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The effect of foreign students in higher education on native students' outcomes[☆]

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ABSTRACT

This paper offers new evidence of the role of immigration in shaping the educational and labour market outcomes of natives. We use administrative data on the entire English higher education system and exploit the idiosyncratic variation of foreign students within university-degree across four cohorts of undergraduate students. Foreign peers have zero to mild effects on natives' educational outcomes, such as graduation probability and degree classification. Significant effects are found on displacement across universities and degree types after enrolment, although these outcomes are rare occurrences. In line with the mild effects on education outcomes, we also find little evidence of foreign peers affecting early labour market outcomes of native graduates.

1. Introduction

Globally, over six million individuals choose to study in a foreign country.[1] This influx of international students has the potential to impact the educational and labour market outcomes of native individuals. For instance, research has shown that international students contribute to cross-subsidize natives' participation into higher education through tuition revenue (Machin and Murphy, 2017; Shih, 2017), which can have a positive effect on the labour market prospects of natives, since graduates tend to earn more than non-graduates.

Furthermore, the presence of international students in higher education can lead to significant changes in the learning environment for native students, potentially influencing their skill development and long-term economic outcomes. Several mechanisms might contribute to this impact. Firstly, the lack of English proficiency among foreign students may potentially lower the overall quality of the learning environment (Anelli et al., 2023). Secondly, the diverse range of skills brought by international students could

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[1] As reported by UNESCO international mobile students data.

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enhance cooperative work among natives, similar to the positive effects of skill diversity on firm productivity (Iranzo et al., 2008). Additionally, by altering the distribution of abilities within a degree programme, international students may affect the reference group that native students use to gauge their own perceived abilities, which can result in changes in their level of effort (Elsner and Isphording, 2017; Murphy and Weinhardt, 2018). It is uncertain which of these effects would have a more dominant influence.

This study focuses on examining the impact of foreign peers on the educational and labour market outcomes of native students, conditional on them having enrolled in Higher Education (HE henceforth). To conduct our analysis, we utilize comprehensive administrative data obtained from the HE Statistical Agency (HESA), which encompasses all universities and degree programmes within the United Kingdom. It is worth noting that the United Kingdom ranks second globally, after the United States, in terms of the number of international students enrolled in HE. Our dataset comprises four cohorts of undergraduate students who were enrolled in HE between the years 2007/08 and 2010/11. We closely track the university and degree programme each student attends and monitor their progress until they complete their HE studies. This longitudinal approach allows us to determine whether students successfully graduated, the specific degree classification they obtained, and whether they changed the university or degree programme from that they initially enrolled in.

We categorize students as either *native* or *foreign* based on whether they resided in the UK or another country before enrolling in HE. Within the group of foreign students, we further differentiate between students from European Union (EU) countries and those from non-EU countries. We label these subgroups as *EU* and *non-EU* students, respectively. This distinction is due to these populations being differently selected: during the period under consideration, EU students were subject to the same fees and eligible for the same financial support as UK students; in contrast, non-EU students were required to pay substantially higher fees upfront.

To estimate the effect of foreign peers on their native counterparts we follow Hoxby (2000) in exploiting the idiosyncratic variation in the share of foreign students across cohorts within university-degree programmes.[2] This idiosyncratic variation enables us to identify the effect of foreign peers on natives' HE outcomes in terms of graduation and degree classification obtained. We also consider whether foreign students affect the probability of native students changing from their initial university and degree. More specifically, we focus on switching from a university belonging to the Russell Group[3] to a non-Russell Group university, and switching from a STEM (Science, Technology, Engineering and Mathematics) to a non-STEM degree and *vice versa*. We do so as graduating in prestigious universities and STEM degrees have sizeable effects on later economic outcomes.[4]

Our research reveals that the presence of foreign students does not have a significant impact on the likelihood of native students successfully completing their undergraduate studies and on their degree classification. However, we do observe some notable effects of EU students. Specifically, EU students do increase the probability of staying in a non-STEM degree vs. changing to a STEM degree and of changing from a Russell to a non-Russell university. The magnitude of these last two effects is large as a proportion of students switching across universities and degrees (75 and 46 percent relative to the mean, respectively, for a one standard deviation increase in the share of EU students). However, changes of degree and university are rare occurrences.

We test whether foreign students differently affect natives from different ability groups. EU students, who typically demonstrate strong academic performance in HE, impact natives' HE outcomes fairly uniformly across natives' ability groups. On the other hand, non-EU students, who tend to have lower academic performance, exert downward pressure on the degree class distribution of high-ability native students. Interestingly, both EU and non-EU students positively impact the retention of native students in non-STEM degrees. This effect is consistent across the entire ability distribution of native students, indicating that the presence of foreign students influences the degree choices of natives regardless of their academic abilities.

To further examine the impact of foreign students, we track the outcomes of graduates six months after their graduation. This is accomplished by linking the HESA student record data with the Destination of Leavers from Higher Education (DLHE) dataset. Our analysis reveals that, on the whole, foreign students do not have a statistically significant influence on the activity status of native graduates. Additionally, for those graduates who are employed, the presence of foreign students does not significantly affect their occupation and working hours. However, there is some evidence that non-EU students have a positive impact on the salary of native students, especially among high-ability graduates. Notably, we do not find relevant variations in the effects based on university and degree type, nor on natives' characteristics.

This paper provides new evidence on the effect of studying alongside international classmates in HE on a wide range of outcomes for native students. In doing so, it contributes valuable insights to the existing literature, which has primarily focused on the influence of foreign students on educational performance at pre-tertiary levels (e.g., Ballatore et al., 2018; Fletcher et al., 2019; Gould et al., 2009; Ohinata and Van Ours, 2013). For instance, Geay et al. (2013) discover a negative impact of foreign students on native performance at primary schools in England, driven solely by selection bias, as foreign students are more likely to attend lower-quality schools. Once selection bias is accounted for, no significant peer effects from foreign students are found.

However, the effects of foreign peers in HE have received less attention. We highlight two notable exceptions in the literature. Anelli et al. (2023) provide evidence showing that an increased proportion of foreign classmates in introductory first-year

[2] For similar approaches see also Anelli and Peri (2019), Carrell et al. (2018), Chevalier et al. (2019), Cools et al. (2019) and Bostwick and Weinberg (2022).

[3] The most prestigious universities in the UK belong to the so-called Russell Group. The twenty-four universities in this group are research-focused institutions, nationally and internationally well recognized as those with the highest standards of research and teaching. The Russell Group is the equivalent of the American Ivy League of prestigious universities.

[4] Alongside the final grade obtained (Feng and Graetz, 2017; French et al., 2015; Jaeger and Page, 1996; Jones and Jackson, 1990), there is ample evidence that, within graduates, labour market returns largely depend on the university attended (Black and Smith, 2006; Broecke, 2012; Chetty et al., 2020; Cunha and Miller, 2014; Dale and Krueger, 2014; Dillon and Smith, 2020; Hoekstra, 2009; Mountjoy and Hickman, 2020; Walker and Zhu, 2018) and the degree studied (Altonji et al., 2012; Blundell et al., 2000; Britton et al., 2021; Chevalier, 2011; Kirkeboen et al., 2016; Walker and Zhu, 2011, 2018). Notably, differences in earnings across degrees can be more important than those across different levels of qualification (Altonji et al., 2012).

maths classes at a university in the USA prompts domestic students to be less likely subsequently to take STEM majors and more likely to take non-STEM majors. Chevalier et al. (2019) investigate the random allocation of students to Economics seminars at an English university and find no impact on performances and educational choices for native English speakers in a more linguistically diverse environment. Interestingly, positive effects on performance are discovered for non-native English speakers when exposed to greater language diversity in the classroom. Building upon these studies, we make four significant contributions.

First, we expand the analysis beyond a single department or course in a single university to encompass the entire HE system, so that our results are representative of the entire native student population in England.[5] Students in our sample attend a range of elite and non-elite institutions and have already made an initial 'major choice', as opposed to in Anelli et al. (2023), whose sample covers students in a single institution and on a path leading to many potential majors. Nevertheless, our findings are consistent with those in Anelli et al. (2023), in that exposure to foreign students discourages natives from switching from non-STEM to STEM degrees (coefficients for the opposite move are insignificant but opposite-signed and similar in magnitude), plausibly due to lowering in-class communication and social interactions. Our findings are also consistent with those of Chevalier et al. (2019), who (while studying one degree at one university) do not find an important effect of language diversity on the academic performances of native English speakers. This paper therefore makes an important contribution in showing that the forms of peer effects of foreign students on natives' outcomes identified in earlier work in distinct settings, are externally valid across the population of universities and degrees in England.

Second, having access to comprehensive data allows us to perform in-depth analyses across different demographic groups, testing the existence of heterogeneous effects along the ability distribution of native students, native students' sex, ethnicity and socio-economic status, as well as variations across universities and degree programmes. This study emphasizes that all native students, regardless of their socioeconomic status, demographic characteristics, university attended, or degree pursued, experience similar impacts (or lack thereof) from the presence of international students.

Third, by examining outcomes in the labour market after graduation, we can assess whether peer effects extend beyond academic achievements. In line with the mild effects on education outcomes, we also find little evidence of foreign peers affecting early activity status and job characteristics of native graduates.

Fourth, our national data analysis offers a sector-wide perspective, as Higher Education for overseas students serves as a significant export industry for the UK and other countries such as the USA, Canada, and Australia. It is, thus, crucial to understand whether the labour market prospects of native students are adversely affected by their exposure to international students. With our study, we contribute to document the dynamics of studying with foreign peers and how these shape the future trajectories of native students. This study presents robust evidence that, once enrolled into HE, international students do not have a significant impact on the educational and initial labour market outcomes of native students. Additionally, this study provides suggestive evidence that international students do not importantly influence the initial sorting of native students into higher education programmes, aligning with previous research conducted in the UK (Machin and Murphy, 2017). Overall, these results suggest that the presence of international students in HE does not substantially affect the opportunities of native undergraduate students. We encourage future research to provide further empirical evidence in this area, especially in light of recent changes in the UK's HE system.

2. Institutional settings

The UK is the second country in the world, after the USA, in terms of foreign students in HE. In 2019/20 over one-fifth of all students in the UK HE system came from outside the UK: 6% from the EU and 17% from the rest of the world.[6] In science (non-science) subjects, international students constitute 13% (16%) of undergraduate students, 26% (39%) of postgraduate taught students, and 42% (42%) of postgraduate research students.

The number of international students entering the UK's HE system is influenced by various factors. Some of these are "push" factors, which depend on the students' home countries, such as the GDP per capita and the exchange rate of their local currency to the British pound (Conlon et al., 2017; Naidoo, 2007; Prazeres and Findlay, 2017). Other factors are related to policies in competing countries, such as differences in tuition fees between the US and UK (Conlon et al., 2017). "Pull" factors also play a role, such as the expansion of the post-study work visa programme in 2008, which allowed graduates to stay for two years after graduation without a sponsor, resulting in an increase in international student numbers.[7] Consistently, the number of international students applying and enrolling in the UK decreased due to restrictive policies such as post-study visa restrictions in 2012 and Brexit in 2016 (Conlon et al., 2017; Amuedo-Dorantes and Romiti, 2021). The negative impact of these policies in terms of number of incoming international students has been found to vary across subjects and universities, due to different elasticities of demand, as well as depending on the employment prospects and economic strength of the students' home countries. It is thus important to note that the elements influencing international student inflows are complex and depend on various internal and external factors, such as policies in third countries and country of origin characteristics. Therefore, there is an exogenous component in the share of foreign students which is independent of universities' admissions policies and demand among home students, overall and across universities.

[5] Braakmann and McDonald (2018) consider all English universities, but they focus on the impact of exposure to socio-economic diversity on undergraduate students' educational outcomes. They define 1200 types of undergraduate students by combining different characteristics (i.e. gender, country of origin, age, ethnicity and several measures of socio-economic status). They find that for getting a good degree (upper second class or better) students benefit both from being exposed to a more diverse set of student types and from having peers more like themselves.

[6] Data source for official statistics on international students: https://www.hesa.ac.uk/data-and-analysis/students/where-from.

[7] https://migrationobservatory.ox.ac.uk/resources/briefings/student-migration-to-the-uk/.

This paper focuses on the English system of HE. English universities represent the largest part of the UK system of HE. Around 84% of all HE students in the UK are enrolled in an English university. The English system of HE is an ideal setting to study the effect of foreign peers. This is because the composition of students at entry in HE is stable along the whole period of study. Differently from other countries, such as the USA and Scotland, in England students enrol in a 'degree programme' or 'course' at the beginning of their first year. Each university course is usually associated with one or two specific fields of study. No general curriculum is offered initially, and there is no 'major choice' decision. An undergraduate degree usually lasts three years, and its duration is fixed because students cannot choose when to take exams, unlike what happens in other European countries, or when to graduate, as in the USA. As a result of the rigidity of the system, dropout and changes of degree and university once enrolled are rare (Vignoles and Powdthavee, 2009).

Native students' applications and acceptances to university courses are managed through the centralized Universities and Colleges Admissions Service (UCAS). Universities publish entry requirements for each course, which can be summarized by the 'UCAS tariff score', derived from achieved grades in each post-16 qualification. Students in the final year of secondary school submit their predicted grades when applying. Universities independently choose to whom they make offers of admission, and students select a first and second choice from among these. Enrolment is usually conditional on students' realized grades or tariff score matching the entry criteria. There is an additional round of 'Clearing', in which students who failed to meet the conditions of either of their choices can match with courses with unfilled places.

Universities are funded by the state through the HE Funding Council for England (HEFCE). To control these costs, in the period here considered HEFCE set a cap on the growth in the number of British and EU nationals that could be enrolled across the country, and (with tolerance limits of $+/-5\%$) in each university. Some subjects and institutions were permitted more extra places to reflect government strategies. Universities faced monetary fines offsetting additional gains derived from student fees, if they enrolled students above their cap (Machin and Murphy, 2017). Non-EU students were not considered for the cap and their enrolment was only subjected to visa restrictions and capacity constraints of the university. Furthermore, non-EU students paid considerably higher fees than EU students; the latter were entitled to the same tuition fees and financial support as native students.

3. Empirical strategy

We follow the literature on peer effects which has mainly relied on quasi-random variation across cohorts within a unit, e.g. a school or a firm, to analyse a vast range of outcomes.[8] As pointed out in Manski (1993), estimating peer effects requires to disentangle contextual and the endogenous effect, i.e. individual outcomes vary with both the characteristics and the outcomes of the group of interest.[9] To separate peer effects from correlated own characteristics we consider the outcomes of native students only (Angrist, 2014; Carrell et al., 2018).

The main challenge for identifying a causal effect of foreign students on natives' outcomes is that we need to net out confounding characteristics that are hardly measurable, such as studying facilities or recruitment effort by university. Omitting such characteristics could impair the causal interpretation of our estimates. For example, those universities that are perceived as delivering an education of high quality might be more attractive to foreign students. If the quality of the university also affects the outcomes of native students, we would obtain an upward biased estimate of the effect of foreign peers on native performances. We account for such correlated effects by introducing a comprehensive set of fixed effects. We use university, degree, and university-degree fixed effects. These take into account the "typical" characteristics of each university and programme degree, and of each degree within a university, which are invariant over time.

To account for transitory common shocks we include cohort (defined by year of enrolment) fixed effects; to account for university-specific and degree-specific shocks we additionally interact the university and degree identifier with cohort dummies. The inclusion of these additional fixed effects allows us to net out certain shocks, such as on labour demand for specific subject degrees,[10] that may affect simultaneously both the flow of international students and the composition of native students. Similar to Lavy and Schlosser (2011), we argue that students may know whether a degree or university or even a degree within a university typically has a high share of foreign students. However, they are unlikely to know, ex-ante, the exact share of students within a cohort in a university and degree.

Therefore, our estimating equation is:

$$y_{iduc} = \alpha_0 + \alpha_1 \bar{s}_{duc} + \mathbf{X}_{iduc}\alpha_2 + \tau_{du} + \upsilon_{dc} + \omega_{uc} + \epsilon_{iduc}, \quad (1)$$

where i stands for each student in the data, d represents the undergraduate degree, u the university, and c the cohort to which the student belongs to (i.e. the first year in which students enrol in an undergraduate course). The share of foreign students is $\bar{s}_{duc}$, hence the coefficient of interest to estimate is α_1.

In our analysis we report coefficients on the standardized share of foreign students across university-degree-cohort groups. Thus α_1 measures the predicted change in the outcome given by switching a native student to a university-degree-cohort group with an 18.5 percentage point (pp henceforth), equivalent to 1 standard deviation (SD henceforth), higher share of foreign students. Eq. (1) is estimated with a linear model for all outcome variables. The standard errors are clustered within university.

[8] See Sacerdote (2011) for a comprehensive literature review on identifying peer effects in education.

[9] In our set-up, the reflection issue is not a problem since being native or foreign is a fixed characteristic pre-determined before university entry.

[10] For example, it has been found that the macroeconomic environment affects the probability of enrolling into HE and the type of degree chosen (Blom et al., 2021; Clark, 2011; Meschi et al., 2011; Taylor, 2013; Tumino and Taylor, 2015; Rampino and Taylor, 2012).

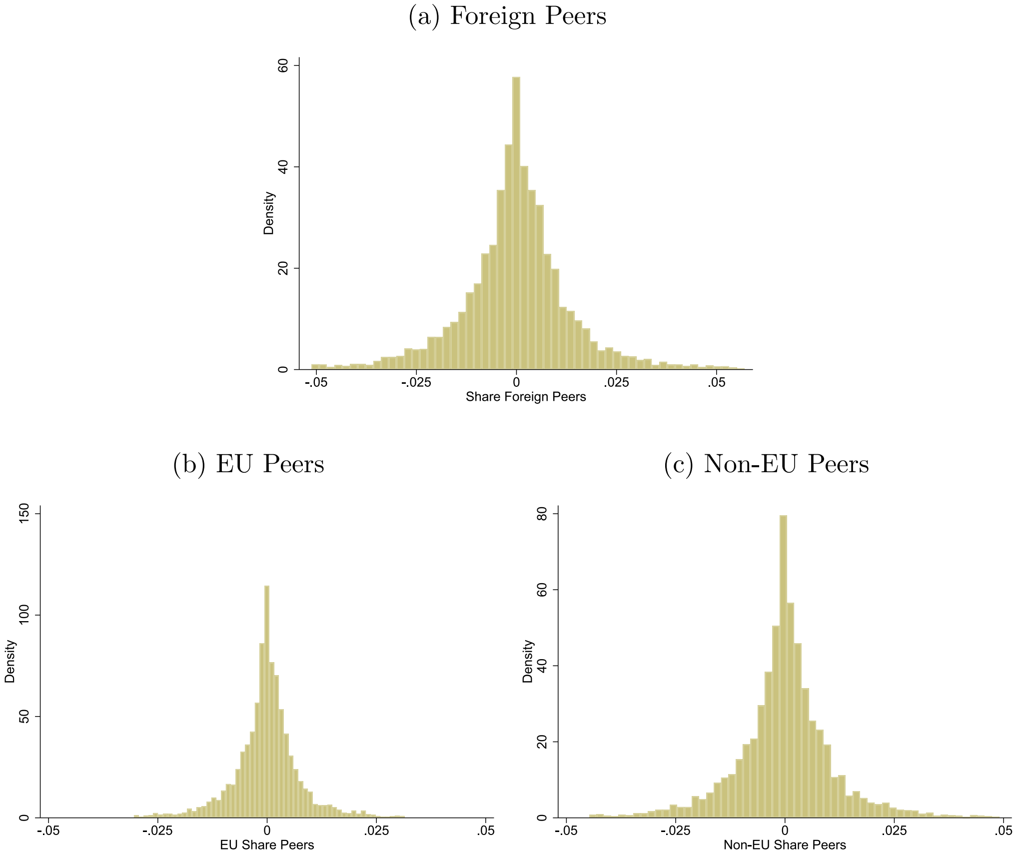

Fig. 1. Residual variation. *Note:* Histograms of foreign peer shares residual variation from a regression with university-degree, year-university and degree-year fixed effects. For display clarity we winsorize all three series at the top/bottom 1%.

Given that EU and non-EU students are differently selected into the HE system (as explained in Section 2), and in practice their average ability differs (as shown later in the paper), in an additional specification we allow EU and non-EU students to have an heterogeneous impact on the outcomes of natives. This is done by estimating separated coefficients, β_1 (impact of 8.9pp or 1SD increase in share of EU students) and β_2 (impact of 15.4pp or 1SD increase in share of non-EU students), as shown in Eq. (2).

$$y_{iduc} = \beta_0 + \beta_1 \bar{s}^{EU}_{duc} + \beta_2 \bar{s}^{NonEU}_{duc} + \mathbf{X}_{iduc}\beta_3 + \tau_{du} + \upsilon_{dc} + \omega_{uc} + \epsilon_{iduc}. \tag{2}$$

Summarizing, the full set of fixed effects τ_{du}, υ_{dc}, and ω_{uc} includes controls for cohort, university, degree, university-cohort, degree-cohort, and degree-university. We observe four cohorts of students, 120 universities and 19 degrees. The variation exploited in the empirical strategy just discussed is the idiosyncratic change in the share of foreign students across cohorts within the same university and degree. The magnitude of this identifying residual variation is documented in Fig. 1. With this approach, our specification is similar to Cornelissen et al. (2017), where they have fixed effects for occupations within firms across years. This is more flexible than some specifications in the literature that account only for institution fixed effects and institution-specific linear time trends (e.g., Hanushek et al., 2003; Geay et al., 2013). To identify the causal effect of foreign peers we rely on the assumption (for which we provide some evidence in Section 5) that conditional on the full set of fixed effects the share of foreign students to which natives are exposed is as good as random.

As explained in Section 2 the share of foreign students will partly be determined by exogenous variation in prospective foreign students' demand, driven by factors such as home country GDP, exchange rates, tuition fees in the United States, and immigration policy. However, universities (and departments) may be capacity constrained in *physical* terms. This would mean that accepting an additional foreign student (either EU or non-EU) would require accepting one fewer UK student, thus possibly changing the ability composition of accepted UK students. They may also be capacity constrained in *financial* terms by the student number controls set by HEFCE. This would mean that accepting an additional EU student would require accepting one fewer UK student. In practice, we do not observe systematic crowd-out along these lines: universities and departments expanding their numbers of non-EU students tend also to recruit more UK and EU students, and those increasing EU enrolment to recruit more UK students (see Appendix Table A.1). This is reassuring for identification, which relies on idiosyncratic variation in the relative numbers of UK, EU and non-EU students. Appendix Table A.1 shows that allowances for expansion mean the physical and financial constraints do not in all cases bind to create a mechanical trade-off between numbers of foreign students and total cohort size. Nevertheless, it is important to account for any possible composite effect of foreign students and course size (e.g., Angrist and Lavy, 1999; Krueger, 2003). We do this by additionally controlling for the (log of the) size of the cohort-specific university-degree cells; and we further control for native students' abilities using their achieved UCAS tariff score.[11] Nevertheless, our balance checks (see Section 5) show that, conditional on our set of fixed effects, these two measures of native student composition (as well as all observed students' characteristics) are orthogonal to the share of foreign, EU and non-EU students. Hence our balancing tests support that our estimates can be given a causal interpretation.

4. Data, sample, and main variables

We use administrative data from the Student Record provided by the Higher Education Statistics Agency (HESA). This contains information on the whole population of students that enrolled in an HE institution in the UK in academic years 2007/08 to 2010/11.

4.1. Definition of native and foreign students and of peers

We define the native status by looking at whether a student was domiciled in the UK prior to enrolment into HE.[12] The peer group is defined as all students that are enrolled in the same university, undergraduate degree, and cohort. For each peer group we compute foreign exposure as the share of foreign peers over native students as:

$$\bar{s}_{duc} = \frac{N^{EU}_{duc} + N^{NonEU}_{duc}}{N^{UK}_{duc} + N^{EU}_{duc} + N^{NonEU}_{duc} - 1} \tag{3}$$

$$\bar{s}^{EU}_{duc} = \frac{N^{EU}_{duc}}{N^{UK}_{duc} + N^{EU}_{duc} + N^{NonEU}_{duc} - 1} \tag{4}$$

$$\bar{s}^{NonEU}_{duc} = \frac{N^{NonEU}_{duc}}{N^{UK}_{duc} + N^{EU}_{duc} + N^{NonEU}_{duc} - 1}, \tag{5}$$

where N indicates the total number of undergraduate students of a given type within a university-degree in the enrolment year.

The undergraduates in our sample are exposed to a mean share of foreign students of 10.5% (SD 11.4%), made up of 3.7% (SD 3.9%) EU students, and 6.8% (SD 9.1%) non-EU students. Fig. 2 shows that EU students are similarly spread among Russell and non-Russell universities while non-EU students are more present in universities belonging to the prestigious Russell group. Among all degrees, those with the highest share of foreign students are Engineering (34%) and Business (28%). The degree least popular for non-natives students is Education, which leads to an especially proscribed career path in UK primary or secondary teaching.

4.2. Analysis sample

Our analysis sample comprises the population of UK-domiciled students, enrolling between the 2007/08 and 2010/11 academic years, on three-year undergraduate courses at English HE institutions,[13] that at time of enrolment were aged 18–21 and had no prior experience of HE, and arrive with 'Level 3' (university entrance-level) qualifications typically obtained from UK 'sixth forms' and further education colleges. This is equivalent to 80% of the entire population of native undergraduate students enrolling in these years. We implement these restrictions to avoid possible selection concerns from students that might have had some previous experience in HE or in the labour market and to limit heterogeneity in terms of the type of their educational background. Selecting young students additionally eliminates possible heterogeneity due to different determinants of entry in HE between young and mature students. Each individual is observed up to three years after the year of enrolment to avoid observing a longer spell of time for the early cohorts compared to the later cohorts (we have Student Record data up to academic year 2013/4). This results in an

[11] This is transformed in a continuous variable ranging from 0 to 1 within each cohort. The UCAS tariff score is missing for about 14% of students within each cohort. These students entered through another channel, such as clearing. We retain these students in the main analysis by imputing to these students the unconditional mean value of non-missing tariff scores across the entire HE outcome estimation sample, and additionally including a dummy variable flagging that the score is actually missing for them. We include students with missing UCAS tariffs in our analysis because this characteristic is not missing at random, see Table A.2. Therefore, the exclusion of students with missing UCAS tariff would imply sample selection in terms of those characteristics correlated with the missing status of UCAS tariff and would complicate the interpretation of resulting estimates. Nonetheless, when we replicate the analysis without students with missing UCAS tariff score, the main findings remain unchanged, see Panel B of Table A.3. Furthermore, the way in which we control for UCAS tariff score does not affect the main findings. Panel C of Table A.3 shows the main results when we use UCAS tariff score quintiles instead of a continuous variable.

[12] A popular definition for native in the literature is whether the individual was born in the country (e.g., Dustmann et al., 2013; Manacorda et al., 2012). However, we have no information about country of birth. A major benefit of defining natives and migrants by place of domicile prior to HE is that students who were residing in the UK likely received secondary education in the UK. We further restrict our sample to those arriving at university with UK-recognized 'Level 3' (A-Level and equivalent) qualifications, to help ensure they represent an homogeneous group in terms of the education received and constraints they faced before enrolling into HE. We have information on nationality (although this information is not available for all students) and find that 95% of our estimation sample have British (United Kingdom) nationality. Together these steps make us confident that residence before entering HE is a good information to determine whether a students is native.

[13] By definition this excludes students studying part-time. We also exclude degrees studied across more than one major subject area (amounting to under 20% of all undergraduate students) as this allows us to identify the foreign group of peers for each native in a clean way. However, considering also mixed degrees were more than one subject is studied and weighting the population of foreign peers for the proportion of the studied subject does not affect the main results.

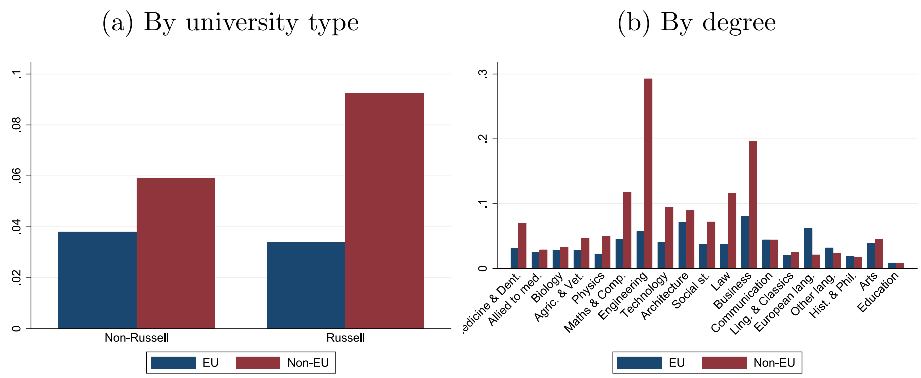

Fig. 2. Share of EU and non-EU students by type of university and of degree. *Notes:* Authors' computation from HESA data. Russell group universities include: University of Birmingham, University of Bristol, University of Cambridge, Durham University, University of Exeter, Imperial College London, King's College London, University of Leeds, University of Liverpool, London School of Economics and Political Science, University of Manchester, Newcastle University, University of Nottingham, University of Oxford, Queen Mary University of London, University of Sheffield, University of Southampton, University College London, University of Warwick, and University of York.

Table 1
Native students' characteristics.

Variable	Mean	SD	Variable	Mean	SD
Female	0.574	0.494	High neighbourhood HE	0.313	0.464
Age	18.835	0.839	Medium neighbourhood HE	0.580	0.494
High parental SEC	0.445	0.497	Low neighbourhood HE	0.099	0.298
Medium parental SEC	0.173	0.378	Unknown neighbourhood HE	0.008	0.092
Low parental SEC	0.193	0.394	No disability	0.682	0.466
Unknown parental SEC	0.189	0.392	Some disability	0.079	0.270
Private school	0.104	0.305	Disability unknown	0.239	0.427
Public school	0.851	0.356	UCAS score	0.305	0.121
Unknown school	0.045	0.206	(log-)Size	6.215	0.904
White	0.788	0.409	Russell group	0.258	0.438
Non-White	0.201	0.401	STEM degree	0.289	0.453
Ethnicity unknown	0.011	0.105			

Note: Authors' computation from HESA data using the sub-population of native students that at the time of entering an undergraduate degree are 18–21 years old and come from high school, without any prior experience in HE. This sub-population contains a total of 509,900 observations. We observe the UCAS score of 436,570 of these students.

analysis sample of 509,900 students, spread across 19 subject areas ("degrees") and 120 universities. We exploit between-cohort variation within 1285 different university-degree groups.[14]

Table 1 reports the summary statistics of the main characteristics of native students in the first year in which they enrolled in an undergraduate degree. Some variables, such as ethnicity and disability, are collapsed to smaller categories than those that we use in the regression analysis for readability. The population of undergraduate students is tilted towards those from families with high SES: about 45% of natives have a parent in the highest socio-economic classification categories.[15] Furthermore, 10% of enrolled native students come from a private school, and 31% come from a neighbourhood with a high (top quintile) proportion of residents who attended HE.[16] About 29% of students attend a STEM degree[17] and about 26% attend a university belonging to the prestigious Russell group.

[14] All reported sample sizes representing counts of individual students in the HESA records and linked datasets are rounded to the nearest 5, to meet non-disclosivity requirements of the data owners.

[15] We know the highest SEC (socio-economic classification) of the student's parents. In Table 1 we group the 8 SEC categories into 3 groups. *High* parental SEC comprises: Higher managerial & professional occupations and Lower managerial & professional occupations; *Medium* parental SEC: Intermediate occupations and Small employers & own account workers; and *Low* parental SEC: Lower supervisory & technical occupations, Semi-routine occupations, Routine occupations, and Never worked & long-term unemployed.

[16] These are derived from "Low Participation Neighborhood" (LPN) quintiles indicating whether students are coming from a neighbourhood where participation in HE is high (fifth quintile) or low (first quintile).

[17] We define as STEM degrees: Biological sciences, Veterinary sciences, agriculture & related, Physical sciences, Mathematical & computer sciences, Engineering, Technologies, Architecture, building & planning. As non-STEM degrees: Medicine & dentistry, Allied to medicine, Social studies, Law, Business & administrative studies, Mass communications & documentation, Linguistics & classics, European languages, Other languages, Historical & philosophical studies, Creative arts & design, Education.

Table 2
Descriptive statistics on higher education outcomes.

	Performance outcomes	
	Mean	SD
Graduated - Pass	0.855	0.352
Graduated - At least a third	0.818	0.386
Graduated - At least a lower second	0.782	0.413
Graduated - At least an upper second	0.569	0.495
Graduated - First class	0.122	0.327
	Displacement outcomes	
	Mean	SD
Changed to Non-Russell	0.024	0.154
Changed to Non-STEM	0.049	0.216
Changed to STEM	0.016	0.125

Note: Authors' computation from HESA data using the sub-population of native students that at the time of entering an undergraduate degree are 18–21 years old and come from high school, without any prior experience in HE. This sub-population contains a total of 509,900 observations. Of these 131,680 start in a Russell group university, 362,690 in a STEM major and 147,210 in a non-STEM major.

4.3. Higher education outcomes

The main HE outcomes are divided into two groups: (i) *performance* and (ii) *displacement*.

Our performance outcomes are markers for exceeding progressively higher thresholds: Successfully graduating with a pass degree within four years since enrolling in an undergraduate degree; graduating with at least a lower second class degree (2:2); graduating with at least an upper second class degree (2:1); and graduating with a first class degree. Each university sets its own precise criteria for being awarded a given degree class, but these measures are usually equivalent to an average mark on second and third courses, out of 100, exceeding 40, 50, 60 and 70 respectively. Note that all students receiving a first class degree have also, by definition, received "at least an upper second", and so on.

We also study whether students switched between university or subject types during their studies. Our displacement outcomes are markers for whether switched from a STEM to a non-STEM degree and *vice versa*, and whether switched from a university belonging to the Russell group to a university not belonging to this group.[18]

We also consider whether the presence of foreign students caused native students to change their degree and university type. We study impacts on displacement from Russell-group to non-Russell group universities, and from/to STEM degrees as Universities belonging to the Russell group and STEM degrees have, on average, high economic returns and are more competitive than universities non belonging to the Russell group and to non-STEM degrees, respectively (Britton et al., 2021; Walker and Zhu, 2018).

Table 2 shows that about 86% of native students successfully completed an undergraduate degree within four years from enrolment, 78% received at least a lower second class degree (2:2), 57% at least an upper second (2:1) and 12% a first class degree. This means that a plurality of natives obtain an upper second degree classification (45%). First, lower second and third degree classifications are more rare, respectively comprising 12%, 21%, and 3.6% of natives students. Displacement across different types of universities and degrees are not common.

4.4. Labour market outcomes

We are able to link the HESA Student Record with the Destination of Leavers from Higher Education (DLHE) survey that collects information of graduates six months after graduation. The DLHE survey collects information such as activity status of graduates and in which occupation they are working, if employed. Despite this information being collected a short-time after graduation, the literature has shown that early labour market outcomes have economic relevance as they largely affect the future working trajectories of graduates (Baert et al., 2013; Del Bono and Morando, 2021; Kahn, 2010; Oreopoulos et al., 2012; Raaum and Røed, 2006; Von Wachter and Bender, 2006).

The labour market outcomes are divided into: (i) *activity status*, i.e. whether working, studying, being unemployed, or other (e.g., gap year, voluntary work); and in (ii) *job attributes*, i.e. for those working we can observe whether they work in a high socio-economic occupation, which is a professional or managerial position. Those working are asked to report their annual gross salary. Just over 60% of our HE outcome population respond to the DLHE, and 45% of those in work do not report their salary. Table 3 shows the unweighted outcomes among respondents. It shows that about 63% of native graduates work six months after graduation, while 22% keep studying, and 8% are unemployed. Among those working, 24% are employed in a high socio-economic classification occupation job, 66% work full-time, and the average log salary is 9.6, equivalent to just under £17,000.

[18] We do not consider the movement from non-Russell to Russell universities as this is extremely rare; less than 0.4% of the analysis sample population made such a change.

Table 3
Descriptive statistics on labour market outcomes.

	Activity status	
	Mean	SD
Working	0.630	0.483
Studying	0.222	0.416
Unemployed	0.084	0.277
Other	0.065	0.246
	Job attributes	
	Mean	SD
High socio-economic status occupation ("High SEC")	0.244	0.429
Full time	0.663	0.473
Salary, £	16 809.04	10 288.90
Log salary	9.628	0.503

Note: Authors' computation from HESA data using the sub-population of native students that at the time of entering an undergraduate degree are 18–21 years old and come from high school, without any prior experience in HE. 316,995 respond to the DLHE survey 6 months after graduation, 225,810 are employed, and 124,710 report a salary.

For our regression analyses below we use inverse probability weights, derived from models predicting (i) DLHE response probability and (ii) (for salary models only) salary response probability conditional on responding to the DLHE and being in work, as a function of observable characteristics. This is to ensure our estimation samples are representative of (i) the graduating population and (ii) the population of recent graduates who are in work, respectively. Table A.4 shows the coefficients and average marginal effects from these two models. Both indicate missingness not-at-random, though not in a uniform direction of positive selection: ethnic minority students and those with lower UCAS tariff scores are less likely to respond at both stages, but so are graduates educated at private schools, for example. This demonstrates the need for weights to correct for non-response biases.

5. Validity of the identification strategy

If variation across cohorts within university and degree is as good as random, once we condition on our set of fixed effects, we should not observe any correlation between the share of foreign peers and student characteristics which pre-date the entry into HE and, thus, any interaction with foreign peers. To test this we estimate the following equation:

$$x_{iduc} = \gamma_0 + \gamma_1 \bar{s}_{duc} + \tau_{du} + \upsilon_{dc} + \omega_{uc} + \epsilon_{iduc}. \tag{6}$$

We show that, conditional on the full set of fixed effects, the cross-cohort variation of the share of foreign students ($\bar{s}_{duc}$) is uncorrelated with native students' tariff score, log cohort size, and a comprehensive set of predetermined characteristics of native students, such as ethnicity and socio-economic background, see Fig. 3.[19] Point estimates are typically close to zero also when we split foreign students into EU and non-EU peers, see Fig. 4.

To be thorough, despite the evidence of the lack of any significant correlation between the share of foreign students and natives' characteristics, in the main analysis we condition on natives' individual characteristics, including their UCAS tariff score, and the log cohort size of the group.[20]

We note that, to the extent that foreign students have different characteristics to native students, it is possible that these characteristics, rather than their being foreign, are partly driving the peer effects we find. Neither EU nor non-EU students affects the sex composition of either the overall (including foreign and mature) or the native (including mature) cohorts. However EU students are typically older than native students. This means they do push up the overall cohort share of mature students, but have no impact on the mature share among natives. We cannot observe other characteristics of foreign students, such as ethnicity, so rather than attempt to capture peer effects of additional characteristics, we are instead careful to interpret the impact of exposure to foreign peers as an overall impact of the package of characteristics that make foreign students different to natives, including age.

A further concern for the validity of the identification strategy would be if the HE outcomes reflects 'grading on a curve', such that the shares of students awarded First Class or Upper Second Class honours (for example) are rationed. In this case, any true peer effects would be confounded by mechanical effects which would vary according to the relative ability distributions of UK and foreign students. We describe and rule out several of these possibilities in detail in Appendix C. Here we simply note that (i) the UK system of moderation by external examiners is intended to result in comparable grading standards within subjects, across universities (Naylor et al., 2016), which is not consistent with grading on a curve; (ii) the pattern of consistently null results we find on academic performance across several thresholds is extremely unlikely in the presence of grading on a curve, since the mechanical

[19] This balance test is amply used in the peer effects literature (e.g., Anelli and Peri, 2019; Chin et al., 2013; Cools et al., 2019; Lavy and Schlosser, 2011).

[20] We show that when omitting all individual and cohort characteristics as control variables (retaining only the fixed effects), the main findings are not affected. This analysis is reported in Panel A of Table A.3.

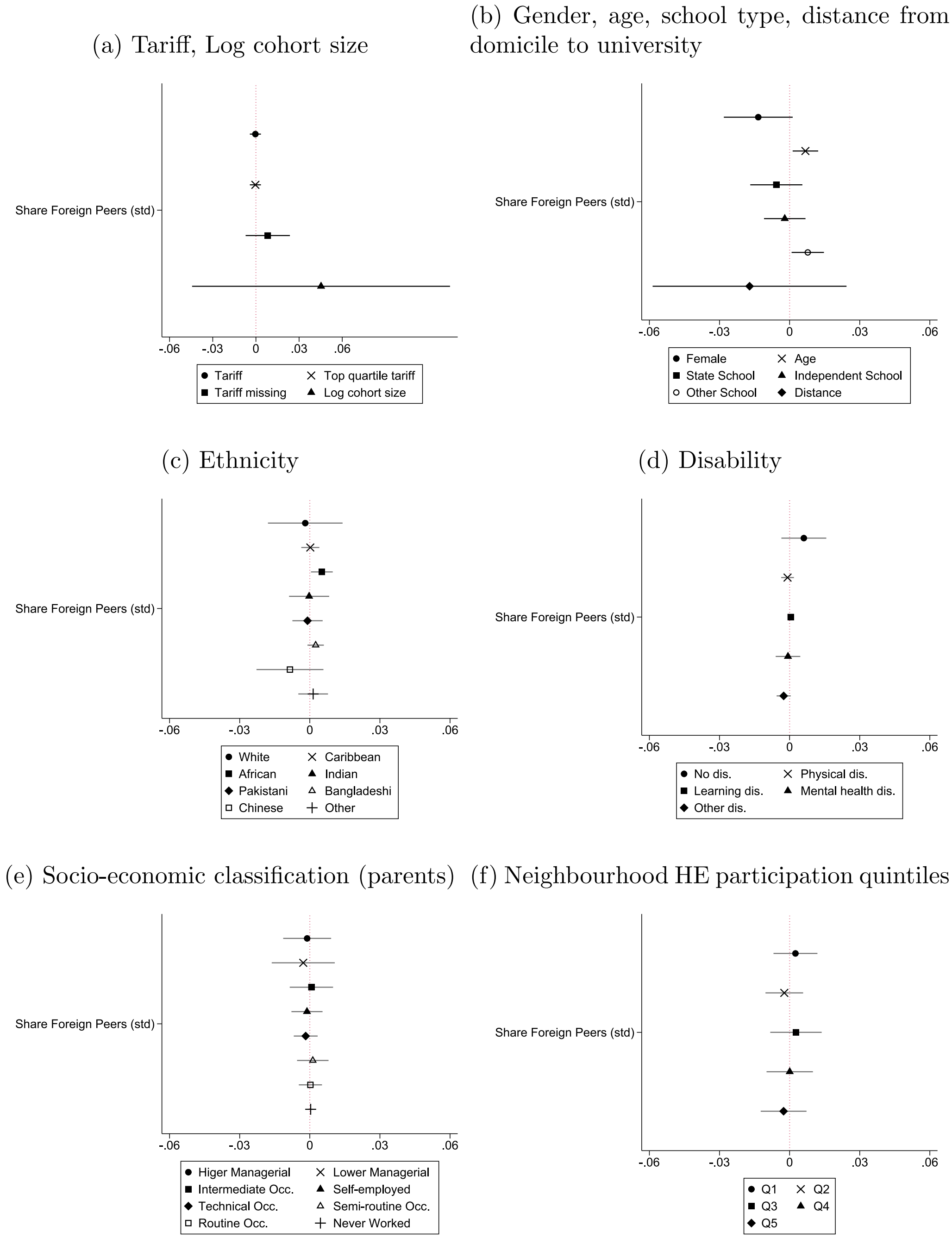

Fig. 3. Balance test: share of foreign students. *Note:* All regressions include fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals reported.

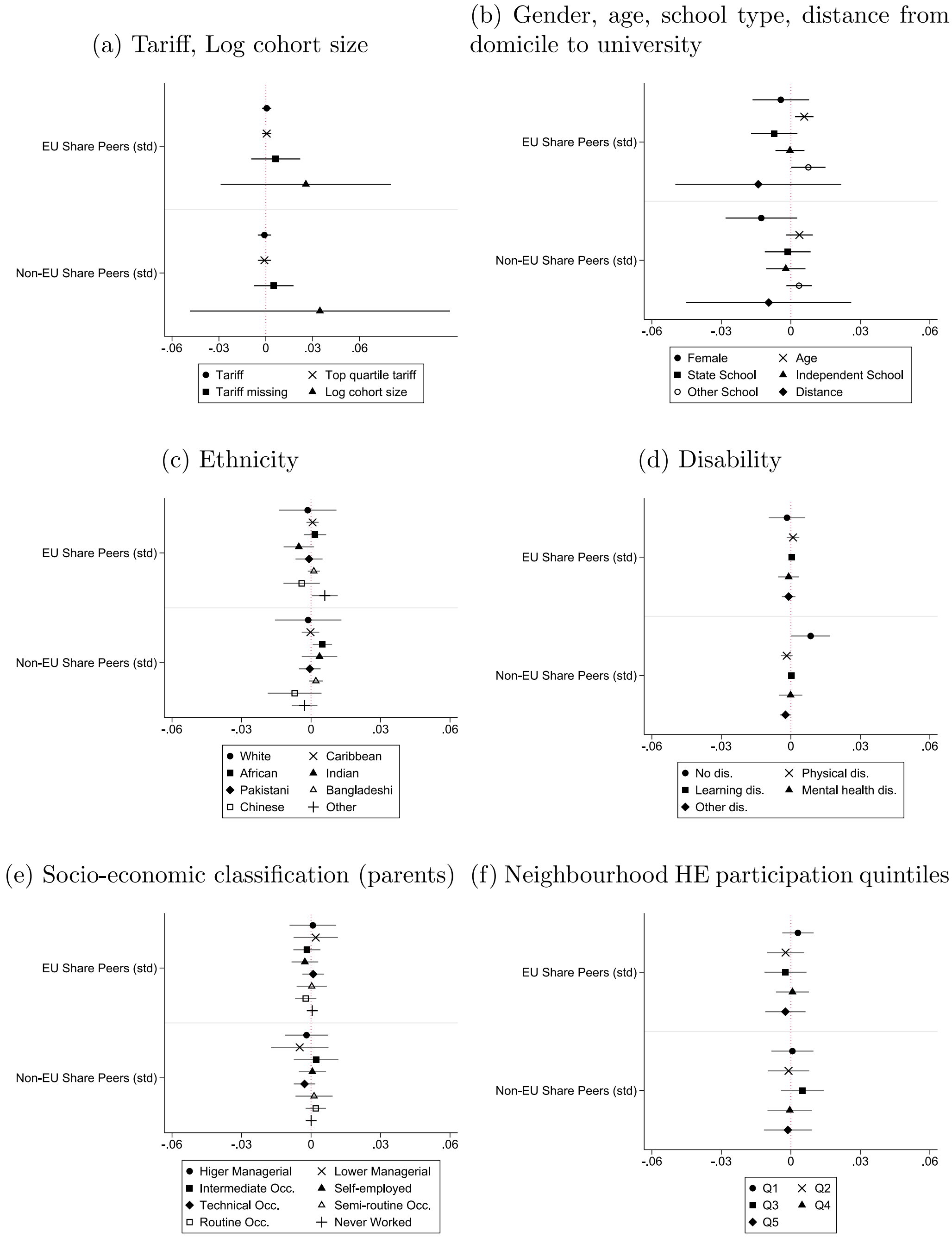

Fig. 4. Balance test: shares of EU and non-EU students. *Note:* All regressions include fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals reported.

impacts of relative ability distribution must exactly offset any true peer effects; (iii) grading-on-a-curve should mean that *within the population* (i.e. including foreign students) the probability of receiving a given degree class would be orthogonal to the share of foreign peers, a situation we empirically reject Table C.1; and (iv) neither on-time degree completion nor any of our labour market outcomes would be subject to rationing, and our null results extend also to these outcomes.

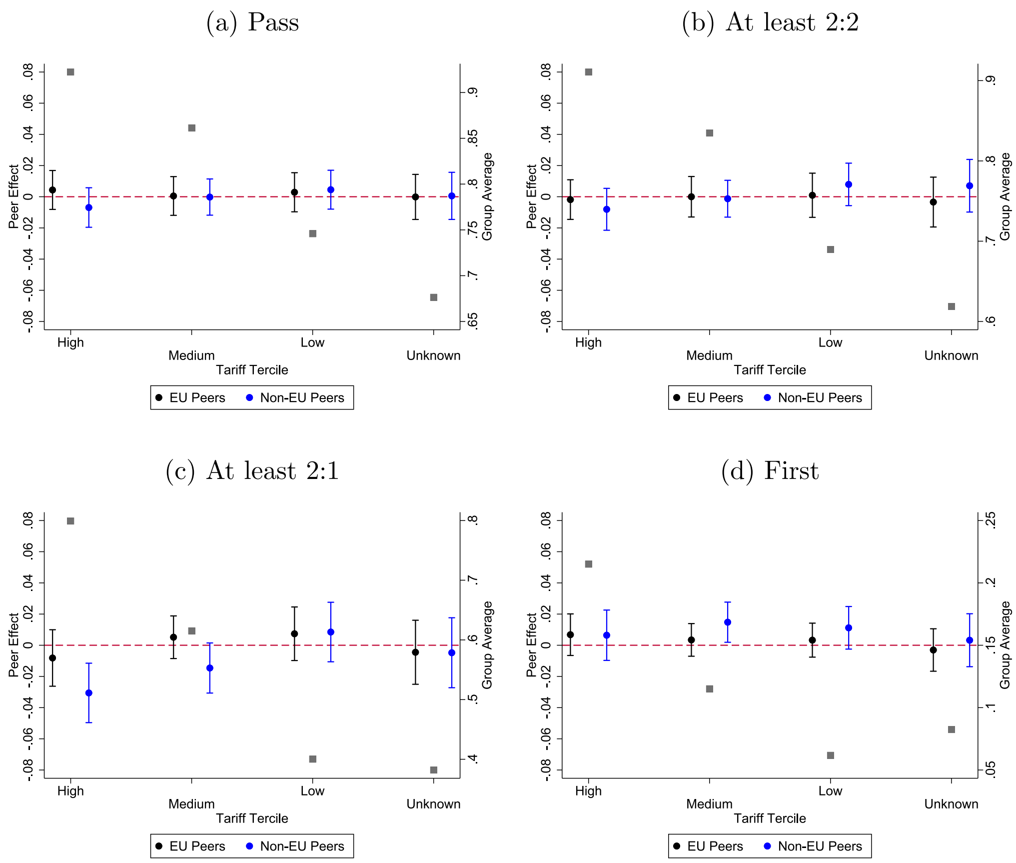

Fig. 5. HE performances by ability group. *Note:* Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals. Effects measured on the left-axis. Outcome averages, represented by grey squares, measured in the right-axis. Estimates report the marginal effect of EU/Non-EU on natives across natives' ability groups, see Eq. (7) and our discussion of it.

6. Results

6.1. *The effect of foreign students on natives' higher education performance and displacement outcomes*

Table 4 shows the estimated coefficients of the standardized share of foreign and of EU and non-EU students on the HE outcomes, which are separated in two main categories: performances in columns 1–4, and displacement outcomes in columns 5–7.

To better interpret the effect of foreign peers on natives' HE performances, the degree classification outcomes are grouped as: pass, which means whether successfully completed the undergraduate degree (column 1); whether got at least a lower second or 2:2 (column 2); whether got at least an upper second or 2:1 (column 3); and, finally, whether got a first (column 4). Note that these outcomes measure whether the student *exceeds* progressively higher performance thresholds, rather than falling within a range, so there is no 'adding up constraint' across these columns.

There is no significant effect of foreign students on the probability of graduating and of getting a certain degree classification. Estimates are not statistically significant and their magnitude is negligible to small. Among displacement outcomes, the only statistically significant effect that we find is that a 1SD increase in foreign students decreases the probability of switching from a non-STEM degree to a STEM degree by 1.3pp, statistically significant at 5% level (column 7). In the context of the low rate of students changing degree at baseline, this is a large effect (81% relative to the mean). EU students are those driving the result on non-STEM degree retention. Furthermore, a 1SD increase in the share of EU students increases the probability of changing from a Russell to a non-Russell university by 1.1pp (46% relative to the mean), statistically significant at 10% level.

We run some additional analysis to understand what drives our findings. If foreign students affect the comparison group to which natives relate themselves with, we would expect the effect of foreign students to be heterogeneous across the ability distribution of

Table 4
The effect of foreign peers on natives' HE outcomes.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	HE performance				Displacement		
	Pass	At least 2:2	At least 2:1	First	To non-Russell	To non-STEM	To STEM
	A. Baseline						
Foreign peers	0.001	0.000	−0.008	0.010	0.002	0.008	−0.013**
	(0.006)	(0.006)	(0.007)	(0.007)	(0.009)	(0.008)	(0.005)
	B. EU vs. Non-EU						
EU peers	0.002	−0.001	0.001	0.003	0.011*	0.011	−0.012***
	(0.005)	(0.006)	(0.007)	(0.005)	(0.006)	(0.008)	(0.004)
non-EU peers	−0.001	0.001	−0.010	0.009	−0.002	0.002	−0.006
	(0.005)	(0.006)	(0.008)	(0.007)	(0.009)	(0.008)	(0.005)
Obs.	509,870	509,870	509,870	509,870	131,670	147,200	362,200
Mean Y	0.818	0.782	0.569	0.122	0.024	0.049	0.016

Note: Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, UCAS tariff score, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, cohort, university-degree, cohort-degree, and cohort-university. Standard errors clustered by university. $^{*}p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$.

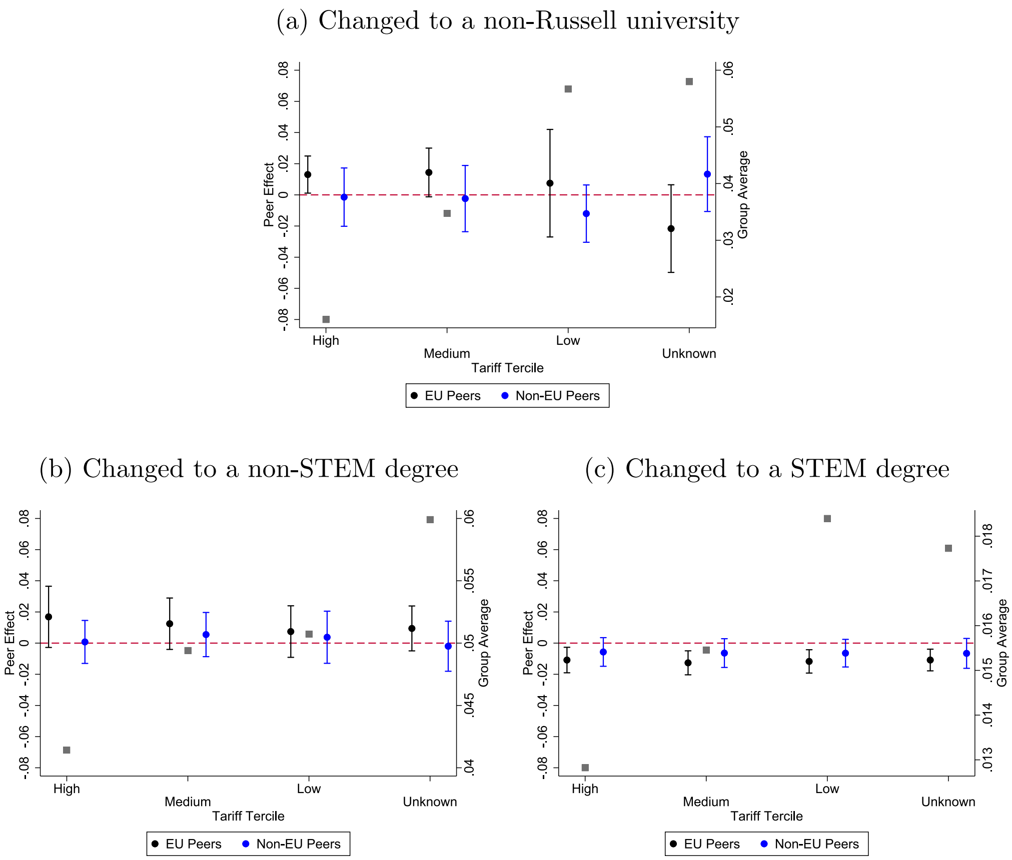

Fig. 6. HE displacement probability by ability group. *Note:* Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals. Effects measured on the left-axis. Outcome averages, represented by grey squares, measured in the right-axis. Estimates report the marginal effect of EU/Non-EU on natives across natives' ability groups, see Eq. (7) and our discussion of it.

Table 5
The effect of foreign peers on natives' HE outcomes by stayers and movers.

	(1)	(2)	(3)	(4)	(5)	(6)
	Stayed in a			Moved to a		
	Russell university	STEM degree	Non-STEM degree	Non-Russell university	Non-STEM degree	STEM degree
	A. Pass					
EU peers	0.009	−0.012	0.006	−0.070	0.092	−0.108
	(0.012)	(0.012)	(0.006)	(0.083)	(0.061)	(0.073)
non-EU peers	−0.019*	−0.005	0.003	0.146**	0.004	−0.120
	(0.010)	(0.011)	(0.007)	(0.052)	(0.072)	(0.107)
Mean Y	0.912	0.802	0.828	0.745	0.699	0.675
	B. At least 2:2					
EU peers	0.001	−0.015	0.004	−0.085	0.076	−0.080
	(0.012)	(0.012)	(0.006)	(0.087)	(0.068)	(0.073)
non-EU peers	−0.014	0.002	0.004	0.170***	−0.027	−0.140
	(0.011)	(0.011)	(0.007)	(0.059)	(0.076)	(0.098)
Mean Y	0.894	0.759	0.796	0.727	0.671	0.640
	C. At least 2:1					
EU peers	0.012	−0.003	0.002	0.016	0.049	−0.039
	(0.015)	(0.015)	(0.008)	(0.133)	(0.050)	(0.075)
non-EU peers	−0.008	−0.004	−0.018*	0.159**	0.000	−0.037
	(0.014)	(0.012)	(0.010)	(0.063)	(0.063)	(0.110)
Mean Y	0.756	0.538	0.584	0.596	0.499	0.458
	D. First					
EU peers	−0.002	0.006	0.003	0.084	0.061**	−0.052*
	(0.012)	(0.009)	(0.006)	(0.069)	(0.028)	(0.031)
non-EU peers	0.027	0.016	0.006	−0.011	0.008	−0.073
	(0.017)	(0.011)	(0.007)	(0.064)	(0.043)	(0.050)
Mean Y	0.173	0.134	0.117	0.203	0.124	0.120
Obs.	128,490	140,005	356,880	3150	7130	5635

Note: Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, UCAS tariff score, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, cohort, university-degree, cohort-degree, and cohort-university. Standard errors clustered by university. $^*p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 6
The effect of foreign peers on natives' labour market outcomes: Activities.

	(1)	(2)	(3)	(4)
	Activity status			
	Working	Studying	Unemployed	Other
	A. Baseline			
Foreign peers	0.001	0.004	0.001	−0.006
	(0.009)	(0.008)	(0.005)	(0.005)
	B. EU vs. Non-EU			
EU peers	−0.009	0.004	0.004	0.001
	(0.007)	(0.006)	(0.004)	(0.003)
non-EU peers	0.008	0.002	−0.002	−0.008
	(0.009)	(0.008)	(0.005)	(0.005)
Obs.	315,215	315,215	315,215	315,215
Mean Y	0.631	0.221	0.084	0.065

Note: Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, UCAS tariff score, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. $^*p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$.

natives. To test this we implement the following equation:

$$\begin{aligned} y_{iduc} &= \delta_0 + \delta_1 \bar{z}^{EU}_{duc} + \delta_2 \bar{z}^{NonEU}_{duc} \\ &+ \sum_{q=2}^{3} [\delta^q_4 + \delta^q_5 \bar{z}^{EU}_{duc} + \delta^q_6 \bar{z}^{Non-EU}_{duc}] \mathbb{1}[a^{q-1}_c < a_i \le a^q_c] \\ &+ \tau_{du} + \upsilon_{dc} + \omega_{uc} + \epsilon_{iduc}, \end{aligned} \tag{7}$$

Table 7
The effect of foreign peers on natives' labour market outcomes: Attributes.

	(1)	(2)	(3)
	Graduates in work		
	High SEC	Full time	Log salary
	A. Baseline		
Foreign peers	0.014	0.008	0.033**
	(0.013)	(0.011)	(0.015)
	B. EU vs. Non-EU		
EU peers	0.004	0.001	0.014
	(0.010)	(0.010)	(0.010)
non-EU peers	0.014	0.009	0.029**
	(0.012)	(0.010)	(0.014)
Obs.	224,865	224,865	124,305
Mean Y	0.244	0.664	9.628

Note: Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, UCAS tariff score, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. $*p < .10$ $**p < 0.05$, $***p < 0.01$.

where $\mathbb{1}[.]$ is the indicator function and a_c^q are cohort-specific tercile thresholds of the UCAS tariff score. Figs. 5 and 6 report the estimated coefficients and the 95% confidence intervals of the impact of foreign students on each of the tercile. More precisely, for EU students (black dots) we report $\widehat{\delta}_1$ for $q = 1$ (i.e. *low* tariff score) and $\widehat{\delta}_1 + \widehat{\delta}_5^q$ for $q = 2, 3$ (i.e. *medium* and *high* tariff score, respectively).[21] For non-EU students (blue dots) we report $\widehat{\delta}_2$ for $q = 1$ and $\widehat{\delta}_2 + \widehat{\delta}_6^q$ for $q = 2, 3$. Moreover, we also report ability tercile-specific mean value of the outcome (grey squares).

Non-EU students seem to push high ability natives downwards at the margin between 2:2 and 2:1 degrees. The heterogeneous effect of EU and non-EU students on performance is consistent with them representing, on average, different ability groups. Table A.5 shows that EU students are over-represented, compared to both native and non-EU students, among the top performers: 16.5% of EU students get a first and 56% at least an upper second degree classification. Non-EU students are, on the other hand, more likely than EU and native students to be in the lower tail of the degree classification. Thus, on average, EU students are high performers and non-EU students are low performers. The displacement effects of EU students on higher ability natives are consistent with a mechanism where high ability students infer their relative ability by comparing themselves with other high ability students, and an additional EU student means, on average, an additional higher ability student. This might bring natives to adjust their perceived ability downward, similar to the effects found in the ordinal ranking literature (see Elsner et al., 2021, and literature cited therein).

Interestingly, the magnitude and significance of the retention effect of EU students in non-STEM degrees is the same across the different ability groups of natives. This suggests that there might be another mechanism at work through which foreign students affect native students: a decrease in the quality of the learning environment due to the lack of English proficiency of foreign students. In non-STEM degrees proficiency in English is essential, definitely more than in STEM degrees. Thus, a higher share of foreign students (which are likely to be non-native English speaker) might increase the self-perceived ability of native students. The retention effect is driven by EU students, the vast majority of whom are non-English mother-tongue speakers.[22] Non-EU students also have a positive effect on non-STEM retention which is homogeneous across the native ability distribution, although it is slightly smaller than the effect of EU students and not statistically significant.

These findings are consistent with the past literature pointing to displacement from STEM driven by foreign peers possessing weak English language ability (Anelli et al., 2023), and with native speakers marginally perceiving a lower quality of English spoken in the classroom when there is a high share of non-native speakers (Chevalier et al., 2019). The consistency with Anelli et al. (2023), of discouragement of STEM and (insignificantly) displacement to non-STEM comes despite students in our sample attending a range of elite and non-elite institutions and having already made an initial 'major choice', as opposed to in Anelli et al. (2023), whose sample covers students in a single institution and on a path leading to many potential majors.[23]

As foreign students affect the probability of natives of moving across universities and degree, we split the population of natives in stayers and movers, and re-estimate the impacts of the composition of the *original peer-group* on the main HE outcomes for those natives who stayed in a Russell university and in a STEM or non-STEM degree and for those who moved across. The results of this analysis are reported in Table 5. We find some negative effects, although small and only marginally statistically significant, of non-EU peers on the probability of passing for the stayers in a Russell university and in a STEM degree. Some more important effects are found among the movers. For example, for those natives moving from a STEM to a non-STEM degree, a 1SD increase in

[21] In the empirical application we add a fourth category for those students with missing tariff score. We also report this in the corresponding plots under label *unknown*.

[22] Among EU states, only Malta and the Republic of Ireland, which make up just 1.3% of the EU population, count English as one of their official languages.

[23] Restricting our sample to those initially studying for a maths degree (the subject for the course in which Anelli et al. (2023) measure exposure to foreign peers), as reported in Table A.6 produces yet clearer alignment, with significant displacement from this subject to non-STEM degrees driven by EU students.

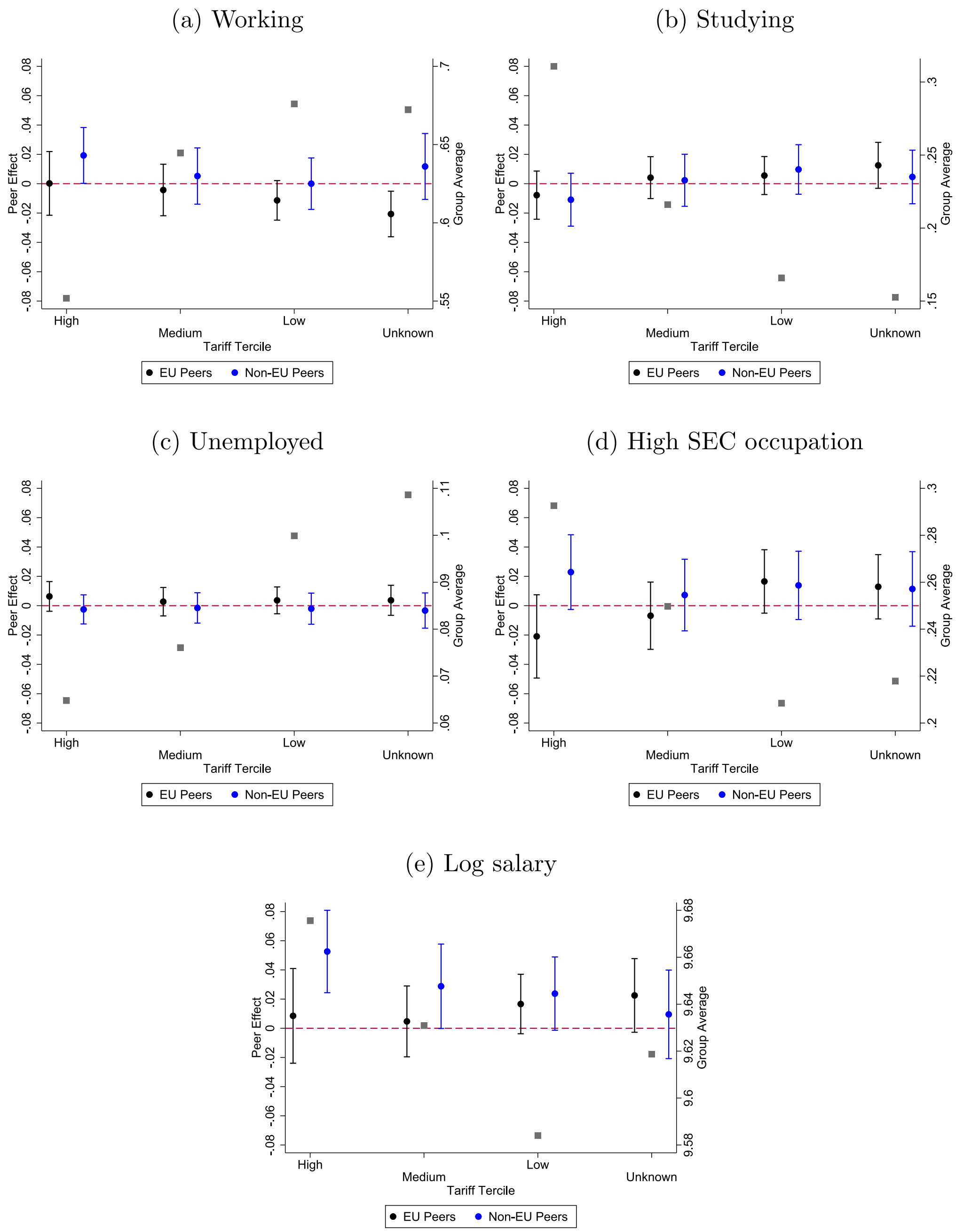

Fig. 7. Labour market outcomes by ability group. *Note:* Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals. Effects measured on the left-axis. Outcome averages, represented by grey squares, measured in the right-axis. Estimates report the marginal effect of EU/Non-EU on natives across natives' ability groups, see Eq. (7) and our discussion of it.

EU peers increases the probability of successfully getting a first by 6.1pp, or by 49% relative to the mean. Non-EU peers, instead, increase the probability of natives who moved to a non-Russell group university of successfully completing the degree (by 20%), and of getting at least a lower or upper second (by 23% and 27%, respectively). This is consistent with the natives who moved to 'less competitive' environments, rather than dropping out, subsequently achieving good outcomes. In contrast, those switching from non-STEM to STEM degrees appear to remain negatively affected by their previous exposure to non-EU peers.[24]

6.2. The effect of foreign students on the initial labour market outcomes of native graduates

Tables 6 and 7 present the results of our analysis on labour market outcomes. These outcomes are based on data collected from respondents to the DLHE survey. To ensure that our sample accurately represents the graduating population, we predict the likelihood of respondents' participation using observable characteristics and adjust the observations in the DLHE using inverse probability weights - as anticipated in Section 4.4.

When examining the effects of foreign peers on natives' activity status, we find that all treatment effects are small and not statistically significant. Specifically, Table 6 shows that there is no significant impact of foreign peers on natives' probability of working, continuing their studies, being unemployed, or engaging in any other activity six months after graduation.

When focusing on native graduates who are employed six months after graduation, Table 7 reveals some positive but not statistically significant effects of foreign peers. These effects include an increased probability of working in a managerial or professional occupation compared to a lower classification occupation, as well as an increased likelihood of having a full-time job rather than a part-time one. The only statistically significant effect of foreign students is found on natives' salary: a 1SD increase in foreign peers results in a 3.3% increase in natives' salaries. This effect is mainly driven by non-EU peers, as a 1SD rise in foreign peers from non-EU countries increases natives' salaries by 2.9%.

As a robustness check for the validity of our inverse probability weighting strategy, in appendix Table A.8 we show the results obtained for impacts of foreign peers on Higher Education outcome results, when estimated on DLHE respondents only but applying our non-response weights. The main significant result, of foreign and specifically EU peers reducing the probability of displacement from non-STEM to STEM degrees, is closely replicated, and there are only a few changes in significance of marginally (in)significant other coefficients.[25]

It is worth noting that if the degree class has significant 'sheepskin effects' on labour market outcomes (Jaeger and Page, 1996; Trostel and Walker, 2004), our lack of significant results may mask genuine peer effects on the accumulation of human capital, particularly if the null results on degree class reflect grading on a curve. To address this possibility, we replicate the analysis by including additional controls such as whether students changed university and degree, as well as the degree classification obtained. By incorporating these additional factors, we aim to capture the impact of foreign students on human capital accumulation beyond any effects driven by the changes in undergraduate outcomes already identified. This exercise must be interpreted as descriptive rather than causal, as these additional controls are themselves endogenous to the proportion of foreign students. Nevertheless, the estimates presented in Tables A.9 and A.10 demonstrate that these additional controls do not significantly affect our findings. This provides supportive evidence that (for example) the impacts of foreign peers on natives' salaries are not an artefact of the reduced displacement from non-STEM to STEM degrees.

We further investigate the effect of foreign students on native graduates by examining UCAS tariff score terciles in Fig. 7. We find few significant effects or differences in effects. For example, the impact of non-EU peers on log salary is significant for high-ability students, although the point estimate is nearly indistinguishable from that for medium and lower-ability students.

6.3. Heterogeneity

We conducted several heterogeneity analyses. Firstly, we separate the analysis by degree type (non-STEM vs. STEM) and university type (non-Russell vs. Russell), see Figs. B.1–B.4.[26] The are no significant differential effects of foreign students on natives' outcomes across university and degree types. However, it is worth noticing that EU students increase the probability of natives switching to non-Russell university only among non-STEM students and increase salary of STEM students; non-EU peers positively impact the probability of continuing in further study among STEM students. Furthermore, non-EU students have some negative effect

[24] The formation of these estimation samples is endogenous to initial exposure to foreign peers. Therefore, in Appendix Table A.7 we also report results estimated on the complete population (of Russell Group and STEM or Non-STEM degrees respectively). In line with the Table 5, these show that EU peers increase the probability of composite outcomes "Moved to a Non-STEM degree and obtained a First", "at least a 2:1" and at "at least a 2:2"; and reduce probability of composite outcomes of moving to STEM degree and obtaining all four levels of academic performance.

[25] We also produced results having imputed missing salaries with the mean salary for workers in the same region, industry sector and 3-digit occupation, with the same full-time status, contract duration, and employer size (four groups), in the Annual Population Survey (APS)(Office for National Statistics Social Survey Division, 2022) for the relevant calendar year. This is not our preferred specification because (i) this required us to topcode all observations at £49,506, the level used in the APS to avoid disclosivity concerns, and (ii) by definition, the graduates in our estimation sample have almost the minimum experience possible in a given job, and the various options available to account for this (imputation flag; defining cells also by worker's age group or with a linear quadratic term for age) all still entail potentially differential measurement error. Moreover, (iii) estimates obtained from imputed wages rely on the effect of foreign students working through, and only through, characteristics used for imputation. The estimates obtained when using imputed salaries show a non significant effect of EU peers and a positive and significant effect of non-EU peers of a very similar magnitude to the one obtained in Table 7 (0.025 versus 0.029).

[26] Fig. B.5 shows that students in Russell universities have higher UCAS tariff score than in non-Russell universities while there is no evidence that STEM and non-STEM degrees differ in the ability distribution of their students.

on native passing probability and positive effect on salary in university belonging to the Russell group only. EU students, instead, negatively and statistically significantly affect the probability of natives switching to a STEM degree in non-Russell universities only. Finally, the positive effect on salary, which is similar for EU and non-EU peers, is statistically significant only for natives who graduated from universities belonging to the Russell group.

Secondly, we split students into subsamples according to several individual characteristics, such as sex, ethnicity, and socio-economic status in B.6, B.7, and B.8.[27] We find some individually significant effects for some groups, but not significant differences. For example, foreign students positively and statistically significantly affect job attributes of males only, although the coefficients are not statistically significantly different from those of females.

Concluding, the heterogeneity analysis shows that for certain outcomes, such as salary, the effect of foreign peers on natives is statistically significant only for certain types of degree and university attended, and for certain natives based on their sex and ethnicity. However, we do not find any statistically significant differential effects of foreign students for any of the outcomes considered across all subgroups studied, which is in line with the main finding of the analysis described in the previous subsections: foreign students do not importantly impact the educational outcomes and the labour prospects of native graduates.

6.4. Mechanisms for differential effects

Although impacts of EU and non-EU students on labour market outcomes are usually either individually insignificant, or not significantly different from each other, our results suggest a thread across outcomes that beneficial effects on these outcomes come more from non-EU than EU peers. For example, coefficients are of opposite signs for working (column (1), Table 6), and of different magnitudes for high SEC occupations and log salary (columns (1) and (3), Table 7), with the largest difference and opposite signs for high SEC occupations among high ability natives (Fig. 7, panel (d)).

We offer suggestive evidence that this result may be driven by the importance of relevant work experience and the ability to effectively signal valuable skills sought by prominent employers. If there is a limited availability of such opportunities, and EU students, who are positively selected (Table A.5), are more proactive in pursuing them, they may outcompete or crowd-out high-ability native students. Table A.11 presents regression coefficients indicating the frequency or probability of EU, non-EU, mid- and low-ability natives, relative to high-ability natives, taking advantage of career development opportunities. These coefficients are derived from administrative and survey data collected from a non-Russell Group university in England as part of the BOOST2018 study (Delavande et al., 2022). Controlling for sex and department of study, we find that EU students (i) attend training events or one-to-one appointments with the Careers Service and use its resources for information about job opportunities, (ii) talk to lecturers and teaching staff about job opportunities, and (iii) participate in university-run internship and placement schemes (for which rationing of positions certainly exists) more frequently than even high-ability native students. While we acknowledge that this pattern may not replicate across all universities in England, it is a typical middle-ranking university that is broadly representative of the wider HE sector in terms of demographic characteristics. In such an environment it seems reasonable to suggest that greater competition from EU students would hamper the high-SEC job opportunities of natives. We propose this mechanism as worthy of further investigation as a potential determinant of the effect of foreign peers on native HE students' labour market outcomes.

7. Conclusion

This paper is the first to study the impact of foreign students on the educational and early labour market outcomes of native students in the entire system of HE. Educating overseas students is a significant export industry for the UK and other countries such as the USA, Canada, and Australia. It is therefore important to understand whether the labour market prospects of native students are adversely affected by their exposure to international students. Our study presents robust evidence that, once enrolled into HE, they are not: the effect of foreign students on natives' outcomes is limited. Thanks to the rich administrative and survey data used we are able to investigate a wide range of outcomes and find small or null results on most. Foreign students have no effect on the probability of graduating, degree classification achieved, activity status six months after graduation, or among those in work, on several job attributes.

We do however find an important effect of EU students on the probability of moving to a less prestigious university and to remain in a non-STEM degree. Nevertheless, these displacement outcomes are rare occurrences and we show that, if anything, the initial share of foreign students at enrolment positively affects the degree classification and graduation probability among the population of natives who moved towards less competitive environments, such as to non-Russell universities and non-STEM subjects.

We provide some evidence that the likely mechanism underlying our findings is that foreign students affect the composition of the group against which natives compare themselves to infer their own academic ability. We find that foreign peers affect HE performances of high academic ability natives, and displacement outcomes of natives of all abilities. This happens in ways consistent with foreign students altering, first, the academic ability and, second, the language skills of natives' comparison group, in particular increasing the perceived ability of natives in non-STEM degrees relative to STEM degrees.

We further show that the lack of important effects of international students on native students' outcomes is found across different groups of universities, subject areas, and natives' characteristics. This finding highlights that the estimated average null effect of international students on natives' outcomes does not mask any relevant heterogeneity across different groups of students.

[27] In these figures we show only certain educational and labour market outcomes to avoid presenting too many figures.

Data availability

The authors do not have permission to share data.

Appendix A. Additional tables

See Tables A.1–A.11.

Table A.1
Recruitment of marginal UK and home-fee students with foreign-student enrolment: University and department-level fixed-effect regressions.

	(1)	(2)	(3)	(4)	(5)	(6)
	University-level: (Uni + year FE)			Uni-degree-level: (Uni×degree + year FE)		
	N. UK	N. UK	N. 'home fee' (UK + EU)	N. UK	N. UK	N. 'home fee' (UK + EU)
A. All						
N. EU	1.342**	1.502**		0.633**	1.700***	
	(0.627)	(0.776)		(0.252)	(0.270)	
N. Non-EU	1.675***		1.768***	0.362***		0.468***
	(0.474)		(0.441)	(0.132)		(0.139)
Observations	484	484	484	5166	5166	5166
B. Russell group						
N. EU	2.672***	3.314***		0.944**	1.010**	
	(0.800)	(1.053)		(0.364)	(0.440)	
N. Non-EU	1.565***		1.910***	0.293		0.480*
	(0.419)		(0.519)	(0.204)		(0.255)
Observations	80	80	80	1031	1031	1031
C. Non-Russell group						
N. EU	1.228*	1.286		0.588***	0.646**	
	(0.627)	(0.837)		(0.272)	(0.297)	
N. Non-EU	2.092***		2.124***	0.442***		0.527***
	(0.612)		(0.555)	(0.153)		(0.159)
Observations	404	404	404	4135	4135	4135

Note: No additional controls. Standard errors clustered by university. *$p < .10$ **$p < 0.05$, ***$p < 0.01$. Columns 1–3 aggregated at university × year level. Columns 3–6 aggregated at university × degree subject × year level.

Table A.2
Predictors of missing tariff score information among native students.

	(1) No fixed-effects	(2) Fixed-effects as in main specifications
Female	−0.014***	−0.009***
	(0.003)	(0.002)
Caribbean	0.088***	0.058***
	(0.015)	(0.006)
African	0.060***	0.048***
	(0.015)	(0.006)
Indian	−0.044***	−0.018***
	(0.007)	(0.004)
Pakistani	−0.033*	−0.009*
	(0.013)	(0.004)
Bangladeshi	−0.049**	−0.029***
	(0.016)	(0.007)
Physical disability	0.022**	0.003
	(0.007)	(0.004)
Learning disability	0.039***	0.016
	(0.010)	(0.009)
Mental health difficulty	0.069***	0.028***
	(0.006)	(0.004)
Parent: Lower managerial	0.013***	0.005***
	(0.002)	(0.001)
Parent: Intermediate Occ	0.014***	0.007***
	(0.002)	(0.002)
Parent: Self-employed	0.033***	0.016***
	(0.003)	(0.002)
Parent: Technical Occ	0.025***	0.010***
	(0.003)	(0.002)
Parent: Semi-routine Occ	0.040***	0.020***
	(0.004)	(0.002)
Parent: Routine Occ	0.049***	0.028***
	(0.004)	(0.003)
Parent: Never worked	0.109	0.057**
	(0.068)	(0.020)
Private school	−0.061***	−0.026***
	(0.006)	(0.004)
Neighbourhood HE participation Q2	−0.014***	−0.011***
	(0.003)	(0.002)
Neighbourhood HE participation Q3	−0.026***	−0.020***
	(0.005)	(0.003)
Neighbourhood HE participation Q4	−0.034***	−0.025***
	(0.006)	(0.003)
Neighbourhood HE participation Q5	−0.051***	−0.034***
	(0.007)	(0.003)
Log university to domicile distance	−0.020***	−0.013***
	(0.003)	(0.001)
Log university-degree cell size	0.052***	0.020*
	(0.005)	(0.010)
Obs.	509,870	509,870

Note: Linear regression. Additional controls: Chinese ethnicity, other ethnicity, other disability, other school type, distance unknown, year and month of birth $*p < .10$ $**p < 0.05$, $***p < 0.01$.

Table A.3
Robustness checks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	HE performance				Displacement		
	Pass	At least 2:2	At least 2:1	First	To non-Russell	To non-STEM	To STEM
	A. without individual or cohort characteristics as controls						
EU peers	−0.001	−0.004	0.000	0.004	0.011*	0.010	−0.012***
	(0.005)	(0.006)	(0.007)	(0.005)	(0.006)	(0.008)	(0.004)
non-EU peers	−0.003	−0.002	−0.012	0.009	−0.001	0.005	−0.006
	(0.006)	(0.006)	(0.008)	(0.007)	(0.009)	(0.007)	(0.005)
Obs.	509,870	509,870	509,870	509,870	131,670	147,200	362,670
Mean Y	0.818	0.782	0.569	0.122	0.024	0.049	0.016
	B. without natives with no UCAS tariff score						
EU peers	0.000	−0.003	−0.003	0.002	0.014*	0.015	−0.013***
	(0.005)	(0.005)	(0.007)	(0.005)	(0.007)	(0.009)	(0.004)
non-EU peers	−0.002	−0.001	−0.012	0.011	0.001	0.010	−0.007
	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)	(0.007)	(0.005)
Obs.	436,535	436,535	436,535	436,535	125,995	128,580	307,950
Mean Y	0.841	0.809	0.600	0.129	0.023	0.047	0.016
	C. UCAS tariff score quintiles						
EU peers	0.001	−0.002	0.000	0.003	0.011*	0.011	−0.012***
	(0.005)	(0.006)	(0.007)	(0.005)	(0.005)	(0.008)	(0.004)
non-EU peers	−0.000	0.001	−0.010	0.009	−0.002	0.003	−0.006
	(0.005)	(0.006)	(0.008)	(0.007)	(0.009)	(0.008)	(0.005)
Obs.	509,870	509,870	509,870	509,870	131,670	147,200	362,670
Mean Y	0.818	0.782	0.569	0.122	0.024	0.049	0.016

Note: Individual and cohort characteristics excluded from panel A are gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, UCAS tariff score, tariff-missing dummy, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, cohort, university-degree, cohort-degree, and cohort-university. Standard errors clustered by university. $^{*}p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A.4
Selection into the post-graduation outcome and salary estimation samples.

	(1)	(2)	(3)	(4)
	Respond to DLHE		Respond to salary question (conditional on working)	
	Coefficients	Average marginal effects	Coefficients	Average marginal effects
Female	0.102***	0.038***	0.030***	0.012***
	(0.004)	(0.001)	(0.005)	(0.002)
Caribbean	−0.326***	−0.123***	−0.137***	−0.054***
	(0.014)	(0.006)	(0.025)	(0.010)
African	−0.368***	−0.139***	−0.093***	−0.036***
	(0.010)	(0.004)	(0.019)	(0.008)
Indian	−0.045***	−0.017***	−0.066***	−0.026***
	(0.009)	(0.003)	(0.014)	(0.006)
Pakistani	−0.166***	−0.062***	−0.125***	−0.049***
	(0.011)	(0.004)	(0.020)	(0.008)
Bangladeshi	−0.083***	−0.031***	−0.048	−0.019
	(0.016)	(0.006)	(0.026)	(0.010)
Learning disability	−0.277***	−0.104***	0.026	0.010
	(0.028)	(0.011)	(0.050)	(0.020)
Mental health difficulty	0.040***	0.015***	−0.117***	−0.046***
	(0.008)	(0.003)	(0.013)	(0.005)
Parent: Lower managerial	−0.037***	−0.014***	−0.012	−0.005
	(0.006)	(0.002)	(0.008)	(0.003)
Parent: Intermediate Occ	−0.018*	−0.006*	0.018	0.007
	(0.007)	(0.003)	(0.010)	(0.004)
Parent: Self-employed	−0.078***	−0.029***	−0.030*	−0.012*
	(0.008)	(0.003)	(0.012)	(0.005)
Parent: Technical Occ	−0.033***	−0.012***	−0.005	−0.002
	(0.010)	(0.004)	(0.014)	(0.006)
Parent: Semi-routine Occ	−0.099***	−0.037***	−0.011	−0.004
	(0.007)	(0.003)	(0.011)	(0.004)
Parent: Routine Occ	−0.119***	−0.044***	0.000	0.000
	(0.009)	(0.004)	(0.014)	(0.006)
Parent: Never worked	−0.326***	−0.123***	−0.089	−0.035
	(0.043)	(0.016)	(0.079)	(0.031)
Private school	−0.056***	−0.020***	−0.067***	−0.026***
	(0.006)	(0.002)	(0.009)	(0.004)
Neighbourhood HE part’ Q2	0.066***	0.024***	0.005	0.002
	(0.007)	(0.003)	(0.011)	(0.004)
Neighbourhood HE part’ Q3	0.084***	0.031***	0.014	0.005
	(0.007)	(0.003)	(0.011)	(0.004)
Neighbourhood HE part’ Q4	0.105***	0.038***	0.008	0.003
	(0.007)	(0.002)	(0.010)	(0.004)
Neighbourhood HE part’ Q5	0.119***	0.044***	−0.013	−0.005
	(0.007)	(0.002)	(0.010)	(0.004)
UCAS tariff	1.278***	0.469***	0.688***	0.269***
	(0.018)	(0.007)	(0.027)	(0.010)
Tariff missing	−0.303***	−0.114***	−0.109***	−0.043***
	(0.006)	(0.002)	(0.009)	(0.004)
Log distance	0.029***	0.011***	0.012***	0.005***
	(0.002)	(0.001)	(0.002)	(0.001)
Log university-degree cell size	0.029***	0.011***	−0.043***	−0.017***
	(0.002)	(0.001)	(0.003)	(0.001)
Obs.	522,400	522,400	225,810	225,810

Note: Probit regression. Additional controls: Chinese ethnicity, other ethnicity, other disability, other school type, distance unknown, year and month of birth. Population size differs from that for HE outcomes as linkage with DLHE for all cohorts was undertaken using separate and non-linkable updated issue of HESA student records. $^{*}p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A.5
Descriptive statistics on Higher Education outcomes for foreign students.

	Mean	Std.dev.
	EU peers	
	Mean	SD
Graduated - Pass	0.817	0.387
Graduated - At least a third	0.787	0.409
Graduated - At least a lower second	0.750	0.433
Graduated - At least an upper second	0.560	0.496
Graduated - First class	0.165	0.372
Changed to Non-Russell	0.005	0.071
Changed to Russell	0.003	0.057
Changed to Non-STEM	0.025	0.158
Changed to STEM	0.009	0.094
	Non-EU peers	
	Mean	SD
Graduated - Pass	0.836	0.371
Graduated - At least a third	0.812	0.391
Graduated - At least a lower second	0.747	0.434
Graduated - At least an upper second	0.492	0.500
Graduated - First class	0.117	0.322
Changed to Non-Russell	0.009	0.093
Changed to Russell	0.004	0.066
Changed to Non-STEM	0.023	0.151
Changed to STEM	0.014	0.118

Note: Authors' computation from HESA data using the sub-population of EU and Non-EU students who are peers to our estimation sample of young native students. These figures are derived from 21,320 EU students and 32,655 Non-EU students. Of these 5880 EU and 15,270 non-EU start in a Russell Group university, 15,550 EU and 22,260 non-EU in a STEM major, and 5770 EU and 10,395 non-EU in a non-STEM major.

Table A.6
The effect of foreign peers on native maths students' HE outcomes.

	(1)	(2)	(3)	(4)	(5)	(6)
	HE performance				Displacement	
	Pass	At least 2:2	At least 2:1	First	To non-Russell	To non-STEM
	A. Baseline					
Foreign peers	−0.022	−0.013	−0.022	0.018	0.019	0.019
	(0.025)	(0.025)	(0.026)	(0.019)	(0.024)	(0.014)
	B. EU vs. Non-EU					
EU peers	−0.020	−0.018	−0.011	−0.013	−0.016	0.025***
	(0.015)	(0.014)	(0.016)	(0.012)	(0.024)	(0.009)
non-EU peers	−0.009	0.001	−0.017	0.034	0.025	0.002
	(0.027)	(0.027)	(0.030)	(0.021)	(0.019)	(0.015)
Obs.	22,895	22,895	22,895	22,895	7155	22,895
Mean Y	0.733	0.675	0.485	0.196	0.039	0.048

Note: Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, UCAS tariff score, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, cohort. Standard errors clustered by university. $^{*}p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$

Table A.7
Alternative presentation of "stayers and movers" analysis.

	(1)	(2)	(3)	(4)	(5)	(6)
	Stayed in a			Moved to a		
	Russell university	Non-STEM degree	STEM degree	Non-Russell university	Non-STEM degree	STEM degree
	A. and Passed					
EU peers	0.000	0.014**	−0.018	0.007	0.011	−0.009***
	(0.014)	(0.006)	(0.013)	(0.005)	(0.007)	(0.003)
non-EU peers	−0.018	0.007	−0.007	0.001	0.003	−0.006
	(0.012)	(0.007)	(0.010)	(0.007)	(0.006)	(0.004)
Mean Y	0.908	0.826	0.797	0.908	0.797	0.826
	B. and obtained at least a 2:2					
EU peers	−0.008	0.011*	−0.021	0.007	0.011*	−0.008***
	(0.014)	(0.006)	(0.013)	(0.005)	(0.007)	(0.003)
non-EU peers	−0.013	0.007	−0.001	0.001	0.001	−0.006
	(0.012)	(0.008)	(0.011)	(0.007)	(0.006)	(0.004)
Mean Y	0.890	0.793	0.755	0.890	0.755	0.793
	C. and obtained at least a 2:1					
EU peers	0.005	0.007	−0.008	0.008	0.010*	−0.005***
	(0.016)	(0.008)	(0.015)	(0.005)	(0.005)	(0.002)
non-EU peers	−0.008	−0.015	−0.007	0.002	0.003	−0.003
	(0.014)	(0.010)	(0.012)	(0.005)	(0.005)	(0.003)
Mean Y	0.752	0.582	0.536	0.752	0.536	0.582
	D. and obtained a First					
EU peers	−0.003	0.004	0.005	0.003	0.004**	−0.002***
	(0.012)	(0.006)	(0.008)	(0.002)	(0.002)	(0.001)
non-EU peers	0.027	0.007	0.014	−0.000	0.001	−0.001
	(0.016)	(0.007)	(0.010)	(0.002)	(0.003)	(0.001)
Mean Y	0.174	0.118	0.133	0.174	0.133	0.118
Obs.	131,670	362,670	147,200	131,670	147,200	362,670

Note: Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, UCAS tariff score, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, cohort, university-degree, cohort-degree, and cohort-university. Standard errors clustered by university. $^{*}p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$

Table A.8
The effect of foreign peers on natives' HE outcomes, using DLHE respondents only and applying non-response weights.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	HE performance				Displacement		
	Pass	At least 2:2	At least 2:1	First	To non-Russell	To non-STEM	To STEM
	A. Baseline						
Foreign peers	0.002	0.002	0.000	0.017*	0.003	0.015	−0.014**
	(0.004)	(0.006)	(0.011)	(0.009)	(0.007)	(0.010)	(0.007)
	B. EU vs. Non-EU						
EU peers	0.003	0.001	0.010	0.008	0.008	0.020*	−0.011**
	(0.003)	(0.005)	(0.009)	(0.006)	(0.008)	(0.011)	(0.004)
non-EU peers	0.001	0.001	−0.007	0.014*	0.001	0.005	−0.008
	(0.003)	(0.005)	(0.011)	(0.008)	(0.007)	(0.008)	(0.006)
Obs.	313,605	313,605	313,605	313,605	90,835	88,870	224,735
Mean Y	0.984	0.952	0.714	0.156	0.015	0.035	0.011

Note: Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, UCAS tariff score, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, cohort, university-degree, cohort-degree, and cohort-university. Standard errors clustered by university. $^{*}p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$

Table A.9
The effect of foreign peers on natives' labour market outcomes, controlling for HE outcomes: Activities.

	(1)	(2)	(3)	(4)
	Activity status			
	Working	Studying	Unemployed	Other
	A. Baseline			
Foreign peers	0.001	0.004	0.001	−0.006
	(0.009)	(0.008)	(0.005)	(0.005)
	B. EU vs. Non-EU			
EU peers	−0.008	0.002	0.004	0.002
	(0.007)	(0.006)	(0.004)	(0.003)
non-EU peers	0.007	0.003	−0.002	−0.008
	(0.009)	(0.008)	(0.005)	(0.005)
Obs.	315,215	315,215	315,215	315,215
Mean Y	0.631	0.221	0.084	0.065

Note: Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, UCAS tariff score, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. $^{*}p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$

Table A.10
The effect of foreign peers on natives' labour market outcomes, controlling for HE outcomes: Attributes.

	(1)	(2)	(3)
	Graduates in work		
	High SEC	Full time	Log Salary
	A. Baseline		
Foreign peers	0.012	0.008	0.031**
	(0.013)	(0.011)	(0.015)
	B. EU vs Non-EU		
EU peers	0.004	0.000	0.014
	(0.010)	(0.010)	(0.010)
non-EU peers	0.014	0.009	0.026*
	(0.012)	(0.010)	(0.013)
Obs.	224,865	224,865	124,305
Mean Y	0.244	0.664	9.628

Note: Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, UCAS tariff score, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, cohort, university-degree, cohort-degree, and cohort-university. Standard errors clustered by university. $^{*}p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$

Table A.11
Accessing of careers advice and work experience in one non-Russell group university.

	(1)	(2)	(3)	(4)	(5)	(6)
	N Careers	N 1 to 1 Careers	Used careers service for job information			
	Service	Service	In 2nd year		In 3rd year	
	Events Attended	Appointments Attended	At least once	At least twice	At least once	At least twice
Native high ability	*Base*	*Base*	*Base*	*Base*	*Base*	*Base*
Native mid ability	−0.240	−0.014	−0.019	0.028	0.005	0.008
	(0.150)	(0.127)	(0.045)	(0.039)	(0.050)	(0.047)
Native low ability	−0.178	−0.005	−0.038	−0.017	−0.030	0.033
	(0.192)	(0.161)	(0.059)	(0.051)	(0.065)	(0.060)
Native unknown	−0.726***	−0.473**	0.014	0.126	−0.024	0.059
	(0.223)	(0.188)	(0.095)	(0.082)	(0.112)	(0.104)
EU	0.926***	0.575***	0.193***	0.220***	0.041	0.131**
	(0.176)	(0.149)	(0.052)	(0.045)	(0.059)	(0.055)
Non-EU	−0.004	0.088	−0.060	0.023	−0.006	0.061
	(0.192)	(0.162)	(0.059)	(0.051)	(0.065)	(0.060)
Obs.	2,620	2,620	1,139	1,139	945	945
Mean Y	1.163	0.906	2.090	2.090	2.357	2.357

	(7)	(8)	(9)	(10)	(11)	(12)
	Participated in		Used Lecturers for job information			
	University Internship		In 2nd year		In 3rd year	
	or Placement Scheme		At least	At least	At least	At least
	In 2nd year	In 3rd year	once	twice	once	twice
Native high ability	*Base*	*Base*	*Base*	*Base*	*Base*	*Base*
Native mid ability	−0.030	−0.002	−0.012	−0.003	−0.027	0.036
	(0.022)	(0.023)	(0.044)	(0.036)	(0.051)	(0.045)
Native low ability	−0.048	−0.004	−0.035	−0.006	−0.072	−0.033
	(0.029)	(0.029)	(0.058)	(0.048)	(0.065)	(0.058)
Native unknown	−0.037	−0.001	−0.022	0.089	−0.004	0.083
	(0.048)	(0.047)	(0.094)	(0.077)	(0.113)	(0.101)
EU	0.078***	0.074***	0.063	0.098**	0.020	0.090*
	(0.026)	(0.026)	(0.051)	(0.042)	(0.060)	(0.053)
Non-EU	−0.030	0.020	−0.048	0.004	−0.025	0.066
	(0.030)	(0.029)	(0.059)	(0.048)	(0.065)	(0.058)
Obs.	1142	1069	1136	1,136	944	944
Mean Y	0.067	0.061	1.908	1.908	2.213	2.213

Note: Additional controls: Department of study, Sex. "High ability" and "low ability' means the top and bottom quintiles of tariff scores at this university, which have thresholds that would place these students in the top and bottom 30% nationally. Columns 1-2 in upper panel are from administrative data on the population at this university. The remainder are on a sample of survey respondents. $*p < .10$ $**p < 0.05$, $***p < 0.01$

Appendix B. Additional figures

See Figs. B.1–B.8.

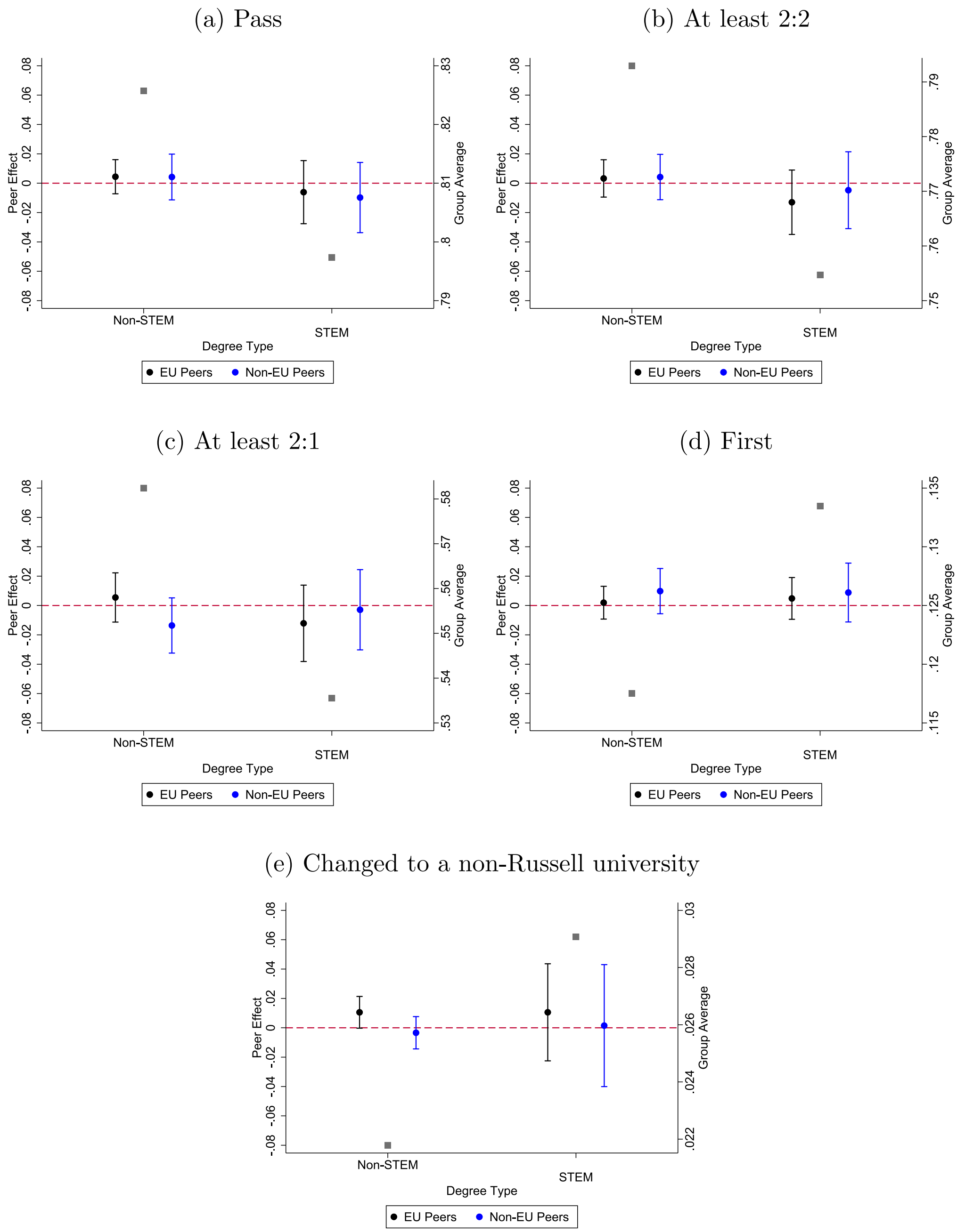

Fig. B.1. HE performances and displacement probability by degree type. *Note:* Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals. Effects measured on the left-axis. Outcome averages, represented by grey squares, measured in the right-axis. Estimates report the marginal effect of EU/Non-EU on natives by natives' degree type, see Eq. (7) and our discussion of it.

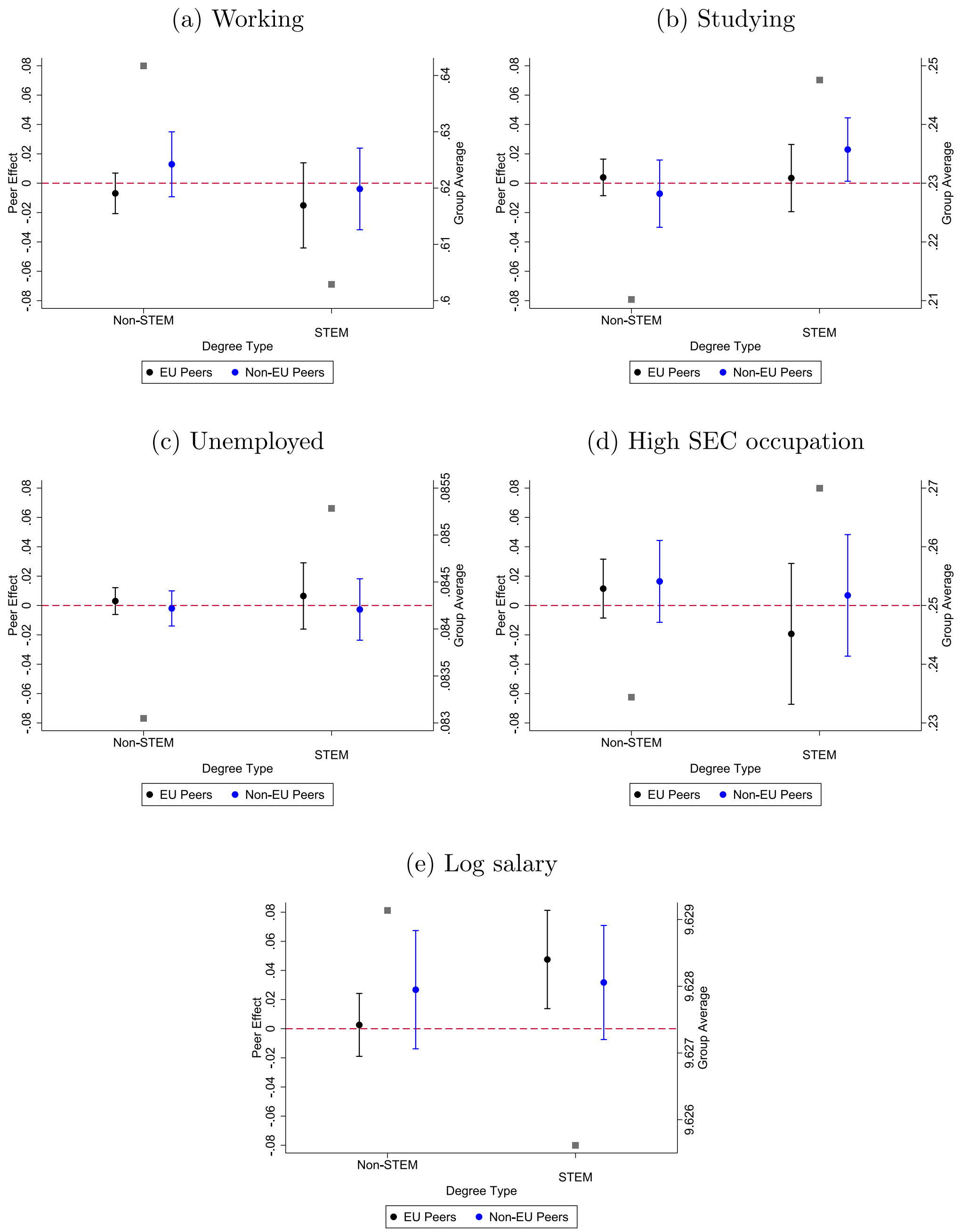

Fig. B.2. Labour market outcomes by degree type. *Note:* Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals. Effects measured on the left-axis. Outcome averages, represented by grey squares, measured in the right-axis. Estimates report the marginal effect of EU/Non-EU on natives by natives' degree type, see Eq. (7) and our discussion of it.

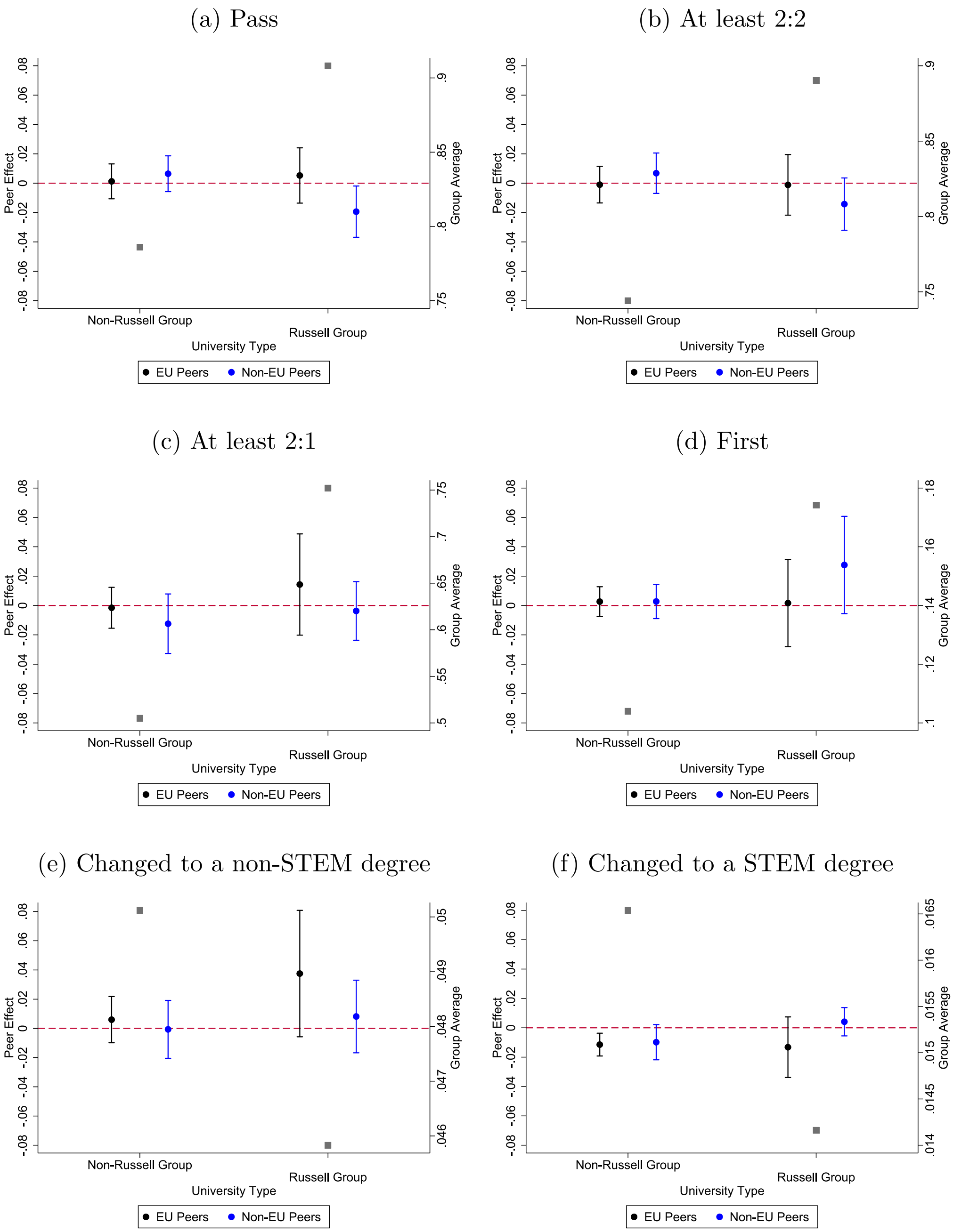

Fig. B.3. HE performances and displacement probability by university type. *Note:* Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals. Effects measured on the left-axis. Outcome averages, represented by grey squares, measured in the right-axis. Estimates report the marginal effect of EU/Non-EU on natives by natives' university type, see Eq. (7) and our discussion of it.

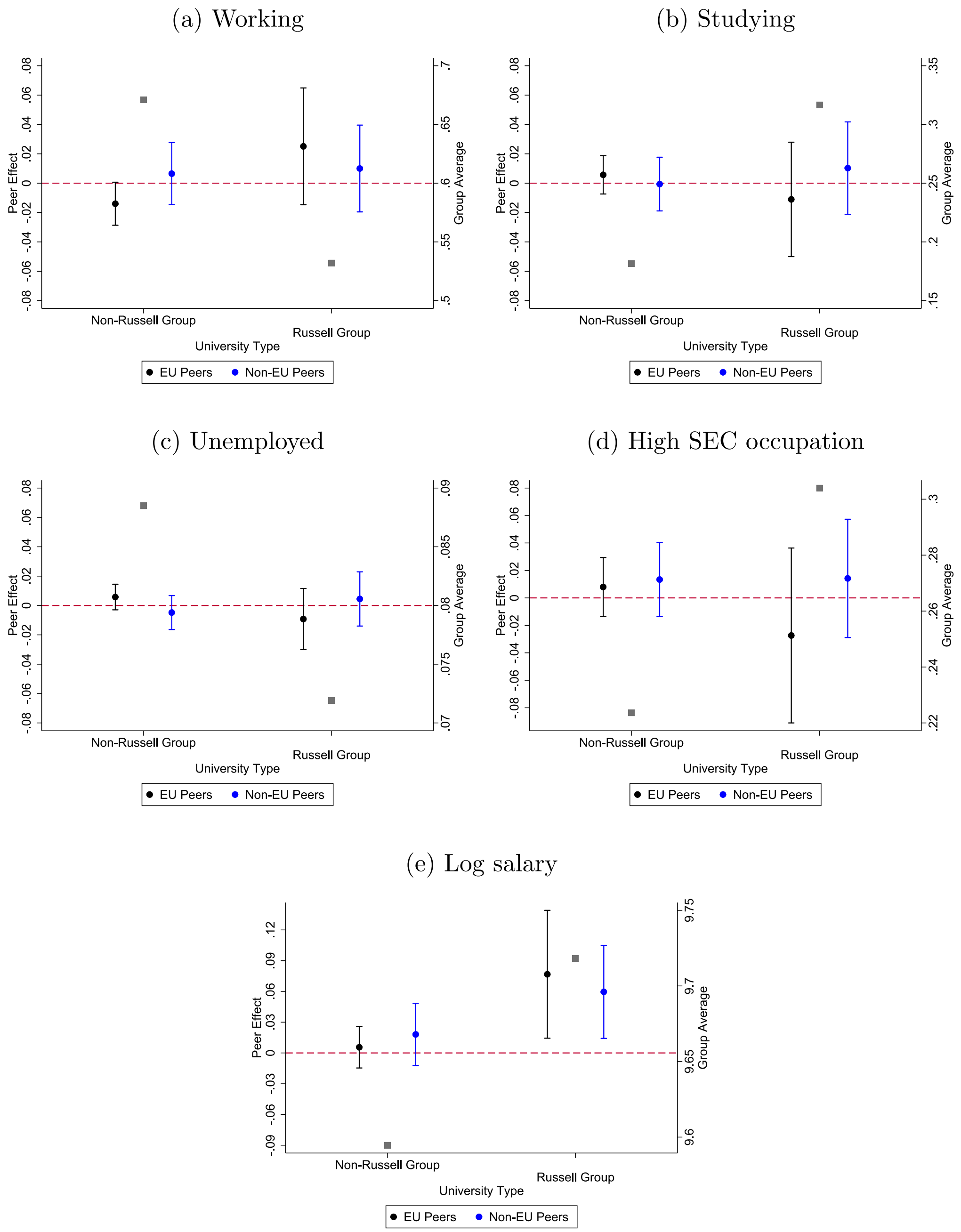

Fig. B.4. Labour market outcomes by university type. *Note:* Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals. Effects measured on the left-axis. Outcome averages, represented by grey squares, measured in the right-axis. Estimates report the marginal effect of EU/Non-EU on natives by natives' university type, see Eq. (7) and our discussion of it.

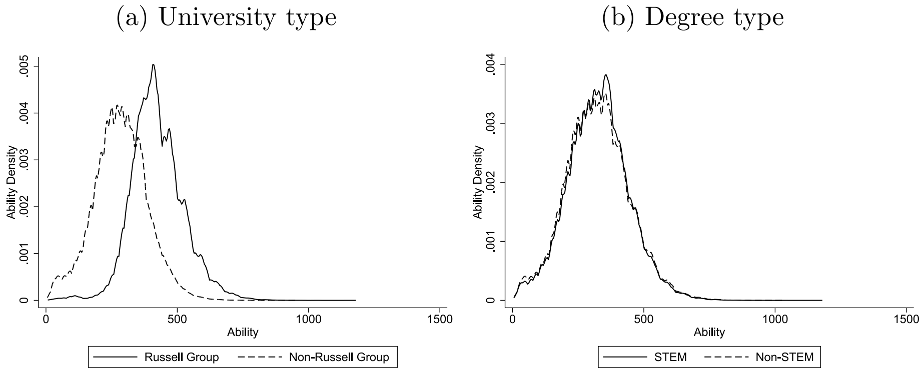

Fig. B.5. Ability of natives by type of university and degree. *Note*: Kernel density of UCAS tariff score by university and degree type. The UCAS tariff score measures pre-higher education academic merits of higher education applicants.

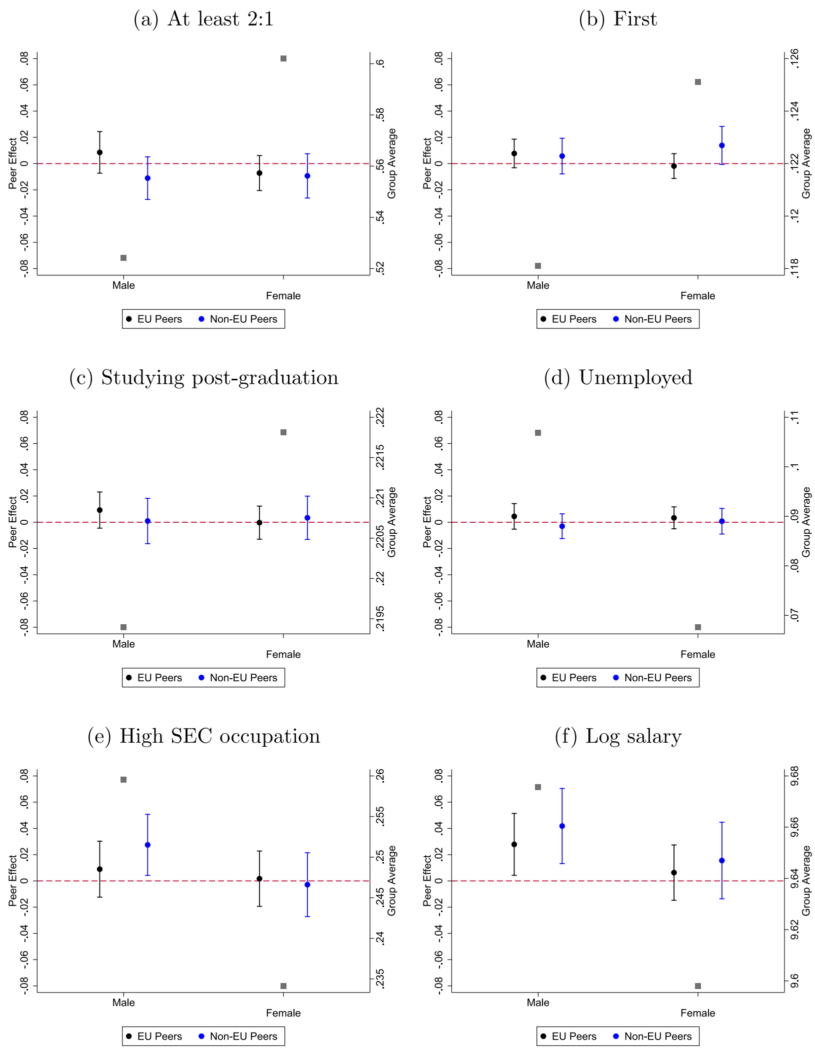

Fig. B.6. HE and labour market outcomes by sex. *Note:* Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals. Effects measured on the left-axis. Outcome averages, represented by grey squares, measured in the right-axis. Estimates report the marginal effect of EU/Non-EU on natives by natives' sex, see Eq. (7) and our discussion of it.

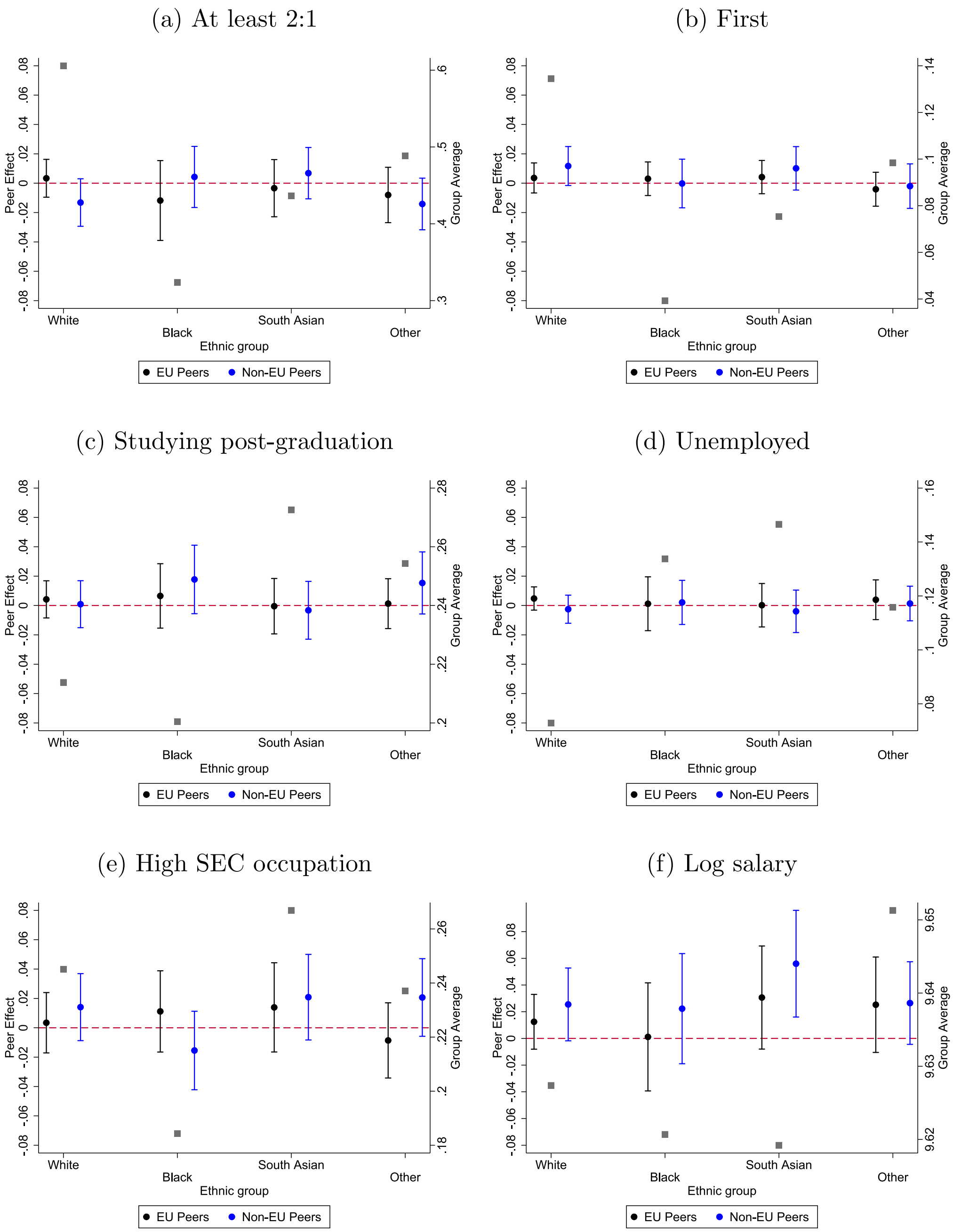

Fig. B.7. HE and labour market outcomes by ethnicity. *Note:* Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals. Effects measured on the left-axis. Outcome averages, represented by grey squares, measured in the right-axis. Estimates report the marginal effect of EU/Non-EU on natives by natives' ethnicity, see Eq. (7) and our discussion of it.

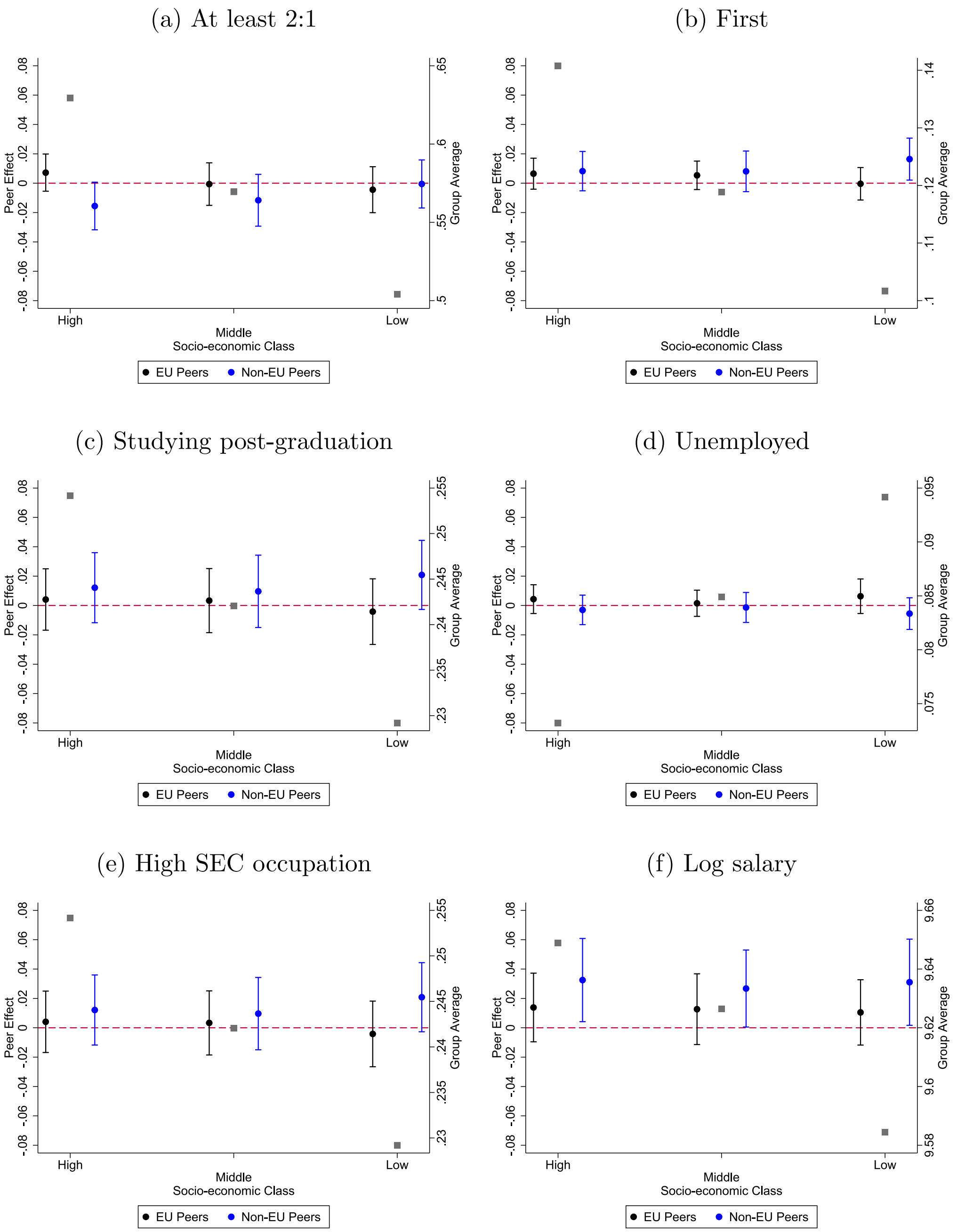

Fig. B.8. HE and labour market outcomes by socio-economic status. *Note:* Controls: gender, year and month of birth, ethnicity, disability, parental socio-economic classification, state school, low participation neighbourhood quintiles, log of distance between university and domicile, and log size of the university-degree cell. Fixed effects: university, degree, year, university-degree, year-degree, and year-university. Standard errors clustered by university. 95% confidence intervals. Effects measured on the left-axis. Outcome averages, represented by grey squares, measured in the right-axis. Estimates report the marginal effect of EU/Non-EU on natives by natives' socio-economic status, see Eq. (7) and our discussion of it.

Appendix C. Grading on a curve

By mapping actual academic performance into an invariant distribution of reported grades, i.e. grading on a curve, teachers may create grade rationing. This would create a mechanical relation between natives grades and the share of foreign peers even when the actual academic performance of both groups moves independently. Foreign students mechanically displace natives along the distribution of reported grades, with the sign of this mechanical effect being a function of the relative densities of actual academic performance for natives and foreign peers.

To elaborate our argument, assume that actual academic performance, $X \in [0, \omega]$, has CDF $F^j(X)$ for $j \in \{M, N\}$, where M are foreign students and N their native peers. Assume that actual academic performance is independent of the foreign peer share. Therefore, we rule out true, non-mechanical, peer effects from foreign students to both natives and foreign students themselves. Moreover, a natural rank preserving mapping for grading on a curve is $Z := G^{-1}(F(X)) \in [0, \omega]$, where G is the CDF of the targetted distribution of grades. It follows that the effect of foreign peers on natives' average reported grades has the form

$$\frac{\partial \mathbb{E}[Z|N]}{\partial \pi} = \int \frac{F^M(x) - F^N(x)}{g\left(G^{-1}(F(x))\right)} dF^N(x) \tag{C.1}$$

Thus, under this simple grading on a curve model an increase in the share of foreign peers (see Eq. (C.1)):

- Increases (decreases) the average reported grade of natives if foreign peers are worst (better) students than natives on a first order stochastic dominance sense, i.e. $F^M(x) \geq (\leq) F^N(x)\ \forall x \in [0, \omega]$
- Produces no effect if natives and immigrants have the same distribution of academic performance

To be closer to our empirical grading outcomes, we can also consider discrete events such as the probability of obtaining a first, $\mathbb{E}[G(Z) > q_1|N] = \mathbb{E}[X > F^{-1}(q_1)|N]$, where q_1 is a given quantile threshold for the reported grade,

$$\frac{\partial \mathbb{E}[G(Z) > q_1|N]}{\partial \pi} = F^M(F^{-1}(q_1)) - F^N(F^{-1}(q_1)) \tag{C.2}$$

It follows from (C.2) that when natives face stronger self-competition than competition from foreign peers, i.e. $F^M(F^{-1}(q_1)) > F^N(F^{-1}(q_1))$, increasing the foreign share has a positive mechanical effect on the probability of obtaining a first.

Finally, an obvious implication of grading on a curve is that, at the class level, any statistic of reported grades must be orthogonal to the share of foreign students. In other words, grading on a curve implies that we should not be able to reject a null of zero effects when we regress any grade measure on the share of foreign students at the class level. Here we use this implication to produce an empirical test.

In Table C.1 we report effects of the foreign peer share on the probability of graduating with a first, upper second, lower second and third. Here we do not constrain the sample to natives only, thus, under grading on a curve, we should see no effects on grades at the population level. Estimates in columns (2) and (3) strongly reject the null of no foreign peer effects implied by grading on curve.

Table C.1
Foreign peer effects on population grade outcomes.

	(1)	(2)	(3)	(4)
	Pass	At least 2:2	At least 2:1	First
	A. Baseline			
Foreign peers	−0.003	−0.017*	−0.025***	−0.002
	(0.008)	(0.009)	(0.007)	(0.004)
	B. EU vs. Non-EU			
EU peers	0.009**	0.005	0.005	0.004
	(0.005)	(0.005)	(0.006)	(0.004)
non-EU peers	−0.010	−0.024***	−0.032***	−0.005
	(0.007)	(0.008)	(0.006)	(0.003)
Obs.	934,080	934,080	934,080	934,080
Mean Y	0.780	0.736	0.519	0.120

Note: Controls: Log size of the university-degree cell. Fixed effects: university, degree, cohort, university-cohort, cohort-degree, and cohort-university. Standard errors clustered by university. $^*p < .10$ $^{**}p < 0.05$, $^{***}p < 0.01$

Appendix D. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.euroecorev.2023.104595.

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