students from outside of Europe and therefore, if anything, we underestimate the Brexit impact. To further ensure that the Covid-19 crisis is not driving our findings, this section excludes countries from our sample that had the strongest travel restrictions or were hit hardest.

6.4.1 Covid-19 in the UK

The Covid-19 virus arrived in Europe in March 2020 and similar to other countries, the UK was hit hard. In the first months, the British government immediately implemented strict regulations, including a first lockdown ordering people to stay home. By the summer, restrictions were slowly eased up until September 2020, when a second wave hit Europe. New restrictions were implemented, including a curfew and region-specific lockdowns. In December 2020, however, the Covid-19 vaccination programme in the UK was set up for priority groups. Starting in spring, the situation improved, the vaccination programme was accelerated, and restrictions were slowly lifted. By July 2021, most restrictions were removed. In December, the Omicron variant caused some rules to be re-introduced (e.g., face masks indoors, NHS COVID pass, etc.) (Institute for Government, 2022). By March 2022, all restrictions were again lifted in the UK (UK Health Security Agency, 2022). Specifically, in terms of higher education, this meant that the 2020/21 academic year took place under strict restrictions with remote teaching. In 2021/22, universities and colleges phased back in. While some teaching continued to be online, much face-to-face teaching and in-person exams returned (HESA, 2023b).

The unpredictable nature of the Covid-19 pandemic in the UK likely deterred international students from applying. Generally, government policies applied equally to all, and everyone was forced to adhere to the same regulations, regardless of their origin country. Following this reasoning,

the use of non-EU students as the control group should capture any confounding impact of Covid, with one exception. In early 2021, the UK introduced stronger travel restrictions for non-UK nationals travelling from a ‘red list’ of countries and territories, mostly from outside the EU. Restrictions varied over time and, at some point, consisted of a full travel ban (Department of Health and Social Care, 2021, 2023), which may have discouraged students. To ensure that we do not underestimate the Brexit impact, panel A of Table A6.3 excludes the ‘red list’ countries from the synthetic DD analysis and shows that this does not affect our estimates. Table A6.4 lists the excluded countries.

6.4.2 Covid-19 across the world

The circumstances in the students’ origin country may also affect their motivation to study abroad. Those from countries with many cases or strict regulations may find it difficult to travel or, to the contrary, may be encouraged to leave. To consider these behavioural responses, we use the Oxford COVID-19 Government Response Tracker from Hale et al. (2021). This dataset collected information on when and which pandemic response measures were enacted by governments from 2020 to 2022. The data reflects the extent of government action and aggregates recorded policies into policy indices. We implement our synthetic DD analysis on a group of 50 countries hit least hard by Covid-19, according to different indices and records provided by the Government Response Tracker. In panel B of Table A6.3, we use the mean government response index, which summarises all policy responses (containment/closure, economic, health, or vaccination) into one index. We specify this further by using the average stringency index (in panel C), which summarises all policies on containments/closure and health-related public information. Finally, we also use the number of confirmed cases (panel D) and deaths (panel E) relative to the origin population to capture the severity of Covid-19 across countries. Table A6.4 in the Appendix lists the 50 included countries for each measure. The selected countries are quite different per measure, showing the variety of possible reactions to the crisis.

We find that the decrease in applications, offers, and acceptances remains large and significant in most specifications. The increased offer rate and decreased acceptance rate remain

significant as well. The impact on student enrolments is again insignificant, except when focusing on countries with the lowest number of Covid-19 deaths. Overall, we find relatively similar coefficients as in the main analysis. The small differences across specifications more likely highlight that Brexit impacted various EU countries differently rather than invalidating our results. The results suggest that the Covid-19 crisis is not driving our results.

7. Back-of-the-envelope calculations on economic impact

Our results indicate that UK HEIs attract fewer EU students due to Brexit, and particularly due to the increased tuition fees. To illustrate the importance of this impact, this section estimates the potential monetary loss due to the decreased number of EU students.

In Table A7.1 in the Appendix, we estimate the number of students “lost” due to Brexit. Using estimates from a DD analysis on the Brexit phases (see Section 5 and Equation 2 in Section 3), we calculate the counterfactual post-Brexit EU mean and compare this with the observed numbers. We do so for two scenarios. In the first scenario, we assume that all students accepting offers also eventually enrol. Given the decrease in student acceptances of 64.5%, we estimate that around 22,712 undergraduate EU students per year were lost. In the second scenario, we estimate the decrease in student enrolments. Because the enrolment data is more comprehensive, this second scenario allows us to differentiate between undergraduate and postgraduate enrolments. We estimate a yearly decrease of 44.0% and 47.1%, respectively, resulting in a loss of 57,383 and 24,486 students.

In Table 7, we use these estimates to calculate the potential financial implications due to Brexit. We estimate how the reduction in EU students translates into monetary losses, given the change in tuition fees and students’ average main expenditures in the UK that are now not being made. We find that universities and colleges miss out on large amounts of tuition fees (ranging from –£181.1 to –£457.5m/year depending on the scenario). However, interestingly, this loss is partly or entirely compensated by the increased tuition fees (i.e., the change from home fee to international

fee) for the remaining EU students in the UK (ranging from +£177.9 to +£1040.1m/year). When accounting for spending on accommodation (ranging from –£94.9 to –£239.9m/year) and other day-to-day expenditures (groceries, clothes, study material, etc.) (ranging from –£194.0 to –£490.1m/year), the potential monetary losses of Brexit become apparent for all scenarios. Based on acceptances, we find that on average, a minimum of 292 million pounds per year is lost. The estimated losses based on enrolment data reach 147 and 413 million pounds per year, for undergraduate and postgraduate students respectively.

Naturally, these back-of-the-envelope calculations do not cover all financial changes. We ignore that part-time students have lower tuition fees and expenditures that may partly be funded from income generated within the UK through part-time work (Conlon et al., 2011). We do not consider possible changes in the expenditure patterns of the remaining EU students (e.g., post-Brexit students likely self-select and have more funds available or, to the contrary, have more constraints due to the increased fees). We ignore other benefits arising from international students. As illustrated by Conlon et al. (2011), income from overseas sources can also originate from consultancy contracts, research grants, charitable donations from overseas alumni, the licensing of intellectual property and new technologies, or selling shares in spin-off companies derived from HEIs. In addition, the UK economy also benefits from recent international graduates entering employment, for instance, through their fiscal contributions (Vickers & Bekhradnia, 2007). Finally, we do not include the potential costs that international students may bring. These costs may include scholarships, subsidised loans, administrative costs, or generally the costs that universities incur in providing for the student (Vickers & Bekhradnia, 2007). These costs are, however, likely smaller than the numerous benefits associated with international students in the UK. Despite these omissions listed above, our simplified analysis illustrates the magnitude of the potential financial impact of Brexit.

Table 7: Potential monetary losses due to Brexit (back-of-the-envelope)

Estimated value/cost of education per student	Estimated yearly loss (in million) due to Brexit		
	[1]	[2]	
	Acceptances Undergrad	Student enrolments Undergrad	Postgrad
Tuition fees for EU students			
Average tuition fee per student lost by Brexit			
Undergraduate £7,973 per year ¹	-181.09	-457.51	-269.34
Postgraduate £11,000 per year ²			
Average increased tuition fee per remaining student ³			
Undergraduate £22,000 vs. £7,973	177.91	1040.14	167.88
Postgraduate £17,109 vs £11,000			
Average other expenditure⁴			
Rent for accommodation			
£4,180 per year (10 months)	-94.94	-239.86	-102.35
Remaining day-to-day expenses			
£8,541 per year (39-week academic year)	-193.99	-490.10	-209.13
Total	-£292.11m	-£147.34m	-£412.95m

Notes: ¹ The average home undergraduate tuition fee varies by nation and has been calculated as the weighted average of each tuition fee based on the distribution of enrolments across nations (£9,250 in England, £9,000 in Wales, £3,145 in Northern Ireland, and no tuition fees in Scotland (Hubble & Bolton, 2018; Lewis, 2023a, 2023b, 2024)), with weights based on nations' share of EU students in the year before Brexit, 2019/20. ² Home postgraduate tuition fees vary from £4,900 a year to over £30,000, with an average of around £11,000 per year (UCAS, 2023c). ³ International undergraduate tuition fees vary from £11,400 - £38,000. The average cost is estimated to be around £22,200 per year. International postgraduate tuition fees vary from £9,000 - £30,000. The average cost is estimated to be around £17,109 per year (British Council, 2023). ⁴ The Save The Student's National Money Survey 2023 found that the average monthly rent for 2023 was £418 and the UCAS's Student Lifestyle Report found that students are on average spending £219 in a typical week, excluding rent (UCAS, 2023b). For a 39-week academic year, this equals £4,180 of rent and £8,541 of remaining expenditures (groceries, clothes, study material, etc.). These numbers are for UK students and are likely higher for foreign visiting students. For instance, Conlon et al. (2011) estimate that undergraduate and postgraduate international students spent, respectively, £10,003 and £13,337 in 2007/08 for accommodation and other day-to-day expenses. These expenses equal £14,473 and £19,296 when inflated forward to 2022/23 using the Consumer Price Index. The more recent (lower-bound) estimates were preferred for the above calculations.

8 Discussion and conclusion

By voting to leave the EU, the UK created a more challenging environment for prospective EU students. Visa requirements changed, tuition fees increased, uncertainty about the long-term status of EU students was introduced, and EU migrants may have felt unwelcome. This paper provides causal evidence on how this impacted international student mobility. By implementing dynamic and

synthetic DD estimators on UCAS and HESA data, we compare the evolution in the number of EU students in the UK with the number of students from unaffected high-income and upper-middle-income non-EU economies. We find that EU students were discouraged from studying in the UK due to Brexit.

We find no significant impact after the referendum or in anticipation of the exit. In the first year after Brexit, 2020/21, we observe no effect despite changes in the visa requirements. Only starting in 2021/22, when EU students became subject to higher tuition fees, we observe a significant impact on EU students. In the two years of increased tuition fees (2021/22-2022/23), we find a large decline in student applications to HEIs of around –56%, which translates into a price elasticity of –0.40. Naturally, this results in a reduction in university and colleges' place offers (–56%), students' acceptances (–64%), and enrolments (–48%). The overall impact of Brexit (2020/21-2022/23) is also significantly negative for all these outcome variables. Our results indicate that the offer rate increased, suggesting that HEIs received applications of better quality or that they had more incentive to recruit EU students as a result of the increased tuition fees. Students' acceptance rate decreased, indicating that students with the intention to study in the UK cancelled their plans relatively late in the process. These results on the offer and acceptance rates are, however, sensitive to the specification and empirical assumptions made. The observed reductions in applications, offers, and acceptances are relatively constant across age groups, sex, and application types, but are driven by students from Northern or Central and Eastern Europe. For enrolments, the reduction is concentrated among first-degree undergraduate and taught postgraduate courses, Northern European students, and students studying in Scotland. For all outcomes, we find evidence that the decline is most pronounced for students from countries with weaker economies and lower employment opportunities, highlighting the importance of credit constraints. Our results are robust to a large set of specification checks, and we illustrate that these results are not driven by the coincidence with the Covid-19 crisis.

Our findings reveal that the initial uncertainty on the status of EU students in the UK and the introduction of visa requirements for EU citizens in the UK had no apparent impact. This highlights that students are willing to incur these increased administrative and time costs. They do not necessarily form a barrier and individuals remain motivated to study in the UK. The large increase in tuition fees, however, had a great impact on students' behaviour, illustrating that this is an important determinant. Our results indicate a price elasticity of demand for UK higher education of -40, which is higher than previous estimates (e.g., Sá (2019) found a much lower elasticity (-0.11) among domestic English students after the 2012 tuition fee increase). This suggests that foreign students may be more price-sensitive, likely due to their greater mobility and access to alternative options, coupled with the substantially larger tuition fee increase faced by EU students post-Brexit. Although previous literature is ambiguous on the significance of tuition fees in students' decision to study abroad (Beine et al., 2014; Dwenger et al., 2012; Wakeling & Jefferies, 2013), our results are as expected. For European students, there is an abundance of cheaper alternative English-taught programmes available within the EU (Mayhew, 2022).

These results reveal one of the broader consequences of Brexit. International students generally generate several positive externalities that are now lost for the UK. They foster innovation and generate important revenues for local economies and institutions (Bound et al., 2020; Gu & Li, 2023; Stuen et al., 2012). In addition, they promote international collaboration in higher education and research, and international graduates generally form an important source of skilled workers (Hou et al., 2022; She & Wotherspoon, 2013). As such, the reduced inflow of EU students may significantly affect the UK's economy and higher education quality. Our study highlights this indirect impact of Brexit by illustrating the large potential monetary losses in a brief back-of-the-envelope calculation.

Although our results are specific to the UK, they are relevant too for other countries considering implementing barriers to limit international enrolment growth (e.g., the Netherlands (ICEF monitor, 2023a, 2023b) or Canada (ICEF monitor, 2023c)). For policymakers wishing to curb international students after reflecting on the wider consequences, our results suggest that raising

tuition fees may be the most effective way. In the following years, it is essential for the UK to ensure student inflows and retain their positive externalities. The limited number of initial initiatives and bilateral agreements (see Highman et al. (2023) or UK Home Office (2023b)) have proven insufficient and recent changes to the UK's visa policy (UK Home Office, 2024) have further restricted access to UK higher education for international students. Therefore, available scholarships and financial aid offers can be expanded and should be listed with their associated eligibility criteria and requirements. Both higher education and government institutions can further promote educational programmes and raise awareness of the benefits of studying in the UK. Brexit can be considered as a nudge to forge new educational markets. British higher education providers should consider setting up new collaborations nationally and internationally and should actively pursue new initiatives and opportunities.

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Appendix: Supplementary material

A1. Higher education in the UK

A1.1 Tuition fees

After having free higher education for several decades, the UK government introduced tuition fees of £1,000 per year for full-time graduate courses across the UK in 1998. Given that education is a devolved power, the constituent parts of the UK could implement their own requirements and as such, over the years, tuition fees have diverged.

Starting in 2006, universities in England were allowed to charge variable fees of up to £3,000 a year for full-time graduate courses. In 2006 and 2007, the same maximum fee was introduced in Ireland and Wales, respectively. In the following years, this cap on tuition fees gradually rose with inflation up to £3,145 (Burgess et al., 2018). In England, tuition fees were drastically raised to £9,000 per year starting the academic year 2012/13. Most ongoing direct public funding for tuition was cut, and loan repayment terms were changed. Five years later, the cap was further increased to £9,250 a year (Hubble & Bolton, 2018). Northern Ireland increased its tuition fees in the same manner to £9,250 per year, but only for students living in the UK outside of Northern Ireland. Residents of Northern Ireland remained under the previous cap, adjusted for inflation (Lewis, 2024). In Wales, the cap on tuition fees for full-time undergraduate courses was increased to £9,000 per year and remains at this level to date. UK students from outside of Wales must pay their tuition fees in full while Welsh students receive grants from almost half the cap to help cover their costs (Lewis, 2023b).

Scotland followed a different path. Several years after the higher education tuition fees of £1,000 were introduced, the Scottish government abolished the upfront tuition fees in 2000. They were replaced with a mandatory student contribution made after completing a degree-level course, initially set at £2,000. This one-off endowment fee was scrapped in 2008. Tuition fees were re-introduced and are, at this date, capped at £1,820 for Scottish students and £9,250 for students who live elsewhere in the UK or Ireland. Home students can, however, if they meet the requirements,

have their tuition fees paid for by the Student Award Agency Scotland, resulting in free higher education for these students (Burgess et al., 2018; Lewis, 2023a).

While UK universities can charge below the tuition fee cap, most of them charge the maximum. Fees for international (or 'overseas') students have never been capped and are determined by providers. They can be much higher depending on the course and the institution. Fees vary from £11,400 - £38,000, with an estimated average cost of around £22,200 per year. (British Council, 2023).

At the postgraduate level, there is generally no fee cap. Tuition fees vary but still tend to be significantly lower for home students than for international students (Hubble & Bolton, 2018). Home postgraduate tuition fees range from £4,900 a year to over £30,000, with an average of around £11,000 per year (UCAS, 2023c). International postgraduate tuition fees vary from £9,000 - £30,000, with an average estimated around £17,109 per year (British Council, 2023).

A1.2 Admission caps

Higher education institutions in the UK must adhere to a series of regulations that often vary over time. These regulations include, among others, restrictions on the number of students that universities and colleges can recruit.

Starting in the 90s, each higher education institution in England could only recruit a maximum number of home-fee undergraduate students (i.e., UK students and pre-Brexit EU students). In 2012/13, this regulation was relaxed, and universities were allowed to accept as many students as they liked who had at least two A grades and a B grade at A-level or equivalent. Other students remained under the cap. In 2013/14, this exemption was expanded to also include those with one A grade and two B grades. In December 2013, the UK government further announced its plans to end student number controls altogether. The cap was first relaxed in 2014/15 by providing an additional 30,000 student places. In 2015/16, the cap on the number of UK and EU-domiciled undergraduates was abolished. The government estimated this to result in an additional 60,000 students a year (Bolton, 2014; Hillman, 2014). In the following years, all UK universities were free to recruit as many students as they wanted to. In 2020, the government debated introducing a temporary cap on

student numbers in 2020/21. The cap was intended to stabilise student admissions and dampen the heightened competition between universities for UK students. This heightened competition was a result of the (expected) loss of international students due to the Covid-19 pandemic. However, before the academic year could start, the cap was already lifted (Bolton, 2023).

Limiting student admissions continues to be a topic of debate. For instance, starting in 2022, the UK government discussed the introduction of a cap to limit the number of students taking “low-value” degrees in the UK, particularly with a focus on foreign students as an attempt to bring down net migration (e.g., Allegretti and Adams (2023) and PA media (2022) in the Guardian). At the time of writing, no actual cap has been formally introduced.

A2. Foreign students in the UK: visa requirements and others

Non-EU migration in the UK is governed by a points-based system of immigration that admits migrants based on their qualifications and potential benefit to the UK. At the time of Brexit in 2020, the system categorised migrants into 5 Tiers: highly skilled workers (1), sponsored skilled workers (2), low skilled workers (3), students (4), and special categories of temporary migrants (short-term or voluntary visas) (5). International non-EU students usually apply for the Tier 4 Student visa or, in some cases, for the Tier 5 Short-term Study visa (Gower, 2018).

Generally, before applying for a student visa, international students must have been accepted by a recognised education institution in the UK and must be able to provide a 'Confirmation of Acceptance for Studies'. During the visa application process, students must have a current passport and pay an application fee. They must also prove they can support themselves financially during their studies, show a sufficient knowledge of English, and pay a healthcare surcharge (£470 for students in 2020). Once arrived in the UK, students must collect their Residence Permit and must comply with the terms and conditions of the student visa (e.g., not working more hours than allowed) (UK Home Office, 2023a).

Most students apply for a Tier 4 student visa, which costs almost £400. How long students can stay in the UK depends on their studies. Usually, they can stay for up to five years for courses at degree level and up to two years for courses below degree level. The visa allows students to bring dependents (i.e., a partner and children) and permits them to work outside of their studies. Students can easily extend their visas if they wish to continue their studies in the UK. Students can also switch to another visa in the months prior to the expiry of their current visa if they wish to stay in the UK after graduation. Students can switch to a Tier 2 category (e.g. Skilled Worker visa) or, since 2021, to a Graduate visa. The Graduate visa allows you to stay in the UK for at least two years after successfully completing your studies. It is not tied to a specific job or skill level and has no salary or sponsorship requirements (UK Home Office, 2023a).

Since the introduction of the point-based immigration system in 2008, there have been made several changes to the regulations and requirements for migrants. Table A2.1 summarises the evolution of all relevant policy changes.

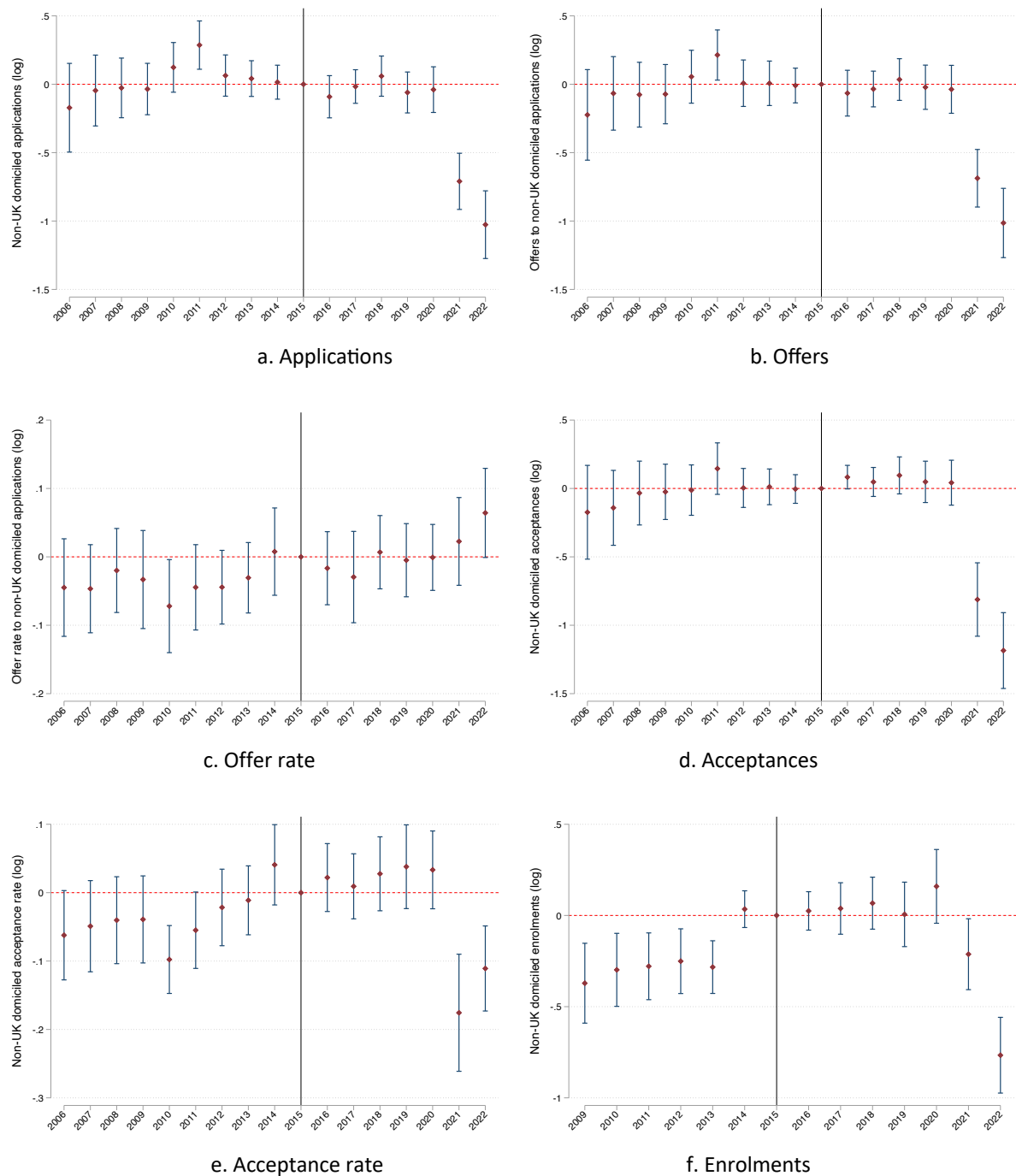
Table A2. 1: Changes in British migration regulations

Feb-2008	Points-based immigration system launched through successive Statements of Changes to Immigration Rules. The visa system with 5 Tiers is now in place.
Jan-2010	Target of reducing total net migration \$<\$ 100,000 introduced. Although target includes international students, this did not translate into immediate relevant policy changes.
Apr-2011	Small adaptations in Tier 4 regulations: restrictions on permission to work, restrictions on the entitlement to bring dependants, and tightened English language requirements.
Apr-2012	Tier 1 (Post-study work) route which allowed non-EU students to stay in the UK and work at any skill level up to two years after graduation, is closed.
Apr-2013	Introduction of doctorate extension scheme, allowing students 1 year in the UK after completing a PhD.
Jan-2014	Transitional restrictions on Bulgarians and Romanians (joined EU in 2012) lifted.
Nov-2014	Tier 4 permitted refusal rate is reduced from 20% to 10%: if 10% of sponsor's prospective students are refused, they lose ability to recruit international students.
Apr-2015	(Extended) student visitor routes re-branded into new routes for short-term study (Tier 5).
Apr-2015	Immigration health surcharge to gain access to NHS introduced for non-Europeans in UK for +6 months. Surcharge set at £200/year and £150/year for students.
Jun-2016	Brexit referendum
Jan-2018	Certain part-time studies removed from short-term study route and included in Tier 4.
Jan-2018	Small adaptations in Tier 4 regulations: permission to apply within UK for leave to complete work placement/study abroad and dependants' work rights remain valid when applying to same course.
Jan-2018	Small adaptations in Tier 5 regulations: minimum age requirement short-term study route reduced from 18 to 16, students permitted to remain in UK up to 30 days after their study, and students permitted to complete electives in certain scenarios.
Jun-2018	Transitional restrictions on Croatians (joined EU in 2013) lifted.
Jul-2018	Small adaptations in Tier 4 regulations: minimum length postgraduate course needed to be eligible for bring dependants reduced, documentary requirements for applications reduced for 11 countries, and all students allowed to participate in study abroad programme.
Dec-2018	Immigration health surcharge increased to £400/year and £300/year for students.
Jul-2019	Target of reducing total net migration \$<\$ 100,000 scrapped. This again did not translate into immediate relevant policy changes.
Aug-2019	Higher Education Reform changes to Tier 4: full privileges are extended to Higher Education Providers with a track record of compliance.
Oct-2020	Immigration health surcharge increased to £624/year and £470/year for students.
Dec-2020	Tiers are revised, simplified, and replaced by routes: Student routes replace Tier 4 (General), Skilled Worker route replace Tier 2 (General), Intra-company routes replace Tier 2 (Intra-Company Transfer/Graduate Trainee), etc.
Dec-2020	Brexit: Free movement between the UK and EEA/Switzerland ended. EEA/Swiss students are now subject to same visa requirements, tuition fees, etc. as non-EEA/Swiss students.
Jul-2021	Graduate route introduced, allowing international students to stay in the UK after graduation and work, or look for work, at any skill level for 2 or years. Discontinuation of Doctorate Extension scheme for PhD students who can now apply for Graduate route.

Notes: More detailed changes and updates in British migration policy or legislation are provided by the UK Home Office, <https://www.gov.uk/government/publications/policy-and-legislative-changes-affecting-migration-to-the-uk-timeline>

A3. Event study figures

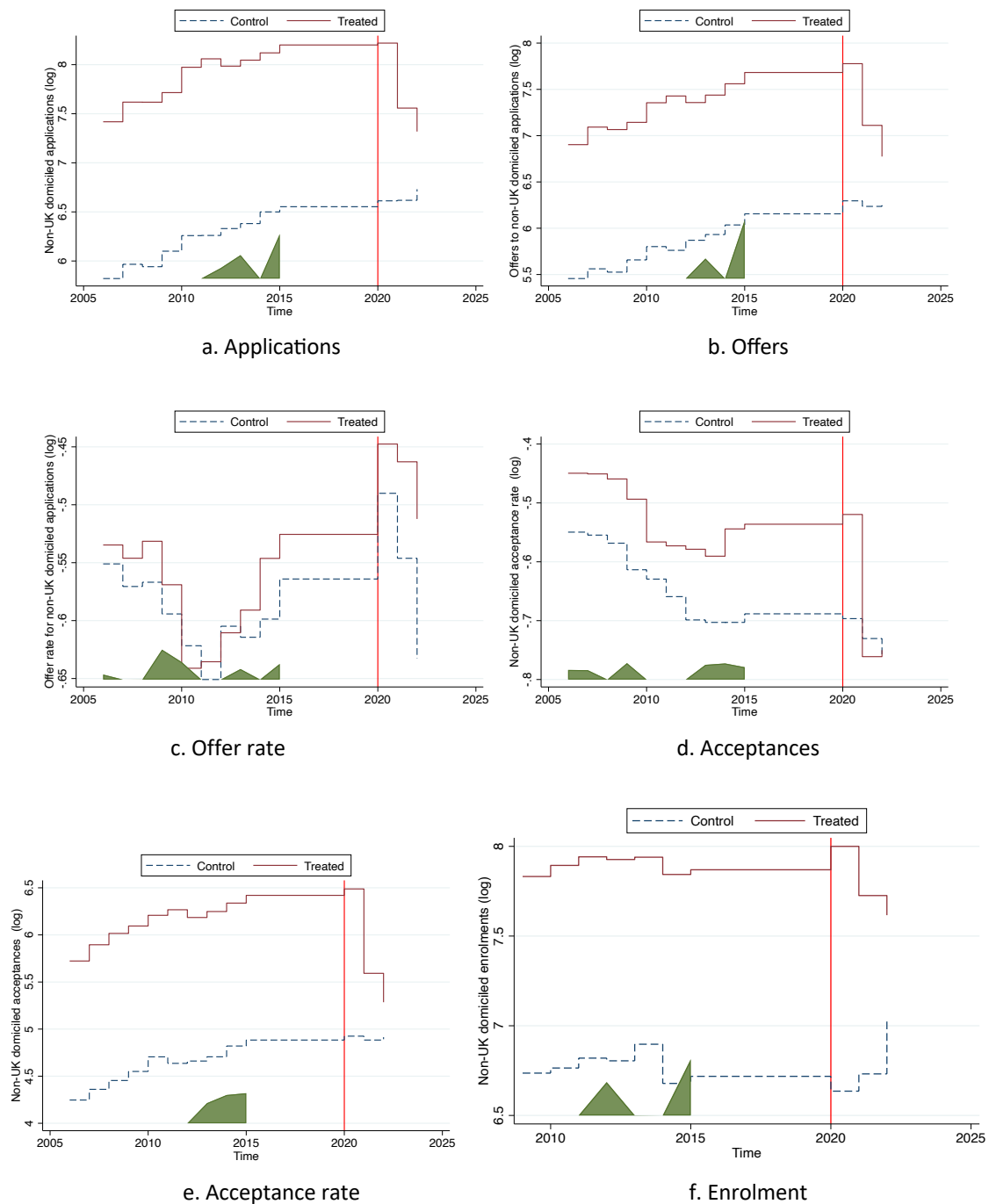
Figure A3. 1: Dynamic DD, referendum as treatment



Notes: Dynamic DD estimations of the log-linear model based on UCAS (2006/07 – 2022/23) (figures a to e) and HESA (2009/10 – 2022/23) (figure f) data. Confidence intervals based on cluster robust standard errors.

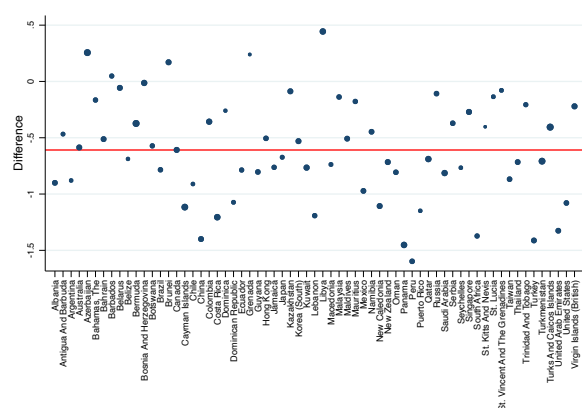
A4. Synthetic DD weights

Figure A4. 1: Time weights, synthetic DD

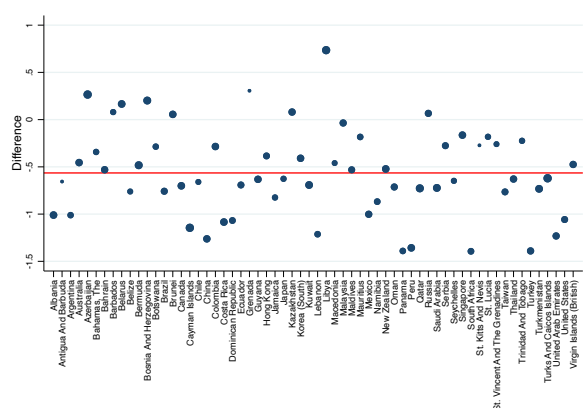


Notes: Treatment and synthetic control outcome trends and their time-specific weights. Estimations based on UCAS (2006/07 – 2022/23) and HESA (2009/10 – 2022/23) data. The period between the referendum and Brexit (2016/17 – 2019/20) is excluded, which is reflected in the long horizontal line between those periods.

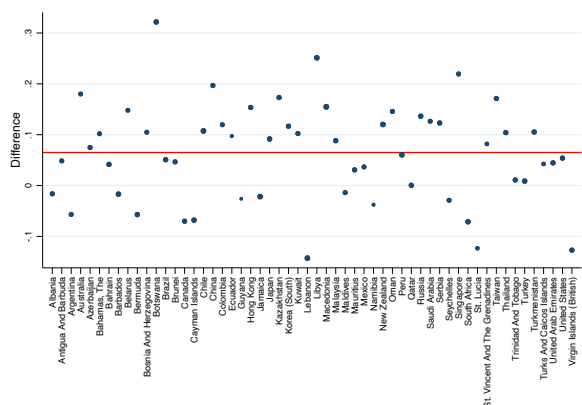
Figure A4. 2: Unit weights, synthetic DD



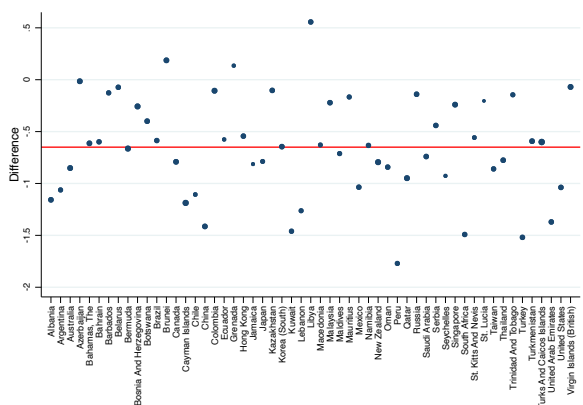
a. Applications



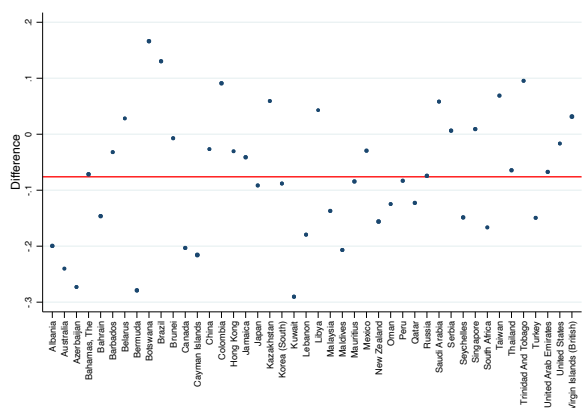
b. Offers



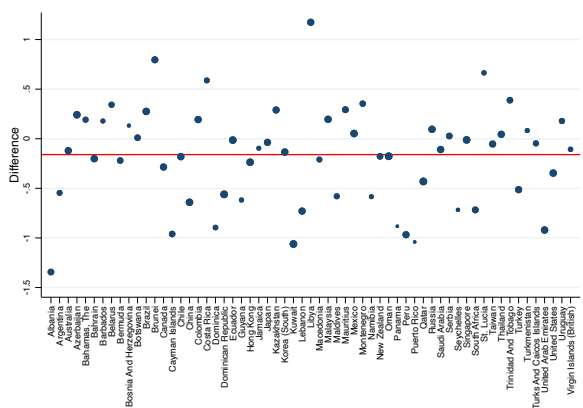
c. Offer rate



d. Acceptances



e. Acceptance rate



f. Enrolment

Notes: Unit-specific weights for synthetic DD estimator. Estimations based on UCAS (2006/07 – 2022/23) and HESA (2009/10 – 2022/23) data.

Table A4. 1: Unit weights top 15 countries, synthetic DD

Applications		Offers		Offer rate	
Turks & Caicos Islands	0.0267	Turks & Caicos Islands	0.0244	Macedonia	0.0243
Bermuda	0.0261	Azerbaijan	0.0242	Chile	0.0232
Azerbaijan	0.0256	Cayman Islands	0.0240	Jamaica	0.0223
Turkmenistan	0.0250	Libya	0.0236	Lebanon	0.0221
Cayman Islands	0.0241	Qatar	0.0224	Libya	0.0220
Costa Rica	0.0223	Bermuda	0.0217	Peru	0.0220
Libya	0.0216	Bosnia & Herzegovina	0.0215	New Zealand	0.0214
Panama	0.0215	Saudi Arabia	0.0209	Cayman Islands	0.0206
Qatar	0.0208	Kuwait	0.0204	Barbados	0.0206
Saudi Arabia	0.0202	Turkmenistan	0.0203	Botswana	0.0205
Colombia	0.0201	Belarus	0.0198	Japan	0.0204
Bosnia & Herzegovina	0.0199	Peru	0.0193	Turkey	0.0204
Kuwait	0.0195	Albania	0.0192	Turkmenistan	0.0201
Singapore	0.0188	Costa Rica	0.0192	Bermuda	0.0201
Virgin Islands (UK)	0.0186	New Zealand	0.0192	South Africa	0.0198

Acceptances		Acceptance rate		Enrolments	
Turks & Caicos Islands	0.0280	Cayman Islands	0.0320	Dominican Republic	0.0235
Cayman Islands	0.0254	Virgin Islands (UK)	0.0307	Qatar	0.0235
New Zealand	0.0240	New Zealand	0.0295	Kuwait	0.0234
Bermuda	0.0239	Botswana	0.0270	Oman	0.0234
Bosnia & Herzegovina	0.0236	Bermuda	0.0268	Ecuador	0.0225
Qatar	0.0226	Russia	0.0265	Singapore	0.0224
Colombia	0.0223	The Bahamas	0.0264	Hong Kong	0.0223
Australia	0.0220	Bahrain	0.0258	Mexico	0.0221
Virgin Islands (UK)	0.0219	Albania	0.0258	China	0.0218
Azerbaijan	0.0214	Colombia	0.0257	Azerbaijan	0.0216
Brunei	0.0214	Jamaica	0.0255	Brazil	0.0213
Singapore	0.0214	Seychelles	0.0252	United Arab Emirates	0.0212
Turkmenistan	0.0210	Turkmenistan	0.0251	United States	0.0211
Canada	0.0209	Mauritius	0.0249	Russia	0.0210
China	0.0204	Cayman Islands	0.0320	Ecuador	0.0225

Notes: Unit-specific weights from the top 15 control countries for synthetic DD estimator. Estimations based on UCAS (2006/07 – 2022/23) and HESA (2009/10 – 2022/23) data. Weights lie very close to each other and no countries receive zero weight.

A5 Synthetic event-study, heterogeneous results

Table A5. 1: Synthetic DD estimates by student characteristics, applications

	Age category				
	Below 18 (1)	18 (2)	19 (3)	20 (4)	21 to 24 (5)
ATT	-0.42*** (0.15)	-0.58*** (0.11)	-0.58*** (0.14)	-0.63*** (0.13)	-0.55*** (0.12)
Observations	715	1,040	1,040	936	949
Pre-mean	651.6	2760	2321	778.4	645.5
	Age category		Applicant's sex		
	25 to 29 (6)	30 and over (7)	Female (8)	Male (9)	
ATT	-0.72*** (0.19)	-0.83*** (0.20)	-0.62*** (0.11)	-0.57*** (0.09)	
Observations	676	546	1,157	1,118	
Pre-mean	110.9	45.34	4310	3002	
	Application deadline				
	October (10)	January (11)	June (12)		
ATT	-0.53*** (0.11)	-0.69*** (0.11)	-0.49*** (0.13)		
Observations	728	1,001	871		
Pre-mean	220.7	1212	244.5		
	EU origin region				
	North (13)	East (14)	South (15)	West (16)	
ATT	-0.85*** (0.18)	-0.83*** (0.19)	-0.29* (0.16)	-0.35*** (0.09)	
Observations	884	871	845	884	
Pre-mean	3904	8333	11454	6901	
	EU origin's economy strength				
	GDP pc.		Unemployment rate		
	Below median (17)	Above median (18)	Below median (19)	Above median (20)	
ATT	-0.91*** (0.26)	-0.50*** (0.10)	-0.56*** (0.13)	-0.75*** (0.16)	
Observations	546	624	546	494	
Pre-mean	12032	6717	4748	10407	

Notes: Log-linear synthetic DD estimations based on UCAS (2006/07 – 2022/23) data. The period between the referendum and Brexit (2016/17 – 2019/20) is excluded. The table reports the average treatment effect on the treated and the mean outcome for EU origin countries in 2019. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A5. 2: Synthetic DD estimates by student characteristics, offers

	Age				
	Below 18 (1)	18 (2)	19 (3)	20 (4)	21 to 24 (5)
ATT	-0.32* (0.16)	-0.51*** (0.11)	-0.63*** (0.12)	-0.50*** (0.13)	-0.47*** (0.13)
Observations	637	962	936	793	845
Pre-mean	438.3	1934	1601	478.6	351.6
	Age		Sex		
	25 to 29 (6)	30 and over (7)	Female (8)	Male (9)	
ATT	-0.55*** (0.19)	-0.64** (0.28)	-0.56*** (0.11)	-0.54*** (0.10)	
Observations	572	351	1,131	1,066	
Pre-mean	55.17	18.28	2871	2006	
	EU origin region				
	North (10)	East (11)	South (12)	West (13)	
ATT	-0.75*** (0.16)	-0.78*** (0.18)	-0.23 (0.15)	-0.35*** (0.09)	
Observations	845	832	806	845	
Pre-mean	2523	6081	7742	4121	
	EU origin's economy strength				
	GDP pc.		Unemployment		
	Below median (14)	Above median (15)	Below median (16)	Above median (17)	
ATT	-0.80*** (0.27)	-0.48*** (0.11)	-0.48*** (0.13)	-0.70*** (0.21)	
Observations	533	598	546	468	
Pre-mean	8840	4333	3029	7080	

Notes: Log-linear synthetic DD estimations based on UCAS (2006/07 – 2022/23) data. Period between referendum and Brexit (2016/17 – 2019/20) is excluded. The table reports the average treatment effect on the treated, the mean outcome for EU origin countries in 2019. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A5. 3: Synthetic DD estimates by student characteristics, acceptances

	Age				
	Below 18 (1)	18 (2)	19 (3)	20 (4)	21 to 24 (5)
ATT	-0.52*** (0.17)	-0.74*** (0.11)	-0.92*** (0.14)	-0.97*** (0.14)	-0.61*** (0.15)
Observations	429	793	793	676	702
Pre-mean	85.17	377.6	331.9	126.2	119.3
	Age		Sex		
	25 to 29 (6)	30 and over (7)	Female (8)	Male (9)	
ATT	-0.61** (0.24)	-0.23 (0.31)	-0.66*** (0.12)	-0.68*** (0.13)	
Observations	390	169	962	949	
Pre-mean	24.66	11.90	627.8	449.5	
	EU origin region				
	North (10)	East (11)	South (12)	West (13)	
ATT	-0.87*** (0.18)	-0.91*** (0.15)	-0.25 (0.21)	-0.43*** (0.10)	
Observations	754	741	715	741	
Pre-mean	534.2	1248	1824	1054	
	EU origin's economy strength				
	GDP pc.		Unemployment		
	Below median (14)	Above median (15)	Below median (16)	Above median (17)	
ATT	-0.84*** (0.24)	-0.64*** (0.12)	-0.63*** (0.14)	-0.77*** (0.23)	
Observations	455	572	520	416	
Pre-mean	1804	984	702.3	1536	

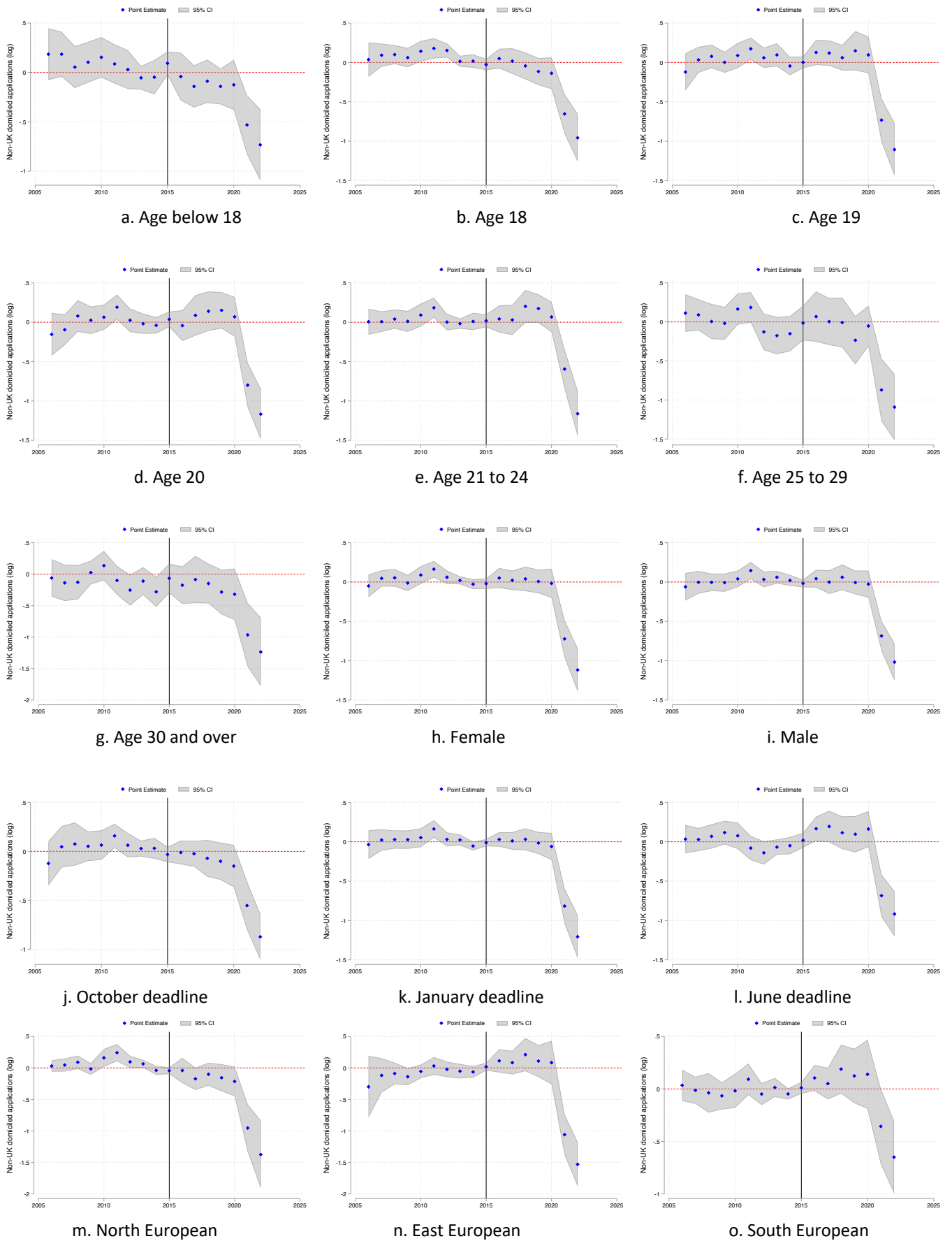
Notes: Log-linear synthetic DD estimations based on UCAS (2006/07 – 2022/23) data. Period between referendum and Brexit (2016/17 – 2019/20) is excluded. The table reports the average treatment effect on the treated, the mean outcome for EU origin countries in 2019. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

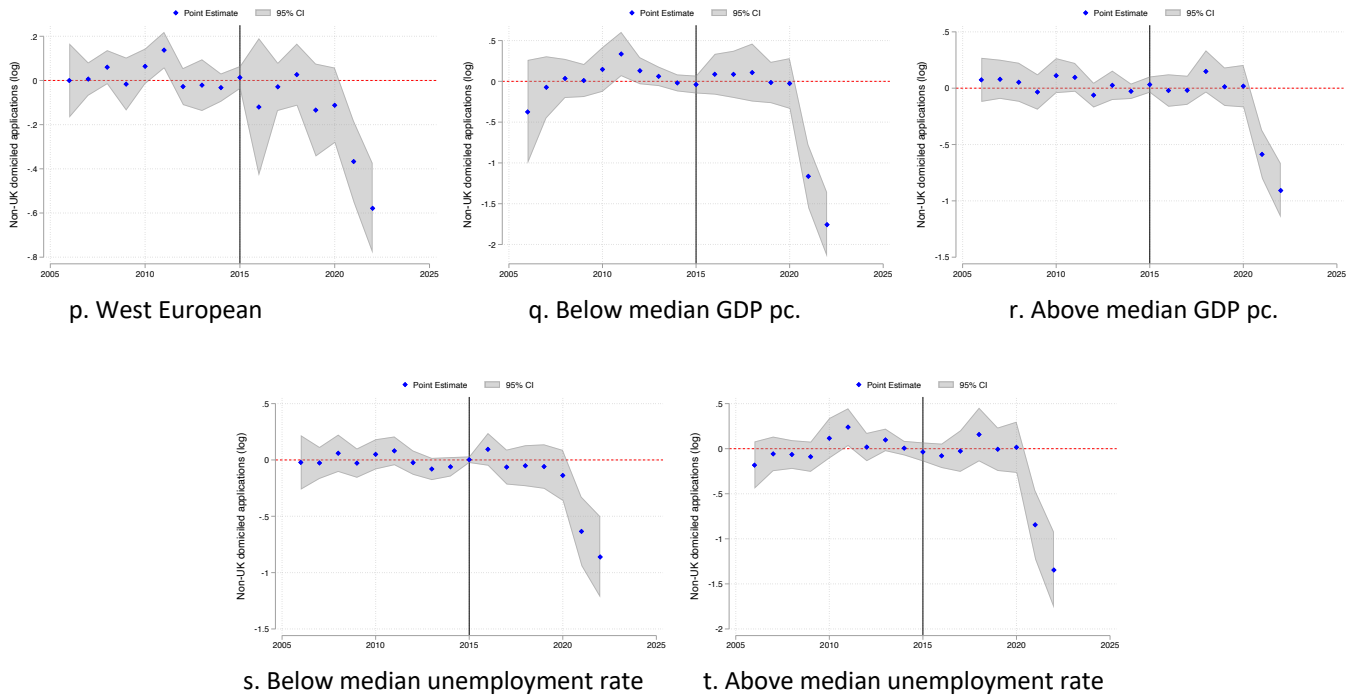
Table A5. 4: Synthetic DD estimates by student characteristics, enrolments

	Education level				Study type
	First degree (1)	Other undergraduate (2)	Postgraduate (research) (3)	Postgraduate (taught) (4)	Fulltime (5)
ATT	-0.25*** (0.10)	-0.91*** (0.18)	-0.12 (0.10)	-0.23** (0.09)	-0.21** (0.08)
Observations	820	480	620	800	440
Pre-mean	3408	75	384.1	919.7	4502
	Study type Parttime (6)	North (7)	EU origin region East (8)	South (9)	West (10)
ATT	-0.16 (0.12)	-0.36*** (0.09)	0.07 (0.13)	0.01 (0.21)	-0.12 (0.09)
Observations	330	630	620	610	620
Pre-mean	284.5	1992	4654	8462	5644
	UK region				
	England (11)	Wales (12)	Scotland (13)	Northern Ireland (14)	
ATT	-0.14 (0.10)	0.39*** (0.13)	-0.42*** (0.10)	-0.49 (0.33)	
Observations	890	580	710	230	
Pre-mean	3944	183.3	649.7	9.66	
	Higher educ. classification University (15)		University classification Russel (17)		Other (18)
ATT	-0.01 (0.09)	-0.05 (0.12)	-0.18 (0.11)	0.03 (0.09)	
Observations	356	264	308	352	
Pre-mean	4247	539.3	572.9	4214	
	EU origin's economy strength				
	GDP pc.		Unemployment		
	Below median (19)	Above median (20)	Below median (21)	Above median (22)	
ATT	0.08 (0.23)	-0.20* (0.11)	-0.13 (0.11)	-0.06 (0.19)	
Observations	400	460	420	380	
Pre-mean	6955	4574	3457	6494	

Notes: Log-linear synthetic DD estimations based on HESA (2009/10 – 2022/23) data. Information on study type is only available for 2014/15-2022/23. Information on higher education classification and university classification is only available for 2014/15-2021/22. The period between the referendum and Brexit (2016/17 – 2019/20) is excluded. The table reports the average treatment effect on the treated, the mean outcome for EU origin countries in 2019. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

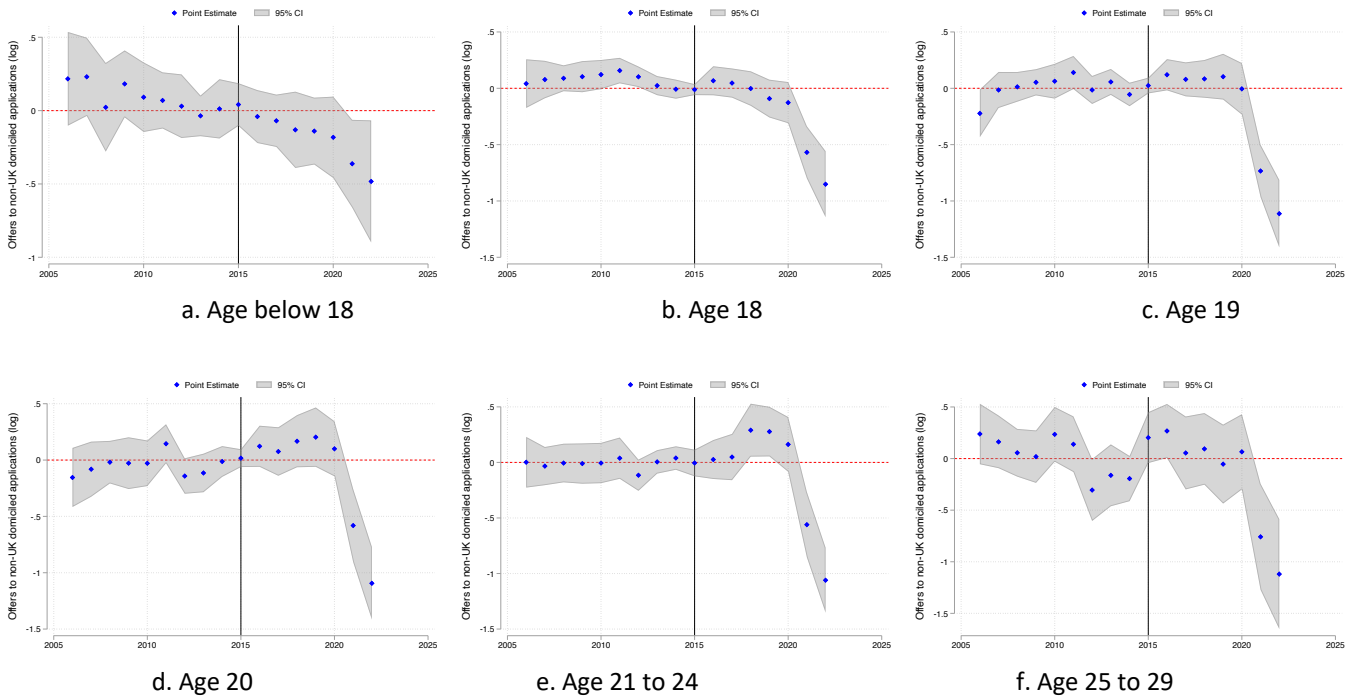
Figure A5. 1: Synthetic DD by student characteristics, applications

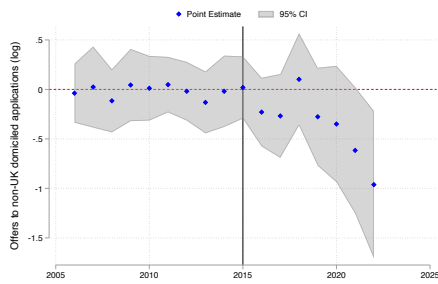




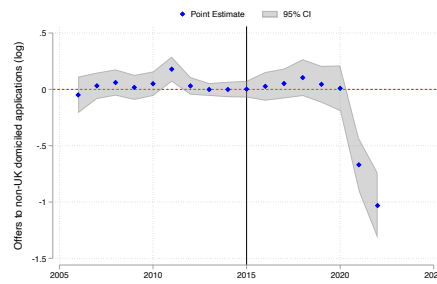
Notes: Synthetic DD estimations based on UCAS data (2006/07 – 2022/23). Confidence intervals are calculated using 200 bootstrap replications.

Figure A5. 2: Synthetic DD by student characteristics, offers

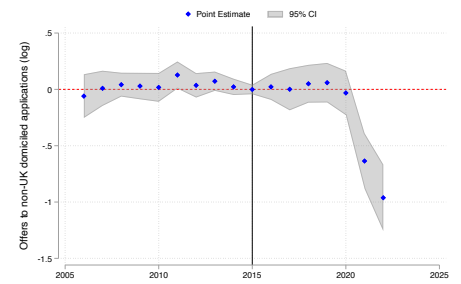




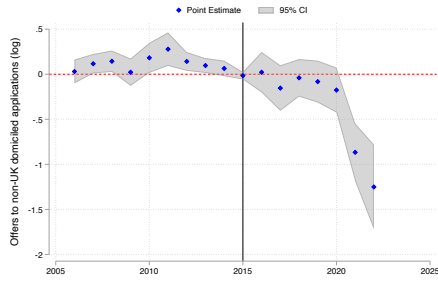
g. Age 30 and over



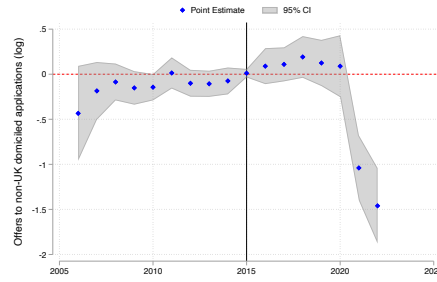
h. Female



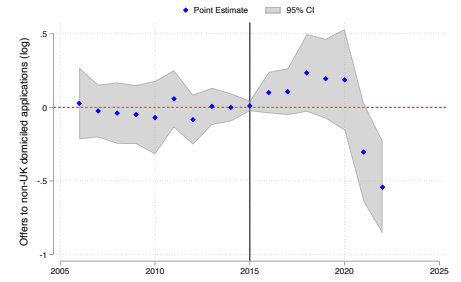
i. Male



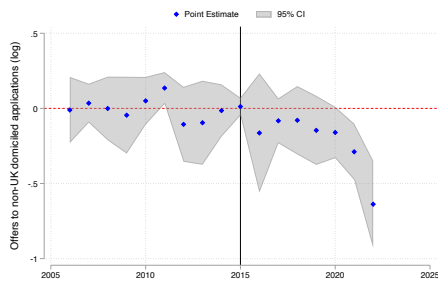
j. North European



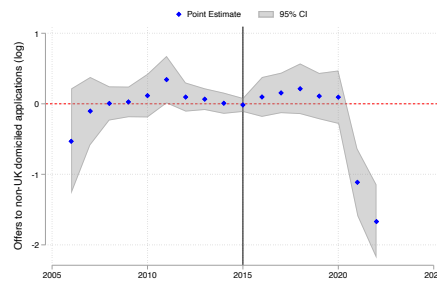
k. East European



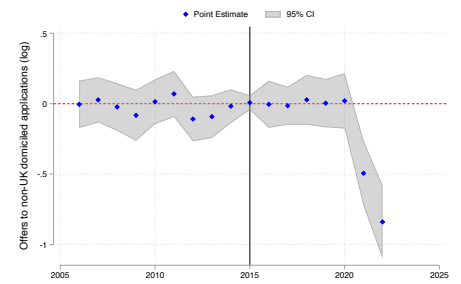
l. South European



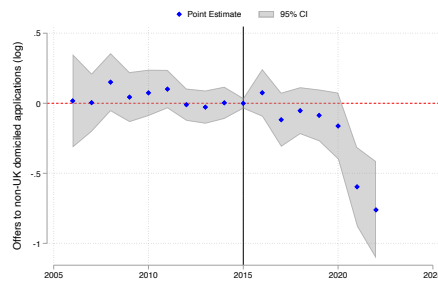
m. West European



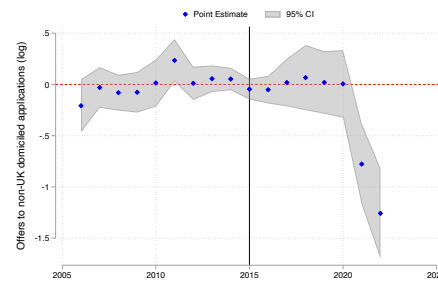
n. Below median GDP pc.



o. Above median GDP pc.



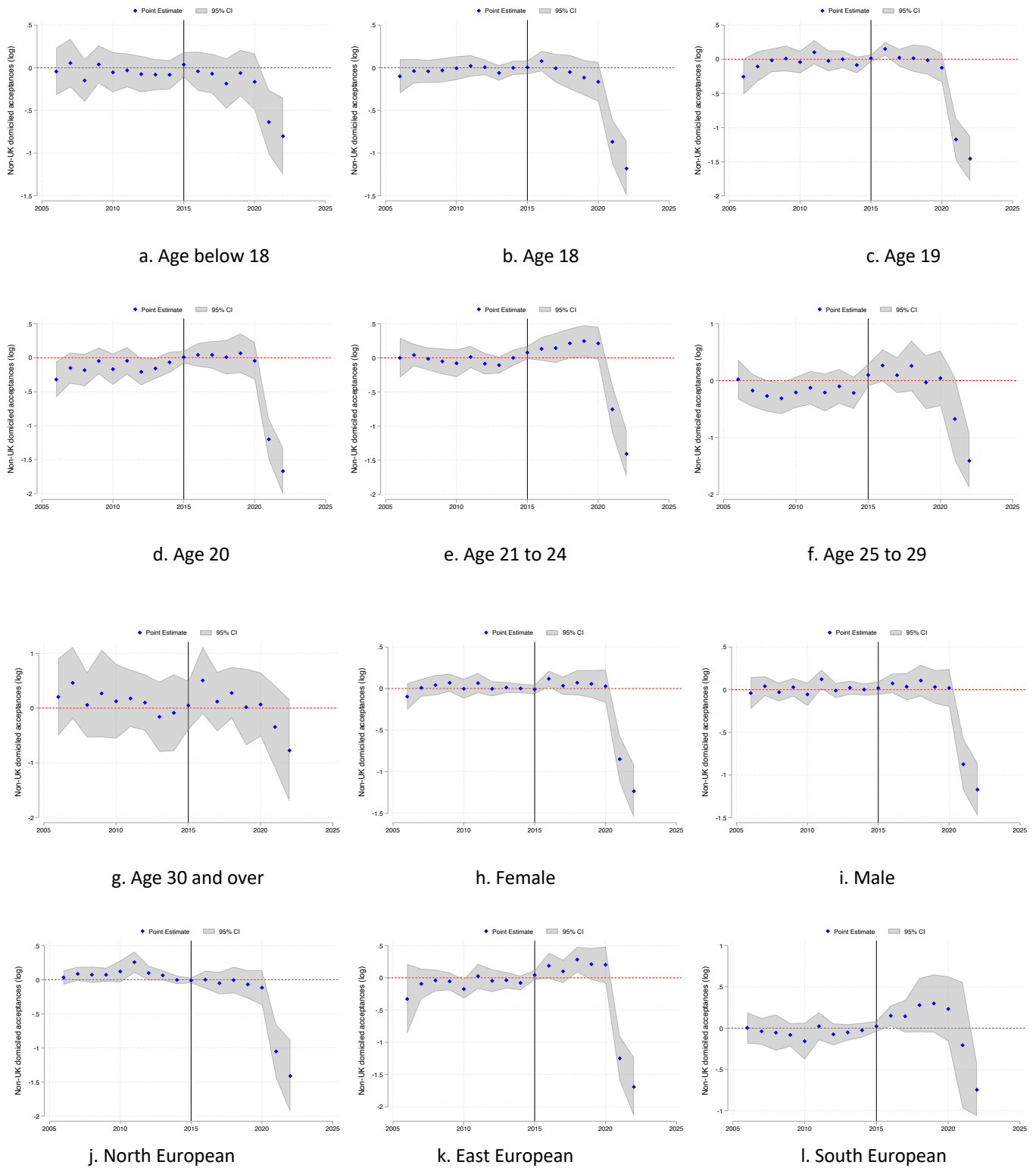
p. Below median unemployment rate

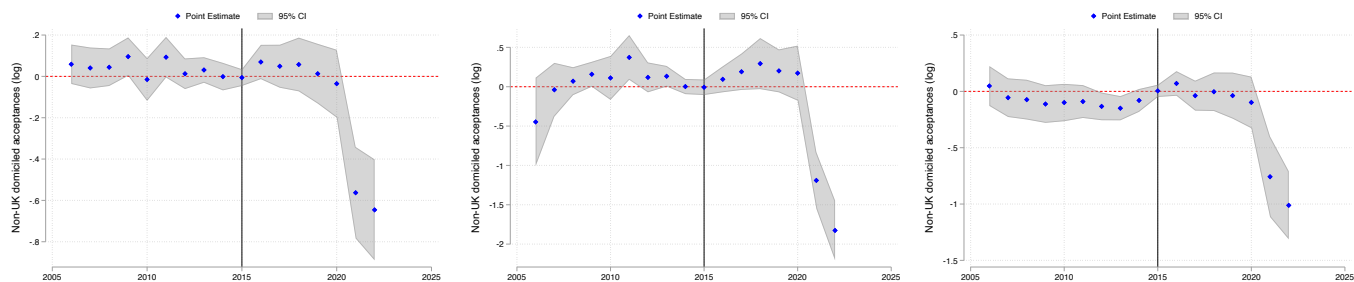


q. Above median unemployment rate

Notes: Synthetic DD estimations based on UCAS data (2006/07 – 2022/23). Confidence intervals are calculated using 200 bootstrap replications.

Figure A5. 3: Synthetic DD by student characteristics, acceptances

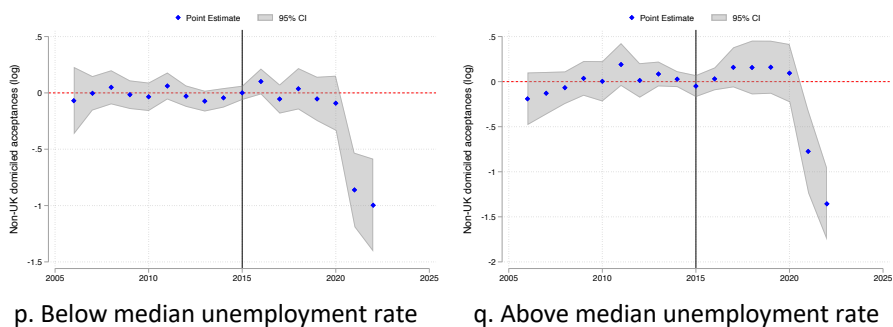




m. West European

n. Below median GDP pc.

o. Above median GDP pc.

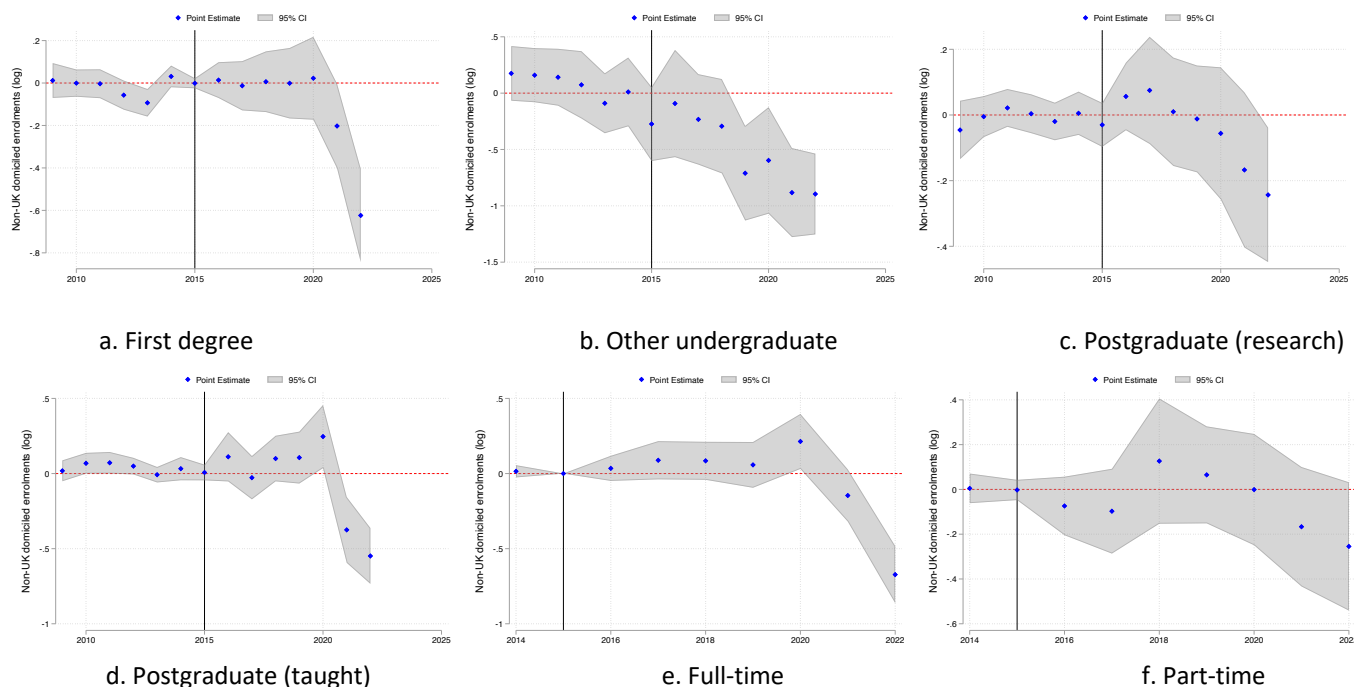


p. Below median unemployment rate

q. Above median unemployment rate

Notes: Synthetic DD estimations based on UCAS data (2006/07 – 2022/23). Confidence intervals are calculated using 200 bootstrap replications.

Figure A5. 4: Synthetic DD by student characteristics, enrolments



a. First degree

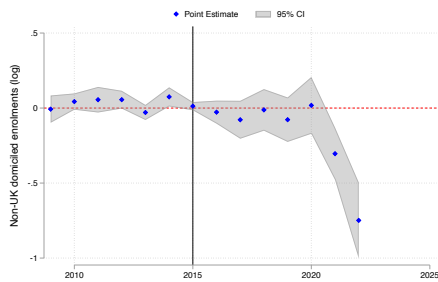
b. Other undergraduate

c. Postgraduate (research)

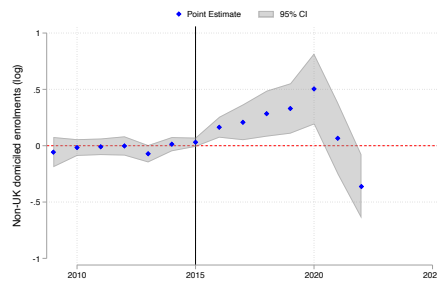
d. Postgraduate (taught)

e. Full-time

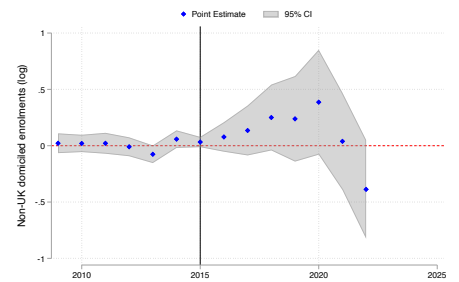
f. Part-time



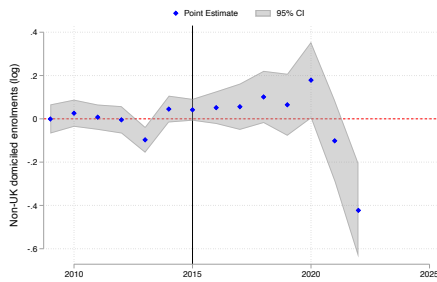
g. North European



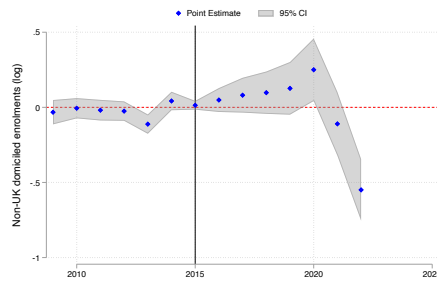
h. East European



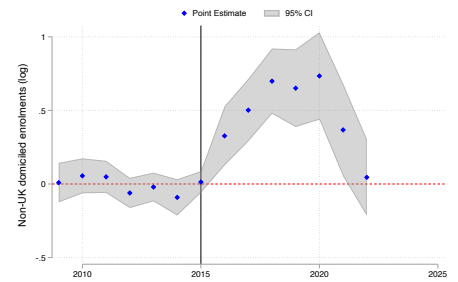
i. South European



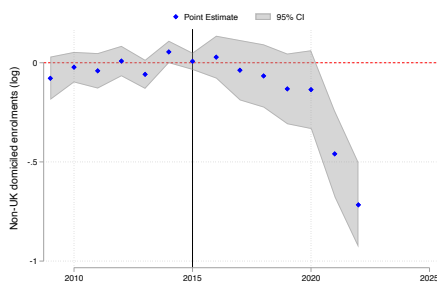
j. West European



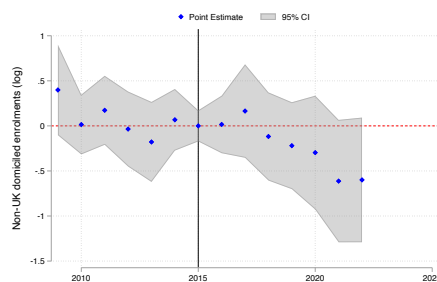
k. England



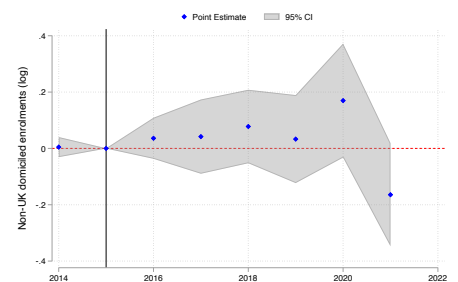
l. Wales



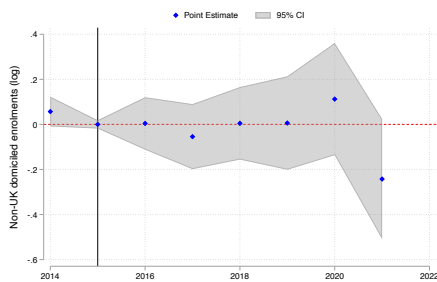
m. Scotland



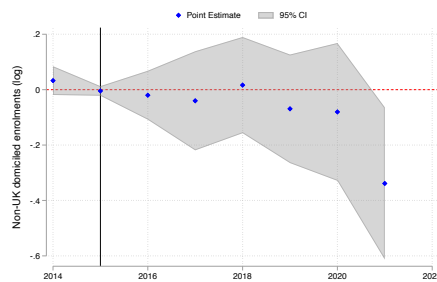
n. Northern Ireland



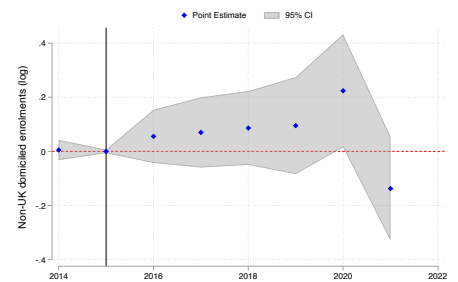
o. University



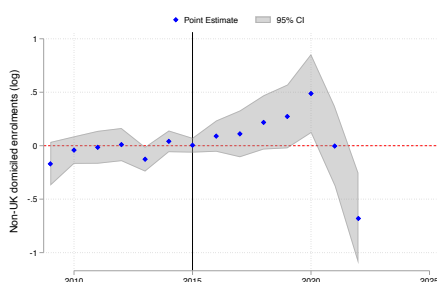
p. Other (non-university)



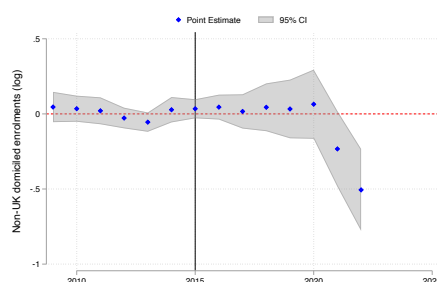
q. Russel university



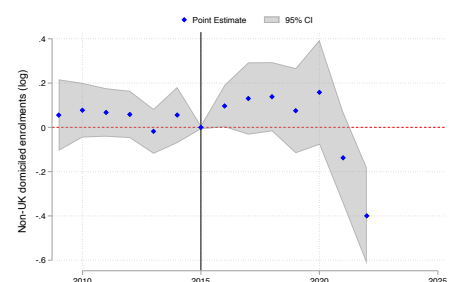
r. Other (non-Russel)



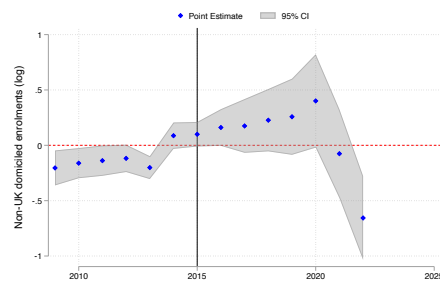
s. Below median GDP pc.



t. Above median GDP pc.



u. Below median unemployment rate



v. Above median unemployment rate

Notes: Synthetic DD estimations based on HESA data (2009/10 – 2022/23). Confidence intervals are calculated using 200 bootstrap replications.

A6. Robustness checks

Table A6. 1: Robustness checks, alternative specifications of the synthetic DD

	(1) Applications	(2) Offers	(3) Offer rate	(4) Acceptances	(5) Acceptance rate	(6) Enrolments
A. Placebo 2013						
ATT	-0.08 (0.06)	0.01 (0.06)	0.05*** (0.02)	0.00 (0.05)	0.05*** (0.01)	0.14** (0.06)
B. Placebo 2015						
ATT	0.02 (0.05)	0.02 (0.07)	0.02 (0.02)	0.03 (0.06)	0.08*** (0.03)	0.03 (0.03)
C. Origin control variables						
ATT	-0.61*** (0.11)	-0.53*** (0.12)	0.09*** (0.03)	-0.67*** (0.14)	-0.08* (0.04)	-0.05 (0.11)
D. UK control variables						
ATT	-0.61*** (0.10)	-0.56*** (0.10)	0.07*** (0.02)	-0.65*** (0.11)	-0.08** (0.03)	-0.16* (0.10)
E. Excluding Asian countries						
ATT	-0.63*** (0.11)	-0.59*** (0.11)	0.05** (0.02)	-0.66*** (0.12)	-0.08** (0.04)	-0.18* (0.10)
F. All non-EU countries						
ATT	-0.65*** (0.09)	-0.59*** (0.09)	0.07*** (0.02)	-0.71*** (0.10)	-0.07*** (0.02)	-0.27*** (0.09)
G. Shorter pre-period (3 years)						
ATT	-0.60*** (0.09)	-0.58*** (0.10)	0.03 (0.02)	-0.66*** (0.10)	-0.10*** (0.03)	-0.11 (0.09)
H. Excluding 2015						
ATT	-0.61*** (0.11)	-0.55*** (0.12)	0.07*** (0.02)	-0.64*** (0.11)	-0.07** (0.03)	-0.07 (0.12)
I. inverse hyperbolic sine						
ATT	-0.60*** (0.11)	-0.57*** (0.11)	0.02 (0.01)	-0.58*** (0.12)	-0.05*** (0.01)	-0.14* (0.08)
J. Poisson regression						
ATT	-0.77*** (0.21)	-0.63*** (0.20)	0.02 (0.03)	-0.68*** (0.20)	-0.08 (0.05)	-0.39** (0.17)

Notes: Log-linear synthetic DD regressions with alternative samples or specifications, inverse hyperbolic sine transformed synthetic DD regression, and Poisson regression, based on UCAS and HESA data. Bootstrapped standard errors (200 replications) or clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A6. 2: Addressing potential spillovers with counterfactual scenarios

	(1) Applications	(2) Offers	(3) Offer rate	(4) Acceptances	(5) Acceptance rate	(6) Enrolments
A. Original SDID						
ATT	-0.61*** (0.10)	-0.56*** (0.10)	0.07*** (0.02)	-0.65*** (0.10)	-0.08** (0.03)	-0.16* (0.10)
B. Counterfactual scenario 1						
ATT	-0.98*** (0.13)	-0.90*** (0.11)	0.05*** (0.02)	-1.05*** (0.13)	-0.10*** (0.02)	-0.16** (0.06)
C. Counterfactual scenario 2						
ATT	-0.50*** (0.07)	-0.46*** (0.08)	0.05*** (0.02)	-0.63*** (0.09)	-0.14*** (0.02)	-0.09 (0.06)
Observations	1,209	1,170	1,079	1,079	923	890
Origin countries	93	90	83	83	71	89
% change (sc. 1)	-62.62	-59.29	5.118	-64.97	-9.535	-14.55
% change (sc. 2)	-39.46	-36.94	5.267	-46.81	-13.13	-8.498

Note: Synthetic DD estimations of the log-linear model based on UCAS (2006/07 – 2022/23) (columns 1 to 5) and HESA (2009/10 – 2022/23) (column 6) data. The period between the referendum and Brexit (2016/17 – 2019/20) is excluded. The table reports the average treatment effect on the treated for the baseline estimation (panel A) and two alternative counterfactual scenarios. Panel A is based on counterfactual non-EU inflows that followed the same growth rate post-referendum as pre-referendum. Panel B is based on counterfactual non-EU inflows that remained constant post-referendum. Bootstrapped standard errors (200 replications) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Percentage change is calculated using the following formula: $\exp(\beta) - 1$.

Table A6. 3: Robustness check, Covid-19 coincidence

	(1) Applications	(2) Offers	(3) Offer rate	(4) Acceptances	(5) Acceptance rate	(6) Enrolments
A. Excluding countries on Covid-19 Red list						
ATT	-0.49*** (0.11)	-0.42*** (0.14)	0.06** (0.02)	-0.57*** (0.12)	-0.10*** (0.04)	-0.11 (0.11)
B. Lowest overall government response						
ATT	-0.69*** (0.15)	-0.61*** (0.14)	0.09** (0.04)	-0.78*** (0.19)	-0.07 (0.04)	-0.15 (0.14)
C. Lowest stringency						
ATT	-0.57*** (0.13)	-0.52*** (0.13)	0.08** (0.03)	-0.65*** (0.15)	-0.09** (0.04)	-0.08 (0.12)
D. Lowest relative cases						
ATT	-0.87*** (0.20)	-0.79*** (0.23)	0.03 (0.04)	-0.94*** (0.20)	-0.12** (0.05)	-0.27 (0.17)
E. Lowest relative deaths						
ATT	-0.56*** (0.19)	-0.50*** (0.17)	0.04 (0.02)	-0.62*** (0.21)	-0.13** (0.05)	-0.37*** (0.11)

Notes: Synthetic DD estimations with alternative samples, based on UCAS (2006/07 – 2022/23) and HESA (2009/10 – 2022/23) data. The period between the referendum and Brexit (2016/17 – 2019/20) is excluded. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Countries included in the sample are listed in Appendix Table A4.1.

Table A6. 4: Sample countries for robustness check, Covid-19 coincidence

A. Excluding countries on Covid-19 Red list

Excluded: Argentina, Bahrain, Botswana, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guyana, Maldives, Namibia, Oman, Panama, Paraguay, Peru, Qatar, Seychelles, South Africa, Surinam, Trinidad and Tobago, United Arab Emirates, Uruguay

B. Lowest overall government response

Included: Albania, Aruba, Belarus, Bermuda, Bosnia And Herzegovina, Botswana, Brazil, Brunei, Bulgaria, Costa Rica, Denmark, Dominica, Dominican Republic, Estonia, Finland, France, Gabon, Guam, Hungary, Iceland, Kazakhstan, Kuwait, Latvia, Libya, Liechtenstein, Lithuania, Luxembourg, Mauritius, Mexico, Namibia, New Zealand, Norway, Oman, Paraguay, Poland, Puerto Rico, Russia, Serbia, Seychelles, Slovenia, Sweden, Switzerland, Taiwan, Thailand, Tonga, Turkey, Turkmenistan, United States, Uruguay, Virgin Islands (US)

C. Lowest stringency

Included: Albania, Aruba, Bahrain, Belarus, Belgium, Bermuda, Bosnia and Herzegovina, Botswana, Brunei, Bulgaria, Costa Rica, Czech Republic, Denmark, Dominica, Estonia, Finland, France, Guam, Hungary, Iceland, Ireland, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Mauritius, Namibia, Netherlands, New Zealand, Norway, Paraguay, Poland, Portugal, Puerto Rico, Russia, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Sweden, Switzerland, Taiwan, Thailand, Turkey, United States, Uruguay, Virgin Islands (US)

D. Lowest relative cases

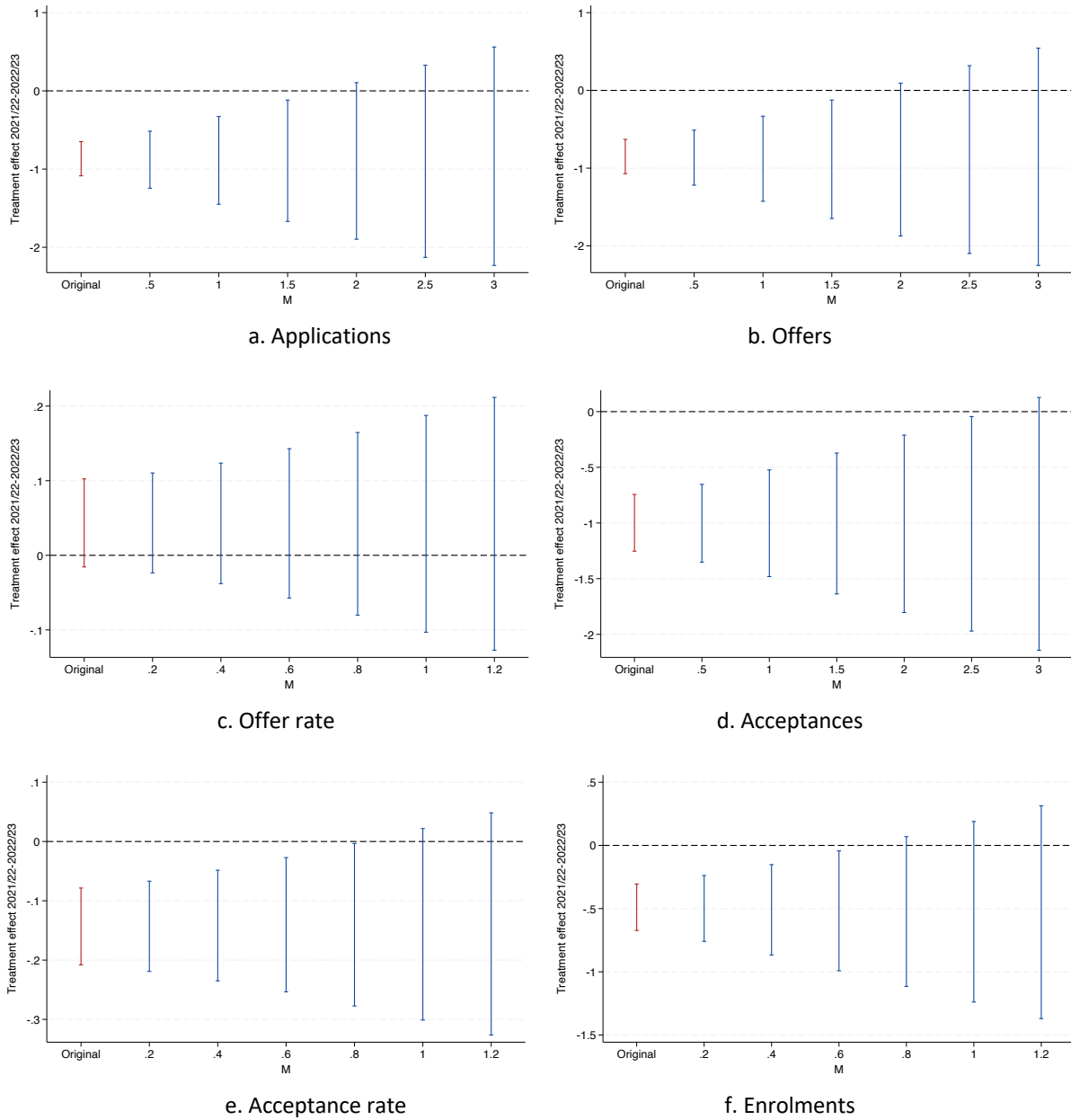
Included: Albania, Azerbaijan, Bahamas, Belarus, Belize, Bosnia and Herzegovina, Botswana, Bulgaria, Canada, China, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Fiji, Finland, Gabon, Guyana, Hong Kong, Jamaica, Japan, Kazakhstan, Kuwait, Libya, Malaysia, Malta, Mauritius, Mexico, Namibia, New Zealand, Norway, Oman, Paraguay, Peru, Poland, Puerto Rico, Qatar, Romania, Russia, Saudi Arabia, South Africa, Surinam, Thailand, Tonga, Trinidad and Tobago, Turkey, United Arab Emirates, Virgin Islands (US)

E. Lowest relative deaths

Included: Albania, Australia, Azerbaijan, Bahrain, Barbados, Belarus, Belize, Bermuda, Botswana, Brunei, China, Costa Rica, Cuba, Cyprus, Denmark, Dominica, Dominican Republic, Estonia, Fiji, Finland, Gabon, Germany, Guyana, Hong Kong, Iceland, Ireland, Jamaica, Japan, Kazakhstan, Kuwait, Libya, Malaysia, Malta, Mauritius, Namibia, Netherlands, New Zealand, Norway, Oman, Puerto Rico, Qatar, Saudi Arabia, Seychelles, Singapore, South Korea, Thailand, Tonga, Turkey, United Arab Emirates, Virgin Islands (US)

Notes: Panel A lists the countries on the Covid-19 Red list, which were excluded from the analysis. Panels B to E list the countries hit the least by Covid-10 according to different measures, which were included in the analysis.

Figure A6. 1: Credible approach to DD parallel trends assumption



Notes: Credible approach to parallel trends implemented on the dynamic DD estimations based on UCAS (2006/07 – 2022/23) and HESA (2009/10 – 2022/23) data. The sensitivity analysis is performed on the significant treatment effects after Brexit, 2021/22 – 2022/23 (figures a to f). Confidence bounds are based on relative magnitude restrictions that allow for M times the max. common trends violation in 2010/11 - 2015/16.

A7. Back of the envelope calculations

Table A7. 1: Estimated counterfactual of EU student numbers in the UK, 2021/22-2022/23

	[1]	[2]	
	Acceptances	Student enrolments	
	Undergrad	Undergrad	Postgrad
Observed summary statistics			
Observed pre-referendum yearly mean (per EU origin)	765.1	2661.9	1391.6
Observed pre-referendum yearly mean (total)	22186.5	54037.5	28249.5
Observed post-Brexit yearly mean (per EU origin)	431.2	2521.0	947.6
Observed post-Brexit yearly mean (total)	12505.0	73110.0	27480.0
Estimated % change	-64.5	-44.0	-47.1
Estimated counterfactuals			
Counterfactual post-Brexit yearly mean (per EU origin)	1214.4	4499.7	1791.9
Counterfactual post-Brexit yearly mean (total)	35217.6	130492.5	51965.7
Yearly absolute loss due to Brexit (per EU origin)	-783.2	-1978.7	-844.3
Yearly absolute loss due to Brexit (total)	-22712.6	-57382.5	-24485.7

Notes: Authors' calculations based on summary statistics and DD estimations of the Brexit phases using a log-linear model. Pre-referendum statistics are estimated for the years 2006/07 to 2015/16. Post-Brexit statistics are estimated for the years 2021/22 to 2022/23. We estimate the counterfactual post-referendum mean based on the estimated effect of increased tuition fees (2021/22 to 2022/23) (Phase 3) (see Equation 2), stating that the observed post-referendum mean is between 44.0 to 64.5% lower than the counterfactual, depending on the outcome. The yearly absolute loss is calculated as the difference between the observed and the counterfactual post-referendum mean.