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# Academic performance, background and pre-existing quantitative skills of economics starters: Mind the Gap! ☆,☆☆

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ABSTRACT

We examine differences in early academic performance among economics entrants by gender, ethnicity and origin (home versus overseas), and assess the role of existing skills before entering university in explaining these differences. Using diagnostic test scores, assessment marks, and demographic data from three student cohorts (over 1000 observations), we identify sizeable attainment gaps between home and overseas students and across ethnic groups. By contrast, we find little evidence of differences by gender or socioeconomic status alone, except for an advantage of state-school over privately educated students and an advantage for men in Microeconomics among home students. Controlling for pre-existing knowledge substantially reduces, and often eliminates, these attainment gaps, suggesting that differences in early performance largely reflect variation in existing quantitative skills on entry. However, residual gaps for overseas students and some ethnic groups remain and our analysis indicates that language barriers may also contribute. These findings highlight the importance of targeted support at university entry to improve equality of opportunity and academic outcomes.

## 1. Introduction

The presence of "awarding gaps", i.e. differences in students' academic performance by demographic characteristics, in economics and other subjects is well-evidenced (see e.g. Bottan et al., 2022; Broecke and Nicholls, 2007; Paredes Fuentes et al., 2023), in particular for differences by gender or ethnicity. Differences between home and overseas students have received comparatively less attention, although possibly relevant given the high reliance of universities in the UK and elsewhere on attracting overseas students. Systematic differences in outcomes between different groups of students are of particular interest in highly remunerative subjects such as economics, because of the potential impact on socioeconomic mobility.

In this article we map differences in first year academic performance of economics students by gender, origin, ethnicity and socioeconomic status (SES), and explore possible factors in explaining observed differences. Any insight into the determinants of awarding gaps is likely to be useful for developing educational policy. We focus on the role of pre-existing quantitative skills, measured through centralised end of school exams (A-levels[1]) and own diagnostic tests for university starters, as quantitative skills have been found to be very relevant for successful performance in economics (Ballard and Johnson, 2004; Schuhmann et al., 2005).

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However, in particular for international students, also heterogeneity in language skills is likely relevant for heterogeneity in academic success, and we are able to offer some suggestions, exploiting the rich exam structure in one of the modules under consideration.

Our analysis combines quantitative skills test results for university starters with marks data and demographic information from survey and administrative data. We use data from three cohorts of first year economics students, yielding more than 1000 observations, at a Russell Group university.[2]

Using regression analysis we identify gaps in exam marks (grades) by origin and ethnicity in both Mathematics and Microeconomics, with a sizable disadvantage (5–13 marks) for overseas and Asian Chinese students, and for Black students in Mathematics, but less so in Microeconomics. Male overseas students have a particular disadvantage in Mathematics. We find a gender gap for home students in Microeconomics, with women performing 6–7 marks worse. We do not find evidence for gaps by our measure of SES, but private school students perform worse in Mathematics than state school students.

Once we control for pre-existing quantitative skills, as measured by A-levels and by our diagnostic test, the overseas performance gap disappears in Mathematics and diminishes in Micro. The same holds for Asian Chinese, many of whom are overseas students, but not for Blacks, nor for the observed gender differences. The private school gap in Mathematics disappears when controlling for our test results. That is, a sizable part of the observed gaps between demographic groups can be explained by heterogeneity when entering university, but a relevant residual remains.

The residual overseas gap in Microeconomics could point to a role for language skills heterogeneity. The structure of the Microeconomics exam allows us to distinguish between two roughly equally weighted parts: one containing multiple choice questions and one containing open questions, requiring brief verbal reasoning. Indeed, the format matters for differences in academic performance: the overseas disadvantage in Microeconomics disappears when controlling for pre-existing knowledge for the MCQ part of the exam, but not for the other part. The same holds for the Asian Chinese disadvantage in Microeconomics. Moreover, adding home interactions we find that the observed Asian Chinese disadvantage in Microeconomics stems only from overseas students, suggesting that language skills play a role. The gender gap for home students is the same in both exam parts, however.

Our contribution is to link heterogeneity in existing knowledge of incoming students to gaps in early academic performance between demographic groups, such as by gender, ethnicity and especially origin. Our research strongly suggests that a substantial part of observed performance gaps between groups reflects heterogeneity in pre-existing knowledge, in the form of quantitative and language skills. Especially the latter is under-researched to the best of our knowledge. Our findings could support both curriculum development and targeted teaching interventions and are likely to be of relevance for other subjects beyond economics that apply quantitative skills and rely on international students. Intriguingly, performance gaps for Black students in Mathematics and female home students in Microeconomics are not explained by our measures of existing skills, leaving their possible determinants a subject for future research.

### *1.1. Literature review*

A substantial literature has documented the central role of quantitative skills in determining success in economics, including early contributions by Anderson et al. (1994), Ballard and Johnson (2004), and Economics Network (2012). However, the mathematical and statistical demands of undergraduate economics programmes are often underestimated by UK students (Dawson, 2012).

Recent work points to a systematic mismatch between pre-existing quantitative skills and the level required to succeed in business and economics degrees (see Munnariz and Rincon, 2025, for a comprehensive review). Systematic differences in academic performance have been documented across demographic groups, including by gender and ethnicity (see e.g. Bottan et al., 2022; Orlov et al., 2021; Arnold and Rowan, 2014; Paredes Fuentes et al., 2023), as well as by geographic origin (home versus overseas students). Given the large presence of international, especially Chinese students, the latter is particularly relevant in the UK and other English-speaking countries, yet remains relatively under-researched. Existing evidence is limited and largely focuses on adjacent fields such as Business and Management (see, for example, Cagliesi et al., 2023 for the UK and He and Banham, 2009 for Canada), with some studies suggesting that home–overseas gaps narrow after the first year of university. It is also well established that, conditional on prior attainment, such as A-level performance, UK undergraduates who attended private schools tend to perform worse at university than their state-educated peers. For instance, Boliver et al. (2019) show that using contextualised offers does not set students up to fail once admitted to university (Boero et al., 2024), but document important heterogeneity by ethnicity, finding that private schooling is, on average, positively associated with degree outcomes for some ethnic minority groups, particularly Black students, but not for White students.

That is, despite the relative wealth of literature there seems a need for a more integrated analysis linking pre-existing skills, demographic characteristics, and early academic performance in economics, going beyond only information contained in A-levels results. We use diagnostic tests to measure prior knowledge relevant for economics including for students who did not take A-levels, coming from different education systems. We focus on the transition into first-year economics, a critical period during which initial disparities may emerge and interventions may have lasting effects. In light of the limited existing literature on the performance gap between home and overseas students, we explore the extent to which language skills contribute to this gap. In particular, we exploit

[1] At age 16 students typically progress to "sixth form" and take A-levels (Advanced Level qualifications), usually in three subjects. A-levels are two-year, exam-based courses that serve as the primary credential for university admission and are broadly comparable to taking multiple advanced AP-level subjects, but with greater depth and subject specialisation. A-levels are also offered outside the UK, mainly in Commonwealth countries.

[2] A group of 24 research-intensive universities in UK.

variation in first-semester assessment formats, comparing performance across assessments that place different demands on written and interpretative language skills.

In the remainder of this article we lay out our empirical approach in Section 2. In Section 3 we present descriptive statistics, our regression analysis and a more detailed analysis of the home-overseas gap in Microeconomics. Section 4 concludes. All tables and graphs not in the text are in Appendix.

## 2. Empirical approach

### 2.1. Diagnostic test

We applied a diagnostic test to students in their first year of an undergraduate degree in economics and related programmes.[3] We administered the test in the first week of teaching as a timed online test, combined with a survey asking for demographic information. We administered the test in three consecutive academic years.

The diagnostic testing framework we use is designed to reflect the content of the university's economics curriculum, approximately pitched between A-level Mathematics and first year Mathematics and Statistics for Economics. It is based on other tests that have already been deployed successfully elsewhere (e.g. pre-calculus concept assessment at several universities in the US, MathsFit in Dublin, Mathematical Diagnostic Test in Edinburgh, ESSA), adjusted to our setting.[4]

The combined test and survey was delivered via the module's regular virtual learning environment (VLE),[5] similar to other online assessment on the module. Students were informed that the first online test in the module would be a maths and statistics test, along with a short demographic survey, in order to map their existing strengths and weaknesses when starting university and to allow the programme team to improve teaching delivery and student experience. The diagnostic test, but not the survey, was a compulsory part of the core module Introduction to Mathematics. Students who participated earned one mark, which is one percent of the total module mark, regardless of their answers to the online test. To incentivise students to perform well, the ten students with the best test scores received a £50 voucher.

To address possible concerns about the online delivery of the test we ran an experiment with the 2025/26 cohort, randomly dividing them into two groups. The first (proctored) group took the online test in a classroom under exam conditions, with several proctors present. The second (unproctored) group also took the online test in a classroom, but not under exam conditions, with only one member of staff present to deal with technical issues. Tables 9 and 10 in Appendix show descriptive statistics and regression analysis of the two groups' performances, yielding no significant difference. We also find that diagnostic test results in 2025/26 are well in line with those in 2023/24 and 2024/25, taken at home, see Table 12 in the Appendix.[6] This mitigates concerns about the reliability of the online test results.

To test for possible order effects, we delivered the test in three versions in 2024/25, differing by the order of the sections, with the different versions randomly assigned to students.[7] Table 11 in Appendix shows no statistically significant effects of the sequence of sections on test results.

The online test consisted of 20 mathematical questions, grouped into five thematic sections (Arithmetics, Algebra, Functions and (Pre-)Calculus, Probability, Statistics) with four questions each. 15 questions out of 20 (three in each thematic section) remained the same for all instances of delivering the diagnostic test, whereas the remaining five questions varied.[8] The choice of test content reflects both the first year curriculum in Mathematics and Statistics and the mathematical content of the economic degree programmes as a whole. Economics programmes at this university are relatively quantitative, with frequent use of mathematical and statistical modelling. The level of the test was aimed to sit between curriculum in pre-University education in Mathematics (A-level Mathematics) and the level of the exams in the first year university modules Mathematics and Statistics for economics. The test was administered in the academic years 2023/24 to 2025/26 and in the data analysis we only use the 15 questions used in all academic years. See Appendix for examples of the test questions used.

[3] The full list of programmes is: BSc Economics, integrated Master in Economics (MEcon), Economics and Accounting, Economics and Actuarial Science, Economics and Business Management, Economics and Finance, Economics with Data Science, Philosophy and Economics, Politics and Economics, and PPE.

[4] Diagnostic tests have been introduced in many mathematics departments since the 1990s as exams or online tests (Hodds et al., 2022). These tests tend to correlate reasonably highly with academic performance (see e.g. Akveld and Kinnear, 2023; Carlson et al., 2010; Mullen and Cronin, 2013; McKee and Orlov, 2023). Existing tests differ in their academic level, areas tested, the use of multiple choice and write-in questions, of reflective questions (e.g. "how confident are you in your answers in this section?"), the taxonomy used (e.g. Bloom, MATH) and category weightings, and the mix of computational and wordy questions.

[5] Also known as learning management system (LMS).

[6] These findings are perhaps a bit surprising in light of e.g. Vazquez et al. (2021) who find significant effects of proctoring on exam results. This is likely due to the fact that the diagnostic test is not an exam, students do not receive feedback and know this, and stakes are low as mere participation yields one percent of the module mark. In addition, students were told that the results of the test are used to inform the material of the course and this may further decrease the incentive to 'cheat'.

[7] The three versions were: A. Arithmetics, Algebra, Functions and (Pre-)Calculus, Probability, Statistics; B. Arithmetics, Probability, Statistics, Algebra, Functions and (Pre-)Calculus; C. Probability, Statistics, Arithmetics, Algebra, Functions and (Pre-)Calculus.

[8] In 2023, we used different test versions to compare the predictive power of different questions, which fed into a redesign of five questions, one per subject area.

### 2.2. Data

We use data from the online survey, which combines the mathematics and statistics test with a short demographic survey, administered in October 2023, 2024 and 2025, and from student records, containing demographic and administrative information.

A total of 1141 students took the diagnostic test (out of 1217 students invited to take the test in the three years). This yields a participation rate of 94%, which mitigates concerns about sample selection. We omit students that did not take both Mathematics and Microeconomics exams in semester 1, as well as those who answered fewer than 12 questions (out of a total of 15 common to all versions of the test).[9] This leaves us with 1051 students and information about test results, gender, origin (home/overseas), UCAS or Direct Entry,[10] dummies for A-level subject results (e.g. grade A or better in Maths A-levels), SES (Low or other),[11] whether they were repeat students and which programme they were enrolled in from student records.

A restricted sample (829 out of 1051 students) contains self-reported demographic information on ethnic group (White British or Other, Black, Asian Chinese or Other, Mixed/Other), whether their parents went to university and whether they went to a private school.[12]

Table 8 in Appendix compares the descriptive statistics for our main and restricted samples. There are no statistically significant differences in diagnostic test or exam performance. However, the restricted sample has significantly more home students, and fewer directly admitted students (who tend to be from overseas). Consistent with this observation, the restricted sample also has more (fewer) observations from 2024 (2023) than the main sample, as the share of overseas students was lower in 2024. There are no statistically significant differences between the samples in terms of A-level or programme composition. We also compare regression results for the main sample with results for the same specifications in the restricted sample (Tables 3, 4 and 13, 14). Reassuringly, results are very similar.

Our sample contains only students enrolled in an economics programme at this Russell Group university. Hence, our sample is likely to be selected, e.g. possibly reflecting academic aspiration (applying to a selective university) and career expectations (economics graduates have higher earnings on average than most other graduates). However, economics students at selective universities are a relevant demographic group for the UK, both in terms of numbers and economic impact. Moreover, the combination of high quantitative skills intensity and earnings prospects is not unique to economics.

## 3. Empirical results

### 3.1. Descriptive statistics

We begin by mapping the pre-existing quantitative knowledge among university starters, for the whole sample and by demographic group. Table 1 presents the test results in different sections of the test and the final exam results for Mathematics for Economics and Principles of Microeconomics, by various demographic characteristics.

At a first glance, Table 1 shows little evidence for gender differences in the diagnostic test, as average scores for men and women are similar, except for the Functions section where women perform better (at a 10% level). This pattern also holds for the final exam in Mathematics for Economics. By contrast, in the Microeconomics exam men statistically significantly outperform women by 4.3 marks on average. Comparing home and overseas students indicates that overseas students perform statistically significantly worse in the diagnostic test (overall and in all sections except Functions and Probability) and in both final exams. Overseas students scored on average 6.0 marks lower than home students in the Mathematics for Economics final exam, and 13.6 marks lower in Microeconomics. These observations could reflect differences in the mathematics curricula at secondary school or college between the UK and other countries, suggesting a potential area of focus for educational practitioners.

Considering both gender and origin, a more complex pattern emerges. Among international students, women outperform men in all test sections (by 2.8 marks overall, but not statistically significant) and in the Mathematics exam (by 6.0 marks on average, statistically significant), but not in the Microeconomics exam. For home students the pattern reverses. Men score 2.9 marks higher on average in the diagnostic test, statistically significant at the 5% level, most pronounced in the Arithmetics and Probability sections, but there is no gender gap in the Mathematics exam. Men significantly outperform women by 5.4 marks on average in the Microeconomics exam.

We do not find notable differences in test or exam performance in mathematics by SES. Low SES students (who satisfy any of the conditions for contextual admission, e.g. eligible for free school meals, been in care, low access to higher education neighbourhood, etc.) perform statistically significantly better in Microeconomics, by 5.9 marks on average. If corroborated by econometric analysis, this finding may indicate a potential for targeted widening participation initiatives in admissions.

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9 This threshold balances the aim to retain observations where participants chose to simply skip a question they did not know the answer to instead of ticking the "I don't know" box with the need to exclude observations from participants who did not engage with the test. Our analysis below is not sensitive to the exact threshold.

10 In the UK most students, home and overseas, apply to university via a centralised system, called UCAS. It is also possible to apply directly to university for international foundation years.

11 Low SES means for our purposes that at least one of the following holds: been in care or looked after for 3+ months; home postcode in low participation neighbourhood; participated in outreach/widening participation programme; home postcode in quintile 1 of Index of Multiple Deprivation (IMD); eligible for free school meals aged 14+; estranged student; UCAT Bursary eligible.

12 Most UK students are educated in state (publicly funded) schools, which are free to attend and include comprehensive schools, grammar schools (selective), and academies. A smaller share of students attend independent or "private" schools, including a subset historically known as "public schools," which, unlike in many other countries, charge fees.

**Table 1**
Test and exam performance by demographics (main sample).

| Variable | Obs | Diagnostic test | | | | | | Final exam | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | Arith | Algeb | Fun | Prob | Stat | Maths | Micro |
| All | 1051 | 57.77 | 73.87 | 74.37 | 51.24 | 38.41 | 50.98 | 59.02 | 60.55 |
| | | (0.51) | (0.82) | (0.79) | (0.82) | (0.99) | (0.83) | (0.54) | (0.49) |
| Male | 680 | 58.20 | 75.34 | 74.80 | 50.17 | 39.36 | 51.30 | 58.56 | 62.06 |
| | | (0.62) | (0.99) | (0.97) | (1.01) | (1.24) | (1.06) | (0.68) | (0.60) |
| Female | 371 | 56.98 | 71.16 | 73.63 | 53.01 | 36.75 | 50.36 | 59.97 | 57.78 |
| | | (0.88) | (1.46) | (1.37) | (1.41) | (1.63) | (1.36) | (0.89) | (0.82) |
| Difference | | 1.21 | 4.18** | 1.17 | −2.84* | 2.62 | 0.94 | −1.41 | 4.28*** |
| Home | 708 | 58.71 | 75.80 | 76.04 | 51.06 | 36.49 | 54.14 | 61.02 | 64.99 |
| | | (0.58) | (0.97) | (0.91) | (0.93) | (1.13) | (1.00) | (0.63) | (0.47) |
| Overseas | 343 | 55.83 | 69.87 | 70.99 | 51.41 | 42.47 | 44.41 | 55.01 | 51.38 |
| | | (1.00) | (1.51) | (1.52) | (1.64) | (1.90) | (1.45) | (1.00) | (0.97) |
| Difference | | 2.87*** | 5.93*** | 5.04*** | −0.35 | −5.98*** | 9.73*** | 6.01*** | 13.61*** |
| Male Home | 491 | 59.59 | 77.73 | 76.68 | 50.58 | 38.49 | 54.45 | 60.97 | 66.64 |
| | | (0.67) | (1.13) | (1.06) | (1.08) | (1.39) | (1.21) | (0.76) | (0.53) |
| Female Home | 217 | 56.71 | 71.43 | 74.58 | 52.15 | 31.95 | 53.46 | 61.13 | 61.25 |
| | | (1.10) | (1.86) | (1.72) | (1.78) | (1.91) | (1.77) | (1.10) | (0.91) |
| Difference | | 2.87** | 6.30*** | 2.10 | −1.57 | 6.54*** | 0.99 | −0.16 | 5.39*** |
| Male Overseas | 189 | 54.59 | 69.14 | 69.93 | 49.12 | 41.62 | 43.12 | 52.30 | 50.15 |
| | | (1.38) | (1.98) | (2.07) | (2.31) | (2.62) | (2.02) | (1.33) | (1.32) |
| Female Overseas | 154 | 57.36 | 70.78 | 72.29 | 54.22 | 43.51 | 46.00 | 58.34 | 52.89 |
| | | (1.43) | (2.35) | (2.25) | (2.30) | (2.77) | (2.06) | (1.47) | (1.42) |
| Difference | | −2.77 | −1.64 | −2.36 | −5.10 | −1.88 | −2.87 | −6.04*** | −2.74 |
| Low SES | 108 | 58.80 | 77.16 | 77.78 | 49.85 | 34.57 | 54.63 | 60.48 | 65.81 |
| | | (1.41) | (2.39) | (2.16) | (2.44) | (2.84) | (2.79) | (1.47) | (1.22) |
| Others | 943 | 57.65 | 73.49 | 74.00 | 51.33 | 38.88 | 50.55 | 58.89 | 59.94 |
| | | (0.54) | (0.88) | (0.84) | (0.88) | (1.05) | (0.87) | (0.58) | (0.52) |
| Difference | | 1.15 | 3.67 | 3.78 | −1.48 | −4.32 | 4.08 | 1.59 | 5.89*** |

*Notes:* Standard errors in parentheses, $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

**Table 2**
Test and exam performance by ethnic group and school type (restricted sample).

| Variable | Obs | Diagnostic test | | | | | | Final exam | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | Arith | Algeb | Fun | Prob | Stat | Maths | Micro |
| All | 829 | 57.84 | 73.74 | 74.85 | 51.07 | 37.64 | 51.91 | 59.96 | 61.54 |
| | | (0.57) | (0.93) | (0.88) | (0.93) | (1.08) | (0.94) | (0.61) | (0.54) |
| Asian Chin | 174 | 58.81 | 73.75 | 73.95 | 54.31 | 46.36 | 45.69 | 55.70 | 49.15 |
| | | (1.47) | (2.10) | (2.10) | (2.41) | (2.66) | (2.13) | (1.40) | (1.31) |
| Asian Oth | 247 | 56.80 | 70.18 | 74.83 | 50.74 | 33.33 | 54.93 | 62.43 | 64.55 |
| | | (0.98) | (1.74) | (1.55) | (1.64) | (1.85) | (1.61) | (1.05) | (0.86) |
| Black | 64 | 54.58 | 68.75 | 74.22 | 48.70 | 29.17 | 52.08 | 54.00 | 61.67 |
| | | (2.14) | (3.63) | (3.36) | (3.16) | (3.44) | (3.55) | (2.19) | (1.69) |
| White Brit | 218 | 59.83 | 80.12 | 75.46 | 51.30 | 38.84 | 53.44 | 61.28 | 66.55 |
| | | (1.03) | (1.63) | (1.60) | (1.65) | (2.13) | (1.85) | (1.08) | (0.81) |
| White Oth | 64 | 57.92 | 71.87 | 77.60 | 47.66 | 38.02 | 54.43 | 64.22 | 65.12 |
| | | (1.76) | (3.17) | (3.24) | (3.04) | (3.31) | (3.02) | (2.16) | (1.74) |
| Mixed/Oth | 62 | 55.54 | 72.58 | 73.12 | 48.39 | 34.41 | 49.19 | 59.18 | 62.85 |
| | | (1.98) | (3.21) | (3.37) | (3.36) | (3.67) | (3.50) | (2.61) | (1.72) |
| State Sch | 511 | 58.66 | 74.30 | 76.81 | 51.57 | 37.18 | 53.46 | 61.64 | 63.39 |
| | | (0.68) | (1.15) | (1.07) | (1.14) | (1.35) | (1.17) | (0.75) | (0.63) |
| Private Sch | 318 | 56.52 | 72.85 | 71.70 | 50.26 | 38.36 | 49.42 | 57.26 | 58.56 |
| | | (1.01) | (1.55) | (1.50) | (1.59) | (1.80) | (1.55) | (1.01) | (0.95) |
| Difference | | 2.14* | 1.45 | 5.11*** | 1.30 | −1.18 | 4.03** | 4.38*** | 4.83*** |

*Notes:* Standard errors in parentheses, $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

Our restricted sample also contains self-reported information on ethnicity and the school type attended, as an alternative measure of SES, reported in Table 2. The sample size is lower than that in Table 1, as there was some attrition in filling out the demographic

**Table 3**
Explaining gaps in mathematics for economics.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Female | 1.44 | | | 5.32*** | 5.00*** | 4.42** | 4.47** | 4.17** |
| | (1.09) | | | (1.98) | (1.86) | (1.83) | (1.77) | (1.76) |
| Home | | 4.33*** | | 6.75*** | 1.86 | 3.65** | 0.40 | 1.17 |
| | | (1.32) | | (1.70) | (1.70) | (1.62) | (1.63) | (1.66) |
| Fem*Home | | | | −5.11** | −4.05* | −4.36* | −3.94* | −3.34 |
| | | | | (2.36) | (2.20) | (2.23) | (2.12) | (2.11) |
| Low SES | | | 1.24 | 0.14 | −0.43 | −0.53 | −0.88 | −1.08 |
| | | | (1.58) | (1.62) | (1.45) | (1.58) | (1.45) | (1.45) |
| Controls | | | | | | | | |
| Test Results | | | | | | x | x | x |
| A-levels | | | | | x | | x | x |
| Admin Ctrls | x | x | x | x | x | x | x | x |
| Programmes | | | | | | | | x |
| Obs | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 |
| $R^2$ | 0.06 | 0.07 | 0.06 | 0.08 | 0.22 | 0.19 | 0.29 | 0.30 |
| F Stat | 18.55 | 20.49 | 17.91 | 14.43 | 34.85 | 9.14 | 15.61 | 14.44 |
| LL | −4462.60 | −4457.09 | −4463.20 | −4452.85 | −4366.00 | −4384.23 | −4320.68 | −4308.47 |

*Notes:* Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
*Admin Ctrls:* year, direct admission and repeat student dummies.
*Programmes:* dummies for programme of study (see footnote 3 for the list).
See Table 23 in Appendix for the full regression results.

survey. As discussed above, main and restricted samples do not show significant differences, except that overseas students are somewhat underrepresented in the restricted sample.

Interestingly, students' ethnicity and their final exam performance are linked in our data. Students identifying as White (British and Other) and Asian Other outperform their peers in both final exams, particularly so for White British students in Microeconomics. These differences are not reflected in the diagnostic test results, as there are no significant differences in diagnostic test results between ethnic groups, except for a statistically significant advantage for White British over Black students.

When comparing Black students to other students, there is no evidence of a significant gap in pre-existing knowledge, in terms of test results. However, by the end of Semester 1, Black students score approximately 7.3 marks lower in Mathematics and 4.9 marks lower in Microeconomics than White British students, both gaps are statistically significant. Comparing Black students with all other students, the same pattern holds for Mathematics, with a statistically significant gap of 6.5 marks in Mathematics, but a slight and insignificant advantage (0.1 marks) in Microeconomics. These performance gaps merit further investigation using econometric analysis.

The restricted sample also shows a link between the school type attended and exam performance, with state school students outperforming students from private schools, with statistically significant differences of 4.4 and 4.8 marks, reflecting their diagnostic test performance. This finding, if corroborated by econometric analysis, will be highly useful to inform policies of widening participation. See Table 12 in Appendix for comparisons of exam and test performance by other control variables.

### *3.2. Regression analysis*

We use simple OLS regression analysis to further investigate the evidence on exam performance gaps between different demographic groups of students, to be able to control for possible confounders as well as to assess whether including our measures of pre-existing knowledge (A-levels and diagnostic test results) can affect the measured performance gaps. To do so we use the following regression model regressing exam scores $y_i$ (in Mathematics and Microeconomics) on different groups of explanatory variables:

$$y_i = \alpha + \beta D_i + \delta K_i + \gamma X_i + \epsilon_i. \tag{1}$$

where $D_i$ is a vector of variables of interest (gender, origin, SES, ethnicity), $K_i$ a vector of measures of pre-existing knowledge (A-level dummies and diagnostic test scores), $X_i$ a vector of control variables and $\epsilon_i$ the error term.

*Mathematics*

Table 3 shows the results for the Mathematics for Economics exam. Simple regression analysis confirms the descriptive results, in that there seems to be only a significant difference by students' origin, with a home advantage worth about 4.3 marks. A multivariate regression with all three variables and an interaction term between gender and origin in column (4) shows a more nuanced picture, as gender, origin and their interaction all have significant coefficients of differing signs. The coefficients indicate that overseas men perform on average about 6.8 marks worse than home men, and about 5.3 marks worse than overseas women, whereas there is no significant difference between men and women among home students. That is, the results indicate a significant disadvantage of overseas men, compared to all other groups.

**Table 4**
Explaining gaps in microeconomics.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Female | −3.91*** | | | 2.03 | 1.63 | 1.36 | 1.20 | 1.06 |
| | (0.93) | | | (1.78) | (1.71) | (1.71) | (1.66) | (1.65) |
| Home | | 11.03*** | | 13.46*** | 7.49*** | 10.53*** | 6.00*** | 5.46*** |
| | | (1.13) | | (1.46) | (1.42) | (1.44) | (1.41) | (1.45) |
| Fem*Home | | | | −7.13*** | −6.04*** | −6.21*** | −5.55*** | −5.31*** |
| | | | | (2.05) | (1.94) | (1.99) | (1.90) | (1.89) |
| Low SES | | | 3.67*** | 0.69 | 0.66 | 0.36 | 0.47 | 0.25 |
| | | | (1.25) | (1.22) | (1.11) | (1.15) | (1.08) | (1.08) |
| Controls | | | | | | | | |
| Test Results | | | | | | x | x | x |
| A-levels | | | | | x | | x | x |
| Admin Ctrls | x | x | x | x | x | x | x | x |
| Programmes | | | | | | | | x |
| Obs | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 |
| $R^2$ | 0.18 | 0.26 | 0.17 | 0.27 | 0.37 | 0.33 | 0.40 | 0.41 |
| F-Stat | 48.70 | 69.03 | 44.18 | 46.51 | 51.28 | 17.75 | 22.15 | 20.62 |
| LL | −4290.31 | −4239.86 | −4296.06 | −4228.25 | −4153.67 | −4183.41 | −4124.51 | −4115.41 |

*Notes:* Robust standard errors in parentheses, $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

Introducing further control variables measuring pre-existing knowledge (A-levels and test results) reduces the point estimates of the differences and their statistical significance. Differences in A-levels in column (5) seem to better explain the gaps between home and overseas students. Together, in column (7), the two measures of pre-existing knowledge explain the raw performance gap between home and overseas students, although the female advantage for overseas students persists. Adding programme dummies in column (8) does not change the results meaningfully.

It is difficult to directly compare coefficients between regression specifications in Table 3. We use an Oaxaca-Blinder decomposition to assess the effect of adding information on prior knowledge (A-levels and diagnostic test results) on group-specific coefficients. The procedure divides the difference in outcomes (exam mark) by demographic group (overseas/home, men/women) into a part that is explained by the regression model used, and an unexplained remainder. We start with the basic model, specification (2) in Table 3, and add A-levels and test results, first on their own and then together, corresponding to specifications (5) to (7). Table 15 in Appendix shows the results of the Oaxaca-Blinder decomposition, supporting our interpretation of the results in Table 3. The left panel of Table 15 shows that both A-levels and test results reduce the unexplained part of the variation to statistical insignificance. Including A-levels has a larger effect on point estimates.

*Microeconomics*

The results for the Microeconomics exam results in Table 4 are a little more nuanced. Simple regression results indicate sizable differences in performance by gender, origin and SES (between 3.7 and 11.0 marks). However, the multivariate regression in column (4) shows these differences mask considerable sub-group effects. Differences in terms of SES are no longer significant, and the sign of the gender difference flips. This is because the coefficient for the interaction term indicates a significant 7.1 marks disadvantage for women among home students, whereas overseas women have an advantage, although not significant. As above, introducing our measures of prior knowledge in columns (5), (6) and (7) reduces the point estimates considerably, although both the home and the home gender differences remain statistically significant. As for Mathematics, A-levels seem to better explain the differences between home and overseas students and adding programme dummies in column (8) does not change the analysis meaningfully.

Again, an Oaxaca-Blinder decomposition using specifications (4)-(7) supports our interpretation. The right panel of Table 15 in Appendix shows that the unexplained difference in exam marks between home and overseas students reduces substantially when including A-levels (by more than half), diagnostic test results (by almost a quarter) or both (by almost two thirds), but not to statistical insignificance. The right panel of Table 16 in Appendix shows the results of a gender decomposition: adding information on diagnostic test results and, in particular, A-levels reduces the unexplained part of the gender difference in outcome, but again not to statistical insignificance.

*Mathematics: Ethnicity gaps*

Table 5 shows the results for performance gaps by ethnicity. Note that only part of the sample has information about ethnicity, which explains the difference in sample size to Tables 3 and 4.[13]

The regression results in Table 5 confirm a negative gap for Black and Asian Chinese ethnicities, but including gender and origin removes the gap for the latter. This is consistent with the Asian Chinese gap picking up a general home gap, as a sizable share of

[13] Repeating the regression analysis above, focusing on gender, origin and SES, for the smaller sample, which contains ethnicity information, yields very similar results as those shown in Tables 3 and 4. While the actual values differ, of course, significance levels and relations between coefficients mirror those presented in the tables above, see Tables 13 and 14 in Appendix.

**Table 5**
Explaining ethnicity gaps in mathematics.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| White Brit | −2.09 | | −2.31 | −1.29 | −1.73 | −0.78 | −0.55 |
| | (1.46) | | (1.50) | (1.39) | (1.55) | (1.46) | (1.43) |
| White Oth | 1.18 | | 1.43 | 1.02 | 1.29 | 1.15 | 1.22 |
| | (2.34) | | (2.38) | (2.17) | (2.32) | (2.18) | (2.19) |
| Asian Chin | −6.15*** | | −4.33* | −3.17 | −5.34** | −3.82* | −2.88 |
| | (1.81) | | (2.27) | (2.15) | (2.16) | (2.08) | (2.08) |
| Black | −7.38*** | | −6.87*** | −5.53*** | −6.06*** | −5.09** | −4.79** |
| | (2.36) | | (2.42) | (2.14) | (2.31) | (2.13) | 2.09) |
| Mixed/Oth | −3.19 | | −2.65 | −0.89 | −1.52 | −0.43 | −0.12 |
| | (2.74) | | (2.75) | (2.48) | (2.44) | (2.25) | (2.20) |
| Private Sch | | −3.87*** | −2.71** | −3.17** | −1.178 | −2.31* | −2.08* |
| | | (1.26) | (1.36) | (1.27) | (1.26) | (1.21) | (1.21) |
| Female | | | 3.97 | 3.87* | 2.86 | 3.22 | 3.07 |
| | | | (2.44) | (2.28) | (2.15) | (2.07) | (2.07) |
| Home | | | 3.10 | −1.81 | −1.21 | −4.02* | −3.08 |
| | | | (3.33) | (3.09) | (3.08) | (2.96) | (3.01) |
| Fem*Home | | | −4.28 | −3.00 | −3.10 | −2.65 | −1.91 |
| | | | (2.84) | (2.62) | (2.61) | (2.48) | (2.46) |
| Low SES | | | −0.26 | −0.88 | −0.39 | −0.86 | −0.78 |
| | | | (1.76) | (1.57) | (1.74) | (1.60) | (1.61) |
| Controls | | | | | | | |
| Test Results | | | | | x | x | x |
| A-levels | | | | x | | x | x |
| Admin Ctrls | x | x | x | x | x | x | x |
| Programmes | | | | | | | x |
| Obs | 829 | 829 | 829 | 829 | 829 | 829 | 829 |
| $R^2$ | 0.09 | 0.08 | 0.10 | 0.24 | 0.22 | 0.31 | 0.33 |
| F Stat | 12.17 | 20.59 | 8.81 | 21.14 | 7.01 | 11.76 | 10.89 |
| LL | −3506.64 | −3512.23 | −3502.57 | −3430.35 | −3441.35 | −3389.78 | −3382.62 |

*Notes:* Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
The omitted category is Male Overseas Asian Other State School.

the overseas students come from China. The performance difference between Black students and the omitted category (Asian Other) remains large and significant, but the gap reduces somewhat when introducing controls for pre-existing knowledge, in particular A-levels in columns (4), (6) and (7). Black students are predominantly (about 80%) home students, which is perhaps surprising, given the general home advantage. Controlling for A-levels or test results does not change the coefficients much, indicating that existing quantitative knowledge seems to matter relatively little for the Black performance gap. These observations are supported by an Oaxaca-Blinder decomposition in Table 17 in Appendix.

As above, the coefficients for female and home students reduce when controlling for pre-existing knowledge. Column (2) adds a private school dummy, indicating a sizable (3 to 4 marks) advantage for state school students, even when controlling for gender, origin, low SES and A-levels. Adding test results in column (5) decreases the gap to statistical insignificance, which is supported by an Oaxaca-Blinder decomposition (Table 19 in Appendix). This is consistent with A-level results not adequately picking up actual preparedness differences between state and private school students, which highlights the need for diagnostics and points to potential policy implications for outreach activities. Adding programme dummies does not change the general picture.[14]

*Microeconomics: Ethnicity gaps*

Table 6 shows in column (1) a sizable disadvantage for Asian Chinese and an advantage for White British students in the Microeconomics exam. We also find a significant 4.3 marks disadvantage of Black compared to White British students. Controlling for origin and gender again reduces the corresponding coefficients in absolute value. Adding controls for pre-existing knowledge reduces the difference between Asian Chinese and the omitted category (Asian Other) further. But even when controlling for pre-existing knowledge, the performance gap for Asian Chinese remains statistically significant and sizable (about 9 marks). The performance gap between Black and White British students reduces to about 3 marks, but remains significant. An Oaxaca-Blinder decomposition (Table 18 in Appendix) confirms that controlling for A-levels or test results does not reduce the unexplained part of the performance gap for Asian Chinese. By contrast, the unexplained difference between Black and White students (i.e. British and Other, to allow for White overseas students; results are similar for only White British) reduces by about 25% when adding both A-levels and test results and loses statistical significance at 5% level. That is, pre-existing knowledge helps to explain the Black-White performance gap, but not the disadvantage of Asian Chinese students in Microeconomics. These findings may be linked to the fact that Microeconomics

[14] Neither does omitting the low SES dummy variable, or separating the analysis of ethnicity and private school dummy variables into two sets of regressions.

**Table 6**
Explaining ethnicity gaps in microeconomics.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| White Brit | 2.07* | | 0.68 | 1.63 | 1.04 | 1.90* | 1.83 |
| | (1.17) | | (1.20) | (1.09) | (1.24) | (1.15) | (1.14) |
| White Oth | 0.76 | | 0.51 | 0.85 | 0.35 | 0.83 | 0.84 |
| | (1.87) | | (1.90) | (1.66) | (1.84) | (1.67) | (1.69) |
| Asian Chin | −12.58*** | | −10.37*** | −9.23*** | −10.75*** | −9.66*** | −9.56*** |
| | (1.55) | | (2.01) | (1.92) | (1.83) | (1.76) | (1.81) |
| Black | −2.22 | | −2.52 | −1.65 | −1.98 | −1.30 | −1.22 |
| | (1.75) | | (1.79) | (1.55) | (1.69) | (1.55) | (1.55) |
| Mixed/Oth | −0.10 | | −1.28 | 0.07 | −0.39 | 0.58 | 0.49 |
| | (1.82) | | (1.79) | (1.65) | (1.69) | (1.61) | (1.59) |
| Private Sch | | −3.10*** | 0.77 | 0.33 | 1.08 | 0.64 | 0.66 |
| | | (1.08) | (1.09) | (1.04) | (1.03) | (1.00) | (1.00) |
| Female | | | 1.28 | 1.22 | 0.19 | 0.41 | 0.38 |
| | | | (2.13) | (2.05) | (1.95) | (1.91) | (1.90) |
| Home | | | 6.13*** | 0.17 | 2.09 | −2.15 | −2.65 |
| | | | (2.27) | (2.12) | (2.07) | (1.99) | (2.05) |
| Fem*Home | | | −6.35*** | −5.34** | −5.00** | −4.53** | −4.23** |
| | | | (2.41) | (2.28) | (2.25) | (2.16) | (2.17) |
| Low SES | | | 0.98 | 0.91 | 0.83 | 0.86 | 0.81 |
| | | | (1.40) | (1.28) | (1.30) | (1.23) | (1.24) |
| Controls | | | | | | | |
| Test Results | | | | | x | x | x |
| A-levels | | | | x | | x | x |
| Admin Ctrls | x | x | x | x | x | x | x |
| Programmes | | | | | | | x |
| Obs | 829 | 829 | 829 | 829 | 829 | 829 | 829 |
| $R^2$ | 0.26 | 0.15 | 0.28 | 0.38 | 0.37 | 0.44 | 0.45 |
| F Stat | 29.87 | 28.36 | 21.27 | 28.02 | 13.85 | 17.63 | 16.81 |
| LL | −3323.13 | −3378.11 | −3311.00 | −3245.60 | −3256.37 | −3206.81 | −3200.95 |

*Notes:* Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
The coefficients for White British and Black are statistically significantly different, at the 5% level for specifications (1), (4) and (6), at the 10% level for (3), (5) and (7).
The omitted category is Male Overseas State School Asian Other.

relies less on quantitative skills than Mathematics, and more on verbal skills, which may disadvantage especially Asian Chinese students who are mostly from overseas. We will return to this conjecture in greater detail in the next section.

Interestingly, controlling for measures of pre-existing knowledge as well as ethnicity decreases the performance gap between home and overseas students and the home gender gap substantially. While the former becomes insignificant, the latter remains sizable (about 5 marks) and statistically significant in columns (5), (6) and (7). That is, differences in pre-existing knowledge and our control variables do not explain the disadvantage of female home students in Microeconomics. While we find a performance gap for private school in column (2), this gap diminishes and becomes statistically insignificant once we add controls, unlike for the Mathematics exam above.

### 3.3. Additional analysis

#### 3.3.1. Exploring possible language barriers

The fact that the exam performance disadvantage of international students can be explained by gaps in existing quantitative skills for Mathematics but only partially for Microeconomics may relate to a greater reliance on formulating wordy answers in Microeconomics. That is, the residual gap for international students in Microeconomics may well reflect language barriers. This logic extends to the observed gaps between Asian Chinese and other students, as about 90% of Asian Chinese students in our restricted sample are from overseas.

Indeed, prior research on economics education suggests that performance in economics assessments reflects more than economics knowledge alone. For instance, Ring and Oberrauch (2024) show that competence in graphical analysis is related to both subject knowledge and general quantitative and graphical analysis skills. Ring et al. (2026) find that performance on graphical analysis is associated with pre-existing knowledge in mathematics as well as in economics, suggesting that achievement in economics can reflect a combination of disciplinary knowledge and broader academic competencies.

Our data allow some explorative analysis of the possibility that both economics knowledge and language skills are at play, as the final exam in Microeconomics consists of two parts: a multiple choice question (MCQ) part and an open ended answer part. Only the latter demands graphical analysis and verbal reasoning. Each part contributes 50% to the final mark. As language skills

**Table 7**
Comparing MCQ and non-MCQ parts of microeconomics.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Panel A: Dependent MCQ Part of Microeconomics | | | | | | | | |
| Female | −5.03*** | | | −0.09 | −0.44 | −0.77 | −0.91 | −1.02 |
| | (0.98) | | | (1.77) | (1.74) | (1.74) | (1.73) | (1.73) |
| Home | | 7.05*** | | 9.05*** | 4.08*** | 6.30*** | 2.59 | 2.26 |
| | | (1.16) | | (1.51) | (1.56) | (1.55) | (1.58) | (1.61) |
| Fem*Home | | | | −6.42*** | −5.51*** | −5.48*** | −4.94** | −4.77** |
| | | | | (2.12) | (2.06) | (2.11) | (2.07) | (2.07) |
| Low SES | | | 1.66 | −0.28 | −0.27 | −0.39 | −0.23 | −0.38 |
| | | | (1.53) | (1.47) | (1.42) | (1.40) | (1.38) | (1.38) |
| $R^2$ | 0.16 | 0.18 | 0.14 | 0.20 | 0.26 | 0.25 | 0.30 | 0.30 |
| F-Stat | 49.76 | 52.49 | 42.34 | 37.17 | 38.23 | 13.57 | 15.99 | 14.29 |
| LL | −4347.46 | −4339.73 | −4359.93 | −4325.41 | −4280.62 | −4291.20 | −4257.52 | −4253.45 |
| Panel B: Dependent non-MCQ Part of Microeconomics | | | | | | | | |
| Female | −2.94** | | | 3.80 | 3.35 | 3.12 | 2.97 | 2.79 |
| | (1.18) | | | (2.33) | (2.24) | (2.23) | (2.17) | (2.15) |
| Home | | 14.52*** | | 17.28*** | 10.56*** | 14.17*** | 9.03*** | 8.34*** |
| | | (1.45) | | (1.88) | (1.84) | (1.82) | (1.81) | (1.87) |
| Fem*Home | | | | −7.61*** | −6.38** | −6.73*** | −5.97** | −5.64** |
| | | | | (2.63) | (2.51) | (2.56) | (2.46) | (2.45) |
| Low SES | | | 5.34*** | 1.45 | 1.36 | 0.90 | 0.96 | 0.66 |
| | | | (1.47) | (1.49) | (1.35) | (1.46) | (1.37) | (1.38) |
| $R^2$ | 0.19 | 0.28 | 0.19 | 0.29 | 0.36 | 0.34 | 0.39 | 0.40 |
| F Stat | 47.58 | 67.97 | 46.07 | 43.84 | 44.16 | 16.79 | 19.47 | 18.45 |
| LL | −4532.41 | −4469.61 | −4531.39 | −4463.42 | −4405.74 | −4427.22 | −4381.39 | −4372.64 |
| Controls | | | | | | | | |
| Test Results | | | | | | x | x | x |
| A-levels | | | | | x | | x | x |
| Admin Ctrls | x | x | x | x | x | x | x | x |
| Programmes | | | | | | | | x |
| Obs | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 |

*Notes:* Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

likely affect open ended answers more than those to MCQs, we would expect the gap between international and home students to be lower for the MCQ part of the exam than for the other part.

Therefore we run two separate versions of our regression model (1), using two separate outcome variables: first, the mark in the MCQ part of the Microeconomics exam and second, the mark in the other part of the exam. Panels A and B in Table 7 show the results for the main sample.

Strikingly, the raw home advantage for the non-MCQ questions is twice that for the MCQ questions, as home students earn on average 7.1 marks more than overseas students in the MCQ part, but 14.5 marks more in the non-MCQ questions, without controls. Controlling for pre-existing knowledge diminishes the home advantage in both parts of the exam, rendering the coefficient insignificant for the MCQ part, but not for the other part. The coefficient for home students in the non-MCQ is at least twice that for the MCQ part throughout all specifications. Intriguingly, the coefficient for female is higher for the non-MCQ part of the exam, in line with observations in the literature that women tend to have a comparative advantage in essay questions. Using a Seemingly Unrelated Regression (SUR) approach to compare coefficients between the two regressions for all specifications confirms that the coefficients for home are statistically significantly different at 1% for all specifications, the coefficients for gender only at the 10% level and the coefficient for the interaction not at all.

Indeed, for the MCQ part of Microeconomics the home advantage, measured by the coefficient for home, behaves much the same as for the Mathematics exam in Table 3, while results for the non-MCQ part look quite different. That is, the regression analysis is very much consistent with language barriers as part of the explanation for performance gaps between home and international students, but less so for explaining the gender gap in microeconomics. We note, however, that the non-MCQ part primarily prompted brief verbal reasoning, and to a lesser extent computations, but not essays.

A similar reasoning may apply to residual performance gaps by ethnicity observed in Microeconomics, especially for Asian Chinese. Therefore, we repeat the same exercise as above and run separate regressions for MCQ and non-MCQ part performance in Microeconomics by ethnicity. Table 20 in Appendix shows the results, indicating that the Asian Chinese disadvantage in the

MCQ part, measured by the coefficient, is about 7–8 marks, which is about half of that in the non-MCQ part (about 12–17 marks). Even when controlling for ethnicity we find sizable differences in the coefficients for home and female (about 6–7 marks) between the different parts. While both home and female students tend to have a relative advantage in the non-MCQ part (i.e. coefficients are higher in Panel B), once we control for existing knowledge, home students tend to perform significantly worse than overseas students in the MCQ part and about the same in the non-MCQ part. Comparing coefficients between the two regressions using SUR for all specifications confirms that the coefficients for home and female are both statistically significantly different at the 5% level for all specifications, indicating an advantage in the MCQ part for overseas students and for men that cannot be explained by our covariates, including measures of prior knowledge. The coefficients for Asian Chinese are statistically significantly different at the 5% level only for specifications (3) and (5), and at 10% for the remainder.

As both origin and ethnicity seem to play different roles in explaining the performance in the different parts, it may be of interest to disentangle the effect by adding interaction terms of the ethnic group and home dummies to our model (1). This comes at the cost of some relatively small cell sizes (10–20), but may still contribute to understanding observed variations. Tables 21 and 22 in Appendix present the results of this exercise. While the coefficients for Asian Chinese mirror the findings above, i.e. the Asian Chinese disadvantage in the MCQ part is about half of that in the non-MCQ part, we find striking heterogeneity between Asian Chinese home and overseas students. For both parts, the combined coefficient for Home and Asian Chinese is not statistically significantly different from zero, and the point estimate for the non-MCQ part is close to zero. The point estimates for Black and Home indicate a substantial 8 marks disadvantage in the non-MCQ part, but it is not statistically significant, indicating that a larger sample of such students would be desirable for a more reliable interpretation.

These observations suggest that different demographic groups experience different exam formats differentially. One potential pathway is differences in language skills, for instance for international students, but also for females who may well have an advantage over males in formulating open ended answers. Interestingly, when including controls, we find no statistically significant gender gap in either component.[15] These results may reflect two offsetting effects: while women may benefit from stronger language and communication skills, they may be relatively disadvantaged in assessment that demands graphical analysis. Similarly, Black Home students may find adjusting to economic and academic jargon more challenging than other Home students, although the statistical analysis lacks power for this subgroup.

#### 3.3.2. Diagnostic tests as predictors

Another question of interest is whether our diagnostic test is useful for predicting marks, and whether using the test results increases the predictive power of a model relying on admissions data alone. While a full machine learning approach to derive prediction models for exam marks is beyond the scope of this paper, our data allow us to make informative observations. We use year 2023 observations as a training sample for a naive OLS learner, incorporating all admissions and diagnostic data, corresponding to specification (8) in Tables 3 and 4. Using the years 2024 and 2025 as the test dataset we obtain the mean square error (MSE) as a measure of predictive power. Our naive learner generally outperforms several other machine learning approaches (LASSO, support vector machines and random forests) for these training and test samples, see Table 24 in Appendix. We then compare the results with those from a reduced specification, omitting the diagnostic test results, leaving us with only information from admissions data.

For both Mathematics and Microeconomics the diagnostic test results add some predictive power, reducing the respective MSE between 1.5% and 4.5%, see Table 25 in Appendix. The out of sample root mean squared errors are 16.7 for Mathematics and 14.5 for Microeconomics. These are best interpreted as mean deviation of the prediction from the actual value in marks (out of 100), indicating only moderate predictive power for actual marks. This is, of course, consistent with the hypothesis that teaching in these modules has an impact on student performance, in that prior knowledge does not fully determine marks. However, the predictions can serve to distinguish students at risk of failing (around 40 marks) from very good students (above 65 marks). A scatterplot of predicted versus actual exam performance (Fig. 1 in Appendix) also suggests that the predicted values can be used to classify students according to their expected exam performance, which in turn could perhaps be used to inform targeted interventions.

## 4. Discussion and conclusion

The aim of this study is to examine the relationship between incoming Economics students' quantitative skills, demographic characteristics, and first-year exam performance. By analysing outcomes across demographic groups and their intersections, we identify substantial awarding gaps between subgroups and investigate the factors that contribute to these differences. We contribute to the literature through the analysis of a rich dataset of more than 1000 students, including a large number of international students. We incorporate an extensive set of control variables, and the distinct assessment formats allow us to disentangle the advantages and disadvantages associated with different skill sets across demographic groups, providing useful insights into the mechanisms driving observed performance differences.

Although our study does not directly test pedagogical interventions, we believe that the results offer valuable insights into the potential determinants of attainment gaps in Economics, particularly those between Home and International students and Black and other students. Our analysis allows a number of conclusions that are likely to be directly relevant to practitioners and policy-makers, as well as of interest to the academic discussion. However, a key caveat is that while our statistical analysis identifies interesting links that suggest policy implications, our data do not allow a causal interpretation, and experimental evidence on the actual impact

[15] Although the point estimates imply a slightly different pattern with female students performing marginally worse on MCQs than on non-MCQ questions.

of these policies is needed. Similarly, the extent to which these results generalise beyond our institutional context remains an open question. Nevertheless, our results are consistent with the literature in the UK context, for instance the performance gap between private and state school students (Boero et al., 2024) and with previous studies investigating the role of prior education on academic performance in international contexts (see e.g. McKee and Orlov, 2023; Ring et al., 2026).

Our research shows that performance gaps between some demographic groups can be well explained by existing differences in preparedness, in particular for overseas students, especially those self-identifying as Asian Chinese, and for students educated in private schools. Our findings indicate that performance gaps at university are linked to the secondary education a student has received. With a view on policy, our research thus strongly supports the use of teaching interventions aimed at remedying pre-existing knowledge gaps for students from some educational backgrounds. Our finding that state school students outperform private school students especially in Mathematics for Economics seems to support policies of widening participation aimed at attracting more state school students to study economics at university, with potential implications for intergenerational mobility.

Perhaps surprisingly, our data does not provide evidence for a gender performance gap in quantitative skills at university, measured at entrance by the diagnostic test or at the end of Semester 1 by the Mathematics exam. There is some evidence for a home gender gap in Microeconomics, with a female disadvantage for home students, although it diminishes to statistical insignificance when controlling for ethnic group and prior knowledge. This contrasts with findings in Bottan et al. (2022) who find a persistent unexplained gap for under-represented minority women, controlling for pre-existing skills.

The structure of the Microeconomics exam allows us to analyse differences in performance gaps between a part comprised of MCQs and another part demanding open-ended answers. Interestingly, the home gap disappears in the MCQ part when controlling for existing knowledge, much like in the Mathematics exam, but remains significant for the other part. This indicates that the exam format and heterogeneity in the ability to write open ended answers matters for performance gaps, suggesting a role for language skills.

Controlling for prior knowledge and other student characteristics, we find that female home students perform better in the non-MCQ component with open ended answers than in the MCQ part. This is consistent with past research suggesting that women have an advantage in applying language and communication skills. However, female home students perform worse in both parts than male home students. A possible explanation is that the non-MCQ component contains some questions that require reasoning based on graphical analysis. As there is some evidence that women perform worse in questions involving graphical analysis (Ring and Oberrauch, 2024; Ring et al., 2026), any advantage conveyed by superior language skills may be counterbalanced by a disadvantage in graphical analysis.

A potentially policy-relevant implication of our research is that the assessment type, for instance using MCQs, may affect performance, and differently so for different demographic groups. Indeed, in our sample first-year international students have the lowest disadvantage in MCQ assessments. These students may require time to adapt both to UK higher education and to study in the English language, suggesting that this format may offer advantages from an inclusivity perspective. This is consistent with Canal and Child (2025) who find MCQ-based assessments to be associated with the smallest performance gap between home and overseas students.

Our findings may contribute to a re-evaluation of MCQs as an assessment tool. Pedagogical research has often questioned their ability to assess deeper learning, arguing that conventional MCQs may fail to capture the full range of cognitive skills outlined in Bloom's taxonomy and not adequately assess students' ability to apply economic reasoning in unfamiliar contexts. However, Buckles and Siegfried (2006) find that carefully designed MCQs can test different levels of understanding, including in-depth conceptual knowledge and higher-order thinking, although such questions are considerably more difficult and time-consuming to develop. Our results and those by Canal and Child (2025) suggest that the debate should not be framed solely in terms of educational depth versus simplicity of marking. Beyond their advantages in terms of consistency, objectivity, and low-cost marking, MCQs may also help reduce unintended disadvantage for specific student groups during the transition into university, particularly international students.[16]

Future research could further explore the mechanisms underpinning attainment gaps across different student groups and examine whether these gaps are linked to particular skills. Comparing performance across different assessment formats may help identify the specific competencies associated with observed disparities and, in turn, provide insights into the challenges faced by particular groups, including international students adapting to a new educational environment.

Our analysis also yields a residual disadvantage for Black students, not explained by pre-existing knowledge, which is consistent with other research. For instance, using data from a Russell Group UK university Boero et al. (2024) report that only 15.4% of Black students obtain a First-class degree, but 37.9% of White students, and that differences in prior attainment, gender and socioeconomic background explain only a small proportion of the difference. Relatedly, Paredes Fuentes (2023) reports that Black students have the highest first-year drop-out rates in economics. Together these findings suggest that the disadvantages experienced by Black students persist throughout the student lifecycle, from progression to final degree attainment.

Different factors may play a role in explaining Black-White performance and awarding gaps, including cultural bias (Seno-Alday and Budde-Sung, 2021) and stereotype threat (Bottan et al., 2022). For mathematics, where all answers were open ended, but highly structured, cultural bias may perhaps be a less immediate explanation for the observed performance gap. Anecdotal evidence from the module lead (also known as Course Coordinator or Lead Instructor) suggests lower engagement of Black students prior to the exam, in that they were less likely to participate in the mock exam. If indeed engagement is a key determinant of performance gaps,

[16] However, our results also point to a female disadvantage in MCQs raising issues of fairness across gender.

this raises the question of what drives engagement of different demographic groups. Sense of belonging provides one plausible mechanism (see e.g. Boero et al., 2024), as students with a weaker sense of belonging are more likely to disengage from attending lectures and from peer learning which, in mathematically intensive subjects can directly affect performance, even when quantitative ability is comparable. If confirmed, there is potential for initiatives designed to enhance students' sense of belonging. We hope that future research will shed light on the mechanisms at play.

Indeed, recent research in economics education has focused on interventions designed to strengthen belonging among underrepresented groups in higher education. For example, Al-Bahrani (2022) highlights the role of inclusive classroom management practices and increased faculty–student interaction in fostering belonging.[17] These studies suggest that creating more inclusive learning environments may help address persistent attainment disparities. Similarly, Serra and Gomez-Vasquez (2025) examine the effectiveness of an intervention directed at all economics majors at a large public university, intended to support and encourage students through the most demanding stages of the semester. Although primarily targeted at other underrepresented groups, the emphasis of these interventions on fostering belonging and academic integration suggests that similar approaches could be adapted to support international students during their transition to university life.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix. Additional figures and tables

See Fig. 1 and Tables 8–25.

[17] Murray (2025) focuses on women and first-generation students and shows how embedding diverse role models within the curriculum can enhance students' perceptions of relevance and belonging in economics courses.

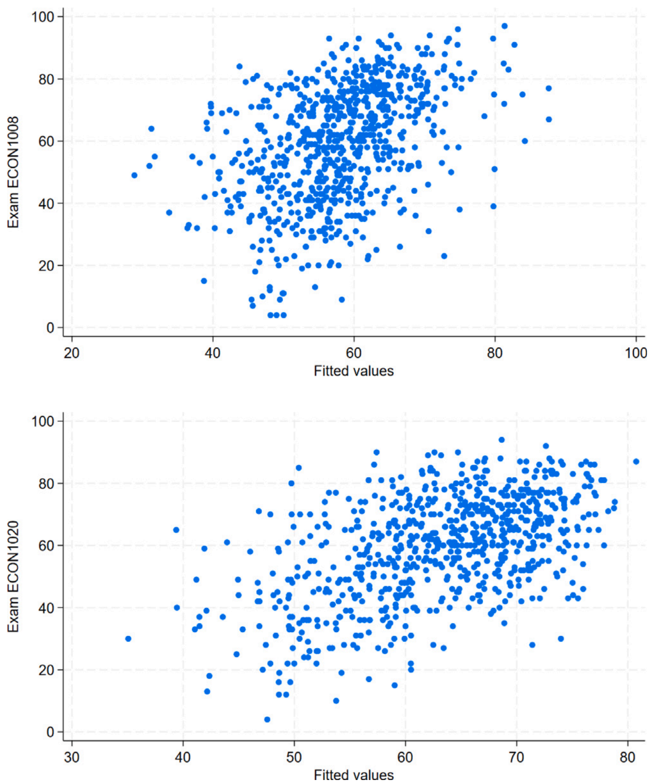


**Fig. 1.** Actual Mathematics (top) and Microeconomics (bottom) Exam Marks versus Full Prediction Model on Test Sample.

**Table 8**
Descriptive statistics: Main and restricted samples.

| Sample | Restricted (N = 829) | Main (N = 1051) | *P*-value |
|---|---|---|---|
| Total Test Score | 57.84 (16.38) | 57.77 (16.46) | 0.923 |
| Test Score Arithmetics | 73.74 (26.63) | 73.87 (26.75) | 0.921 |
| Test Score Algebra | 74.85 (25.33) | 74.39 (25.61) | 0.698 |
| Test Score Functions/Calculus | 51.07 (26.72) | 51.17 (26.73) | 0.931 |
| Test Score Probability | 37.64 (31.15) | 38.44 (32.01) | 0.584 |
| Test Score Statistics | 51.91 (26.94) | 50.97 (27.00) | 0.453 |
| Exam Mathematics | 59.96 (17.45) | 59.06 (17.47) | 0.265 |
| Exam Microeconomics | 61.54 (15.48) | 60.55 (15.86) | 0.175 |
| Gender Dummy (Female 1) | 0.35 (0.48) | 0.35 (0.48) | 0.929 |
| Residence Dummy (Home 1) | 0.73 (0.45) | 0.67 (0.47) | 0.012 |
| Low SES Dummy | 0.10 (0.30) | 0.10 (0.30) | 0.987 |
| Direct Admission Dummy | 0.04 (0.20) | 0.06 (0.24) | 0.030 |
| Repeat Year Dummy | 0.02 (0.14) | 0.02 (0.16) | 0.543 |
| Year 2023 Dummy | 0.23 (0.42) | 0.28 (0.45) | 0.007 |
| Year 2024 Dummy | 0.36 (0.48) | 0.32 (0.47) | 0.052 |
| A-level Maths Grade A+ Dummy | 0.27 (0.44) | 0.26 (0.44) | 0.486 |
| A-level Econ Grade A+ Dummy | 0.25 (0.43) | 0.24 (0.43) | 0.561 |
| A-level Econ Grade B Dummy | 0.27 (0.44) | 0.24 (0.43) | 0.240 |
| A-level Further Maths Dummy | 0.07 (0.25) | 0.06 (0.24) | 0.692 |
| Economics | 0.35 (0.48) | 0.34 (0.47) | 0.622 |
| Economics & Finance | 0.24 (0.43) | 0.25 (0.43) | 0.569 |
| Economics & Statistics | 0.12 (0.33) | 0.11 (0.31) | 0.531 |
| Economics & Business | 0.11 (0.32) | 0.13 (0.34) | 0.332 |
| PPE | 0.17 (0.38) | 0.17 (0.37) | 0.731 |
| Ethnic Group Mixed/Other | 0.07 (0.26) | | |
| Ethnic Group White British | 0.26 (0.44) | | |
| Ethnic Group White Other | 0.08 (0.27) | | |
| Ethnic Group Asian Chinese | 0.21 (0.41) | | |
| Ethnic Group Asian Other | 0.30 (0.46) | | |
| Ethnic Group Black | 0.08 (0.27) | | |
| Private School Dummy | 0.38 (0.49) | | |
| First in Family | 0.22 (0.41) | | |

Notes: Low SES: at least one of: been in care or looked after for 3+ months; home postcode in low participation neighbourhood; participated in outreach/widening participation programme; home postcode in quintile 1 of Index of Multiple Deprivation (IMD); eligible for free school meals aged 14+; estranged student; UCAT Bursary eligible. Economics includes BSc Econ, MEcon. Economics & Statistics: BSc Econ & Actuarial Science, BSc Econ with Data Science. Economics & Business: BSc Econ & Business Management, BSc Econ & Accounting. PPE: BA Philosophy, Politics & Econ, BA Politics & Econ, BA Philosophy & Econ.

**Table 9**
Comparing proctored and unproctored test-takers 2025.

| 2025 Test Group | Unproctored (N = 250) | Proctored (N = 190) | *P*-value |
|---|---|---|---|
| Total Test Score | 56.28 (16.67) | 56.86 (16.38) | 0.716 |
| Test Score Arithmetics | 73.49 (26.65) | 69.47 (27.07) | 0.121 |
| Test Score Algebra | 71.35 (26.40) | 76.05 (23.41) | 0.053 |
| Test Score Functions/Calculus | 52.21 (27.12) | 52.46 (27.54) | 0.925 |
| Test Score Probability | 36.41 (33.26) | 37.19 (31.75) | 0.804 |
| Test Score Statistics | 47.93 (27.21) | 49.12 (26.82) | 0.646 |
| Exam Mathematics | 54.95 (18.72) | 56.98 (18.34) | 0.267 |
| Exam Microeconomics | 62.09 (15.30) | 62.84 (17.64) | 0.642 |
| Exam Micro MCQ Part | 58.35 (17.97) | 60.69 (18.44) | 0.193 |
| Gender Dummy (Female 1) | 0.33 (0.47) | 0.34 (0.48) | 0.825 |
| Residence Dummy (Home 1) | 0.72 (0.45) | 0.71 (0.45) | 0.828 |
| Low SES Dummy | 0.15 (0.36) | 0.09 (0.29) | 0.064 |
| Direct Admission Dummy | 0.07 (0.26) | 0.07 (0.25) | 0.885 |
| Repeat Year Dummy | 0.02 (0.14) | 0.03 (0.16) | 0.661 |
| A-level Maths Grade A+ Dummy | 0.16 (0.36) | 0.19 (0.40) | 0.288 |
| A-level Econ Grade A+ Dummy | 0.18 (0.39) | 0.18 (0.38) | 0.892 |
| A-level Econ Grade B Dummy | 0.28 (0.45) | 0.31 (0.46) | 0.564 |
| A-level Further Maths Dummy | 0.05 (0.22) | 0.08 (0.28) | 0.178 |
| Economics | 0.25 (0.44) | 0.36 (0.48) | 0.016 |
| Economics & Finance | 0.30 (0.46) | 0.25 (0.44) | 0.315 |
| Economics & Statistics | 0.12 (0.33) | 0.13 (0.34) | 0.814 |
| Economics & Business | 0.16 (0.37) | 0.13 (0.33) | 0.322 |
| PPE | 0.17 (0.37) | 0.13 (0.34) | 0.293 |

Notes: proctored: in person in class test with proctors; Unproctored: in person in class test without proctors. Low SES and programmes defined as above.

**Table 10**
Test results 2025 and treatment group.

| Variables | Arith | Algeb | Fun | Prob | Stat | Total |
|---|---|---|---|---|---|---|
| proctored | 4.20 | −3.97* | 0.22 | 0.16 | −0.76 | −0.03 |
| | (2.59) | (2.38) | (2.67) | (3.17) | (2.61) | (1.58) |
| Obs | 439 | 439 | 439 | 439 | 439 | 439 |
| $R^2$ | 0.09 | 0.07 | 0.05 | 0.07 | 0.08 | 0.09 |
| F Stat | 3.03 | 4.22 | 1.85 | 1.69 | 2.89 | 3.46 |

*Notes:* Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Controls: Female-Home interaction, Low SES, A-levels, programme dummies, administrative controls.

**Table 11**
Test results 2024 and sequence of questions (no controls).

| Variables | Arith | Algeb | Fun | Prob | Stat | Total |
|---|---|---|---|---|---|---|
| Sequence B | −1.6450 | −1.0949 | −0.2839 | 1.2400 | 0.7944 | −0.9893 |
| | (1.3344) | (1.3045) | (1.3048) | (1.4473) | (1.2050) | (4.459) |
| Sequence C | −0.7935 | 0.14829 | −1.7377 | −0.4041 | −2.0860 | −4.8729 |
| | (1.3344) | (1.3763) | (1.4110) | (1.5217) | (1.2938) | (4.5273) |
| Obs | 345 | 345 | 345 | 345 | 345 | 345 |
| $R^2$ | 0.0049 | 0.0025 | 0.0051 | 0.0032 | 0.0131 | 0.0036 |
| F Stat | 0.79 | 0.45 | 0.78 | 0.57 | 2.50 | 0.60 |

*Notes:* Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Sequence A (omitted) : Arithmetics, Algebra, Functions, Probability, Statistics.
Sequence B: Arithmetics, Probability, Statistics, Algebra, Functions.
Sequence C: Probability, Statistics, Arithmetics, Algebra, Functions.

**Table 12**
Diagnostic test and final exam performance by other control variables.

| Variable | Obs | Diagnostic Test | | | | | | Final Exam | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | Arith | Algeb | Fun | Prob | Stat | Maths | Micro |
| Direct Entry | 67 | 55.47 | 64.18 | 72.14 | 47.51 | 45.77 | 47.76 | 49.27 | 41.84 |
| | | (2.33) | (3.57) | (3.81) | (3.44) | (4.80) | (3.36) | (1.72) | (1.87) |
| UCAS Entry | 984 | 57.93 | 74.53 | 74.53 | 51.49 | 37.91 | 51.20 | 59.69 | 61.82 |
| | | (0.52) | (0.84) | (0.80) | (0.85) | (1.00) | (0.86) | (0.56) | (0.48) |
| Repeat | 26 | 51.67 | 57.69 | 67.95 | 42.31 | 42.31 | 48.08 | 44.77 | 44.04 |
| | | (4.47) | (5.72) | (5.46) | (6.49) | (7.52) | (5.01) | (2.72) | (2.61) |
| First Attempt | 1025 | 57.93 | 74.28 | 74.54 | 51.46 | 38.31 | 51.06 | 59.39 | 60.97 |
| | | (0.51) | (0.83) | (0.80) | (0.83) | (0.99) | (0.85) | (0.54) | (0.49) |
| Year 2023 | 299 | 56.78 | 75.36 | 71.46 | 48.38 | 37.35 | 51.34 | 59.34 | 63.18 |
| | | (0.93) | (1.52) | (1.47) | (1.51) | (1.78) | (1.66) | (0.85) | (0.80) |
| Year 2024 | 338 | 60.01 | 74.95 | 77.96 | 52.02 | 41.22 | 53.90 | 62.62 | 55.89 |
| | | (0.91) | (1.48) | (1.42) | (1.44) | (1.75) | (1.39) | (0.97) | (0.87) |
| Year 2025 | 414 | 56.67 | 71.90 | 73.55 | 52.66 | 36.88 | 48.35 | 55.86 | 62.45 |
| | | (0.80) | (1.31) | (1.24) | (1.34) | (1.60) | (1.31) | (0.91) | (0.80) |
| Parent Uni | 620 | 58.53 | 74.57 | 75.40 | 52.23 | 38.28 | 52.18 | 60.28 | 62.06 |
| | | (0.62) | (1.05) | (1.02) | (1.07) | (1.24) | (1.06) | (0.69) | (0.60) |
| First in Fam | 172 | 57.07 | 71.90 | 73.64 | 49.03 | 37.60 | 53.20 | 59.66 | 61.28 |
| | | (1.42) | (2.19) | (1.94) | (2.00) | (2.50) | (2.15) | (1.44) | (1.22) |

**Table 13**
Gaps in mathematics for economics (restricted sample).

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Female | 0.73 | | | 4.04 | 3.85* | 2.99 | 3.27 | 3.08 |
| | (1.24) | | | (2.47) | (2.31) | (2.19) | (2.11) | (2.09) |
| Home | | 3.87** | | 5.86** | 0.83 | 2.05 | −1.12 | −0.66 |
| | | (1.58) | | (2.08) | (2.08) | (1.90) | (1.98) | (1.99) |
| Fem*Home | | | | −3.87 | −2.72 | −3.01 | −2.60 | −1.82 |
| | | | | (2.85) | (2.64) | (2.61) | (2.49) | (2.47) |
| Low SES | | | 0.76 | −0.15 | −0.84 | −0.41 | −0.90 | −0.87 |
| | | | (1.72) | (1.75) | (1.58) | (1.75) | (1.61) | (1.62) |
| Controls | | | | | | | | |
| Test Results | | | | | | x | x | x |
| A-levels | | | | | x | | x | x |
| Admin Ctrls | x | x | x | x | x | x | x | x |
| Programmes | | | | | | | | x |
| Obs | 829 | 829 | 829 | 829 | 829 | 829 | 829 | |
| $R^2$ | 0.07 | 0.08 | 0.07 | 0.08 | 0.23 | 0.21 | 0.30 | 0.32 |
| F Stat | 17.03 | 18.91 | 16.97 | 12.33 | 29.42 | 7.68 | 13.37 | 12.14 |
| LL | −3517.03 | −3513.49 | −3517.13 | −3511.86 | −3438.86 | −3449.52 | −3396.97 | −3388.47 |

*Notes:* Robust standard errors in parentheses, $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

**Table 14**
Gaps in microeconomics (restricted sample).

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Female | −4.66*** | | | 1.72 | 1.57 | 0.66 | 0.82 | 0.86 |
| | (1.05) | | | (2.24) | (2.14) | (2.07) | (2.02) | (2.00) |
| Home | | 10.76*** | | 13.14*** | 6.93*** | 9.23*** | 4.76*** | 4.18* |
| | | (1.36) | | (1.84) | (1.78) | (1.76) | (1.72) | (1.76) |
| Fem*Home | | | | −7.01*** | −6.07** | −5.92** | −5.48** | −5.31** |
| | | | | (2.50) | (2.36) | (2.34) | (2.25) | (2.25) |
| Low SES | | | 3.41** | 0.70 | 0.57 | 0.46 | 0.46 | 0.43 |
| | | | (1.44) | (1.42) | (1.28) | (1.31) | (1.23) | (1.23) |
| Controls | | | | | | | | |
| Test Results | | | | | | x | x | x |
| A-levels | | | | | x | | x | x |
| Admin Ctrls | x | x | x | x | x | x | x | x |
| Programmes | | | | | | | | x |
| Obs | 829 | 829 | 829 | 829 | 829 | 829 | 829 | |
| $R^2$ | 0.16 | 0.23 | 0.15 | 0.24 | 0.35 | 0.33 | 0.41 | 0.42 |
| F Stat | 33.70 | 44.23 | 28.19 | 30.86 | 38.05 | 14.47 | 19.11 | 18.09 |
| LL | −3372.43 | −3340.70 | −3380.36 | −3330.44 | −3265.41 | −3279.49 | −3229.97 | −3223.10 |

*Notes:* Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

**Table 15**
Oaxaca-Blinder decomposition by origin.

| | Mathematics | | Microeconomics | |
|---|---|---|---|---|
| | Coeff. | Std.Err. | Coeff. | Std.Err. |
| Home=0 | 55.01 | (1.00) | 51.38 | (0.97) |
| Home=1 | 61.02 | (0.63) | 64.99 | (0.47) |
| Diff | −6.01 | (1.18) | −13.61 | (1.08) |
| Base Model | | | | |
| Expl | −1.36 | (0.61) | −3.07 | (0.64) |
| Unexpl | −4.65 | (1.34) | −10.54 | (1.16) |
| A-level | | | | |
| Expl | −5.87 | (0.90) | −8.68 | (0.81) |
| Unexpl | −0.13 | (1.38) | −4.93 | (1.14) |
| Test results | | | | |
| Expl | −3.81 | (0.81) | −5.40 | (0.76) |
| Unexpl | −2.20 | (1.30) | −8.21 | (1.13) |
| Test & A-level | | | | |
| Expl | −7.00 | (0.98) | −9.79 | (0.87) |
| Unexpl | 0.99 | (1.34) | −3.81 | (1.13) |

*Notes:* Robust standard errors in parentheses. 1051 Observations. Base Model includes gender, SES and admin dummies.

**Table 16**
Oaxaca-Blinder decomposition by gender.

| | Mathematics | | Microeconomics | |
|---|---|---|---|---|
| | Coeff. | Std.Err. | Coeff. | Std.Err. |
| Female=0 | 58.56 | (0.68) | 62.06 | (0.60) |
| Female=1 | 59.97 | (0.89) | 57.78 | (0.82) |
| Diff | −1.41 | (1.12) | 4.28 | (1.02) |
| Base Model | | | | |
| Expl | 0.62 | (0.36) | 1.75 | (0.53) |
| Unexpl | −2.04 | (1.09) | 2.54 | (0.91) |
| A-level | | | | |
| Expl | 0.99 | (0.54) | 2.04 | (0.62) |
| Unexpl | −2.41 | (1.00) | 2.24 | (0.84) |
| Test results | | | | |
| Expl | 0.46 | (0.54) | 1.78 | (0.60) |
| Unexpl | −1.87 | (1.04) | 2.50 | (0.88) |
| Test & A-level | | | | |
| Expl | 0.77 | (0.63) | 2.04 | (0.66) |
| Unexpl | −2.18 | (0.98) | 2.24 | (0.83) |

*Notes:* Robust standard errors in parentheses. 1051 Observations. Base Model includes gender, SES and admin dummies.

**Table 17**
Oaxaca-Blinder decomposition by ethnicity for mathematics.

| | Coeff. | Std.Err. | | Coeff. | Std.Err. |
|---|---|---|---|---|---|
| Black=0 | 60.46 | (0.63) | As Chin=0 | 61.09 | (0.67) |
| Black=1 | 54.00 | (2.17) | As Chin=1 | 55.70 | (1.39) |
| Diff | 6.46 | (2.26) | Diff | 5.39 | (1.54) |
| Base Model | | | | | |
| Expl | 0.75 | (0.68) | Expl | 2.31 | (1.66) |
| Unexpl | 5.71 | (2.17) | Unexpl | 3.08 | (2.10) |
| A-level | | | | | |
| Expl | 1.45 | (1.15) | Expl | 3.03 | (1.65) |
| Unexpl | 5.01 | (1.92) | Unexpl | 2.36 | (1.99) |
| Test results | | | | | |
| Expl | 1.08 | (1.14) | Expl | 1.43 | (1.63) |
| Unexpl | 5.38 | (2.06) | Unexpl | 3.96 | (1.95) |
| Test & A-level | | | | | |
| Expl | 1.44 | (1.35) | Expl | 2.54 | (1.62) |
| Unexpl | 5.01 | (1.88) | Unexpl | 2.84 | (1.89) |

*Notes:* Robust standard errors in parentheses. 829 Observations. Base Model includes gender, origin, SES and admin dummies.

**Table 18**
Oaxaca-Blinder decomposition by ethnicity for microeconomics.

| | Coeff. | Std.Err. | | Coeff. | Std.Err. |
|---|---|---|---|---|---|
| White=1 | 66.23 | (0.74) | As Chin=0 | 64.83 | (0.51) |
| Black=1 | 61.67 | (1.68) | As Chin=1 | 49.15 | (1.31) |
| Diff | 4.56 | (1.84) | Diff | 15.68 | (1.41) |
| Base Model | | | | | |
| Expl | 0.65 | (1.05) | Expl | 5.57 | (1.41) |
| Unexpl | 3.91 | (1.75) | Unexpl | 10.11 | (1.85) |
| A-level | | | | | |
| Expl | 1.16 | (1.26) | Expl | 6.28 | (1.40) |
| Unexpl | 3.39 | (1.47) | Unexpl | 9.40 | (1.76) |
| Test results | | | | | |
| Expl | 1.32 | (1.24) | Expl | 5.02 | (1.38) |
| Unexpl | 3.23 | (1.71) | Unexpl | 10.66 | (1.66) |
| Test & A-level | | | | | |
| Expl | 1.73 | (1.36) | Expl | 5.68 | (1.37) |
| Unexpl | 2.82 | (1.54) | Unexpl | 10.00 | (1.60) |

*Notes:* Robust standard errors in parentheses. 346 (829) Observations for comparing White and Black (Asian Chinese and all others). Base Model includes gender, origin, SES and admin dummies.

**Table 19**
Oaxaca-Blinder decomposition by school type.

| | Mathematics | | Microeconomics | |
|---|---|---|---|---|
| | Coeff. | Std.Err. | Coeff. | Std.Err. |
| Private=0 | 61.64 | (0.75) | 63.39 | (0.63) |
| Private=1 | 57.26 | (1.01) | 58.56 | (0.95) |
| Diff | 4.38 | (1.26) | 4.83 | (1.14) |
| Base Model | | | | |
| Expl | 1.35 | (0.69) | 5.39 | (0.77) |
| Unexpl | 3.03 | (1.33) | −0.56 | (1.11) |
| A-level | | | | |
| Expl | 1.00 | (0.81 | 5.05 | (0.83) |
| Unexpl | 3.38 | (1.24) | −0,22 | (1.05) |
| Test results | | | | |
| Expl | 2.02 | (0.78) | 5.77 | (0.81) |
| Unexpl | 2.36 | (1.22) | −0.94 | (1.03) |
| Test & A-level | | | | |
| Expl | 1.57 | (0.86) | 5.31 | (0.84) |
| Unexpl | 2.81 | (1.17) | −0.48 | (1.00) |

*Notes:* Robust standard errors in parentheses. 829 Observations. Base Model includes gender, origin, SES and admin dummies.

**Table 20**
Comparing MCQ and non-MCQ parts: Ethnicity.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Panel A: Dependent MCQ Part of Microeconomics | | | | | | | |
| White Brit | 3.56*** | | 2.19 | 3.00** | 2.31* | 3.01** | 2.97** |
| | (1.33) | | (1.35) | (1.27) | (1.39) | (1.32) | (1.32) |
| White Oth | 1.95 | | 1.79 | 2.02 | 1.52 | 1.90 | 1.99 |
| | (2.35) | | (2.36) | (2.11) | (2.27) | (2.09) | (2.10) |
| Asian Chin | −7.98*** | | −7.24*** | −6.29*** | −8.15*** | −7.26*** | −7.01*** |
| | (1.58) | | (2.15) | (2.11) | (2.04) | (2.02) | (2.07) |
| Black | −0.52 | | −0.67 | 0.15 | −0.03 | 0.60 | 0.68 |
| | (2.15) | | (2.13) | (1.96) | (1.96) | (1.89) | (1.87) |
| Mixed/Oth | 0.99 | | −0.30 | 0.89 | 0.65 | 1.44 | 1.36 |
| | (2.08) | | (2.04) | (1.92) | (1.98) | (1.89) | (1.88) |
| Private Sch | | −2.85** | −0.41 | −0.85 | −0.18 | −0.61 | −0.59 |
| | | (1.15) | (1.24) | (1.19) | (1.18) | (1.15) | (1.16) |
| Female | | | −2.19 | −2.27 | −3.24 | −3.07 | −3.04 |
| | | | (2.14) | (2.11) | (2.04) | (2.05) | (2.05) |
| Home | | | 2.41 | −2.85 | −1.68 | −5.34** | −5.66** |
| | | | (2.51) | (2.44) | (2.40) | (2.37) | (2.40) |
| Fem*Home | | | −4.25* | −3.33 | −3.03 | −2.64 | −2.55 |
| | | | (2.51) | (2.43) | (2.43) | (2.39) | (2.42) |
| $R^2$ | 0.18 | 0.13 | 0.21 | 0.29 | 0.29 | 0.34 | 0.34 |
| F Stat | 22.39 | 27.43 | 17.17 | 21.67 | 10.67 | 12.86 | 11.81 |
| LL | −3409.67 | −3434.74 | −3396.95 | −3352.46 | −3353.77 | −3321.72 | −3318.74 |
| Panel B: Dependent non-MCQ Part of Microeconomics | | | | | | | |
| White Brit | 0.75 | | −0.66 | 0.40 | −0.09 | 0.89 | 0.81 |
| | (1.42) | | (1.47) | (1.38) | (1.55) | (1.47) | (1.45) |
| White Oth | −0.47 | | −0.79 | −0.36 | −0.84 | −0.28 | −0.36 |
| | (1.97) | | (2.00) | (1.87) | (2.03) | (1.95) | (1.97) |
| Asian Chin | −16.88*** | | −13.44*** | −12.15*** | −13.33*** | −12.05*** | −12.11*** |
| | (2.00) | | (2.44) | (2.35) | (2.30) | (2.22) | (2.27) |
| Black | −3.45 | | −3.87* | −2.96 | −3.43 | −2.72 | −2.63 |
| | (2.18) | | (2.25) | (2.05) | (2.25) | (2.12) | (2.13) |
| Mixed/Oth | −1.06 | | −2.14 | −0.65 | −1.29 | −0.17 | −0.24 |
| | (2.29) | | (2.29) | (2.20) | (2.23) | (2.20) | (2.19) |
| Private Sch | | −3.37** | 1.79 | 1.35 | 2.14* | 1.69 | 1.73 |
| | | (1.33) | (1.31) | (1.28) | (1.28) | (1.25) | (1.26) |
| Female | | | 4.20 | 4.15 | 3.05 | 3.32 | 3.21 |
| | | | (2.76) | (2.66) | (2.58) | (2.52) | (2.51) |
| Home | | | 9.24*** | 2.75 | 5.20** | 0.54 | −0.09 |
| | | | (2.76) | (2.67) | (2.53) | (2.50) | (2.63) |
| Fem*Home | | | −8.05*** | −6.95** | −6.58** | −6.06** | −5.60** |
| | | | (3.09) | (2.95) | (2.94) | (2.84) | (2.84) |
| $R^2$ | 0.28 | 0.18 | 0.30 | 0.37 | 0.36 | 0.41 | 0.42 |
| F Stat | 28.68 | 32.16 | 19.34 | 23.32 | 12.50 | 14.39 | 14.05 |
| LL | −3504.39 | −3561.32 | −3494.59 | −3448.60 | −3454.92 | −3420.52 | −3415.39 |
| Controls | | | | | | | |
| Test Results | | | | | x | x | x |
| A-levels | | | | x | | x | x |
| Admin Ctrls | x | x | x | x | x | x | x |
| Low SES | x | x | x | x | x | x | x |
| Programmes | | | | | | | x |
| Obs | 829 | 829 | 829 | 829 | 829 | 829 | 829 |

*Notes:* Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
The coefficients for White British and Black are not statistically significantly different, except at the 10% level for specifications (1) and (6) in panel B.
The omitted category is Male Overseas State School Asian Other.

**Table 21**
Ethnicity gaps with home interactions: Microeconomics MCQ.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| White Brit | 3.46** | 2.27* | 3.26** | 2.28 | 3.11** | 3.06** |
| | (1.37) | (1.37) | (1.28) | (1.40) | (1.33) | (1.33) |
| White Oth | 1.98 | 1.98 | −2.24 | 0.50 | −2.45 | −2.15 |
| | (6.93) | (6.76) | (6.08) | (6.37) | (5.86) | (5.90) |
| White Oth*Home | −0.04 | −0.23 | 4.97 | 1.20 | 5.07 | 4.81 |
| | (7.36) | (7.21) | (6.49) | (6.80) | (6.27) | (6.28) |
| Asian Chin | −7.99** | −8.15** | −8.07** | −8.46*** | −8.29*** | −7.97** |
| | (3.16) | (3.21) | (3.17) | (2.99) | (3.00) | (3.10) |
| Asian Chin*Home | 3.82 | 4.14 | 5.03 | 3.90 | 4.40 | 4.26 |
| | (4.76) | (4.86) | (4.73) | (4.40) | (4.26) | (4.31) |
| Black | −1.05 | −0.93 | −1.82 | 2.59 | 1.36 | 1.47 |
| | (5.57) | (5.47) | (5.30) | (4.76) | (4.80) | (4.75) |
| Black*Home | 0.66 | 0.31 | 2.40 | −3.16 | −0.88 | −0.91 |
| | (6.04) | (5.93) | (5.68) | (5.24) | (5.23) | (5.18) |
| Mixed/Oth | 1.56 | 1.41 | 2.19 | 5.48 | 5.66 | 5.95 |
| | (5.09) | (5.28) | (5.17) | (5.47) | (5.35) | (5.37) |
| Mixed/Oth*Home | −0.71 | −2.04 | −1.56 | −5.68 | −4.97 | −5.41 |
| | (5.57) | (5.71) | (5.54) | (5.87) | (5.70) | (5.72) |
| Home | 0.59 | 1.73 | −4.69 | −1.72 | −6.33* | −6.56* |
| | (3.04) | (3.60) | (3.55) | (3.35) | (3.35) | (3.41) |
| Female | | −2.22 | −2.29 | −3.24 | −3.06 | −3.03 |
| | | (2.16) | (2.13) | (2.05) | (2.05) | (2.06) |
| Fem*Home | | −4.28* | −3.36 | −3.13 | −2.73 | −2.64 |
| | | (2.53) | (2.46) | (2.44) | (2.40) | (2.44) |
| Controls | | | | | | |
| Test Results | | | | x | x | x |
| A-levels | | | x | | x | x |
| SES, School | | x | x | x | x | x |
| Admin Ctrls | x | x | x | x | x | x |
| Programmes | | | | | | x |
| Obs | 829 | 829 | 829 | 829 | 829 | 829 |
| $R^2$ | 0.18 | 0.21 | 0.29 | 0.29 | 0.34 | 0.35 |
| F Stat | 14.64 | 13.48 | 17.75 | 9.68 | 11.77 | 10.89 |
| LL | −3408.94 | −3396.32 | −3351.33 | −3352.28 | −3319.96 | −3316.94 |

*Notes:* Robust standard errors in parentheses, $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.
The omitted category is Male Overseas State School Asian Other.

**Table 22**
Ethnicity gaps with home interactions: Microeconomics non-MCQ.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| White Brit | 0.18 | −0.49 | 0.78 | −0.14 | 1.01 | 0.94 |
| | (1.46) | (1.49) | (1.39) | (1.58) | (1.49) | (1.48) |
| White Oth | 1.40 | 1.30 | −3.63 | 0.98 | −2.57 | −2.58 |
| | (4.40) | (4.58) | (4.14) | (4.27) | (4.22) | (4.37) |
| White Oth*Home | −2.26 | −2.43 | 3.82 | −2.09 | 2.69 | 2.53 |
| | (4.91) | (5.07) | (4.64) | (4.87) | (4.79) | (4.92) |
| Asian Chin | −15.79*** | −15.76*** | −15.59*** | −14.53*** | −14.26*** | −14.67*** |
| | (3.27) | (3.31) | (3.21) | (3.03) | (2.95) | (3.11) |
| Asian Chin*Home | 13.90*** | 13.67*** | 15.00*** | 11.95*** | 12.94*** | 13.76*** |
| | (4.92) | (5.04) | (4.70) | (4.52) | (4.22) | (4.41) |
| Black | 2.65 | 2.00 | 0.95 | 5.85 | 4.26 | 4.34 |
| | (5.94) | (5.96) | (5.85) | (5.28) | (5.44) | (5.41) |
| Black*Home | −7.52 | −7.34 | −4.95 | −11.39** | −8.61 | −8.59 |
| | (6.37) | (6.40) | (6.20) | (5.80) | (5.87) | (5.84) |
| Mixed/Oth | 0.23 | 0.05 | 1.02 | 5.11 | 5.26 | 5.04 |
| | (7.29) | (7.15) | (7.06) | (6.30) | (6.42) | (6.59) |
| Mixed/Oth*Home | −1.61 | −2.56 | −1.94 | −7.49 | −6.39 | −6.20 |
| | (7.66) | (7.51) | (7.38) | (6.73) | (6.80) | (6.98) |
| Home | 3.61 | 7.75** | −0.14 | 4.95 | −0.91 | −1.76 |
| | (2.95) | (3.56) | (3.52) | (3.29) | (3.28) | (3.45) |
| Female | | 4.08 | 4.03 | 2.98 | 3.24 | 3.07 |
| | | (2.76) | (2.67) | (2.56) | (2.51) | (2.50) |
| Fem*Home | | −8.07*** | −6.96** | −6.68** | −6.14** | −5.55* |
| | | (3.09) | (2.95) | (2.92) | (2.83) | (2.83) |
| Controls | | | | | | |
| Test Results | | | | x | x | x |
| A-levels | | | x | | x | x |
| SES, School | | x | x | x | x | x |
| Admin Ctrls | x | x | x | x | x | x |
| Programmes | | | | | | x |
| Obs | 829 | 829 | 829 | 829 | 829 | 829 |
| $R^2$ | 0.30 | 0.31 | 0.38 | 0.37 | 0.42 | 0.43 |
| F Stat | 19.47 | 15.59 | 19.39 | 11.51 | 13.31 | 13.11 |
| LL | −3494.80 | −3488.28 | −3441.69 | −3447.01 | −3412.76 | −3407.00 |

*Notes:* Robust standard errors in parentheses, $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.
The omitted category is Male Overseas State School Asian Other.

**Table 23**
Explaining gaps in Mathematics: Full regression result.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Female | 1.44 | | | 5.32*** | 5.00*** | 4.42** | 4.47** | 4.17** |
| | (1.09) | | | (1.98) | (1.86) | (1.83) | (1.77) | (1.76) |
| Home | | 4.33*** | | 6.75*** | 1.86 | 3.65** | 0.40 | 1.17 |
| | | (1.32) | | (1.70) | (1.70) | (1.62) | (1.63) | (1.66) |
| Fem*Home | | | | −5.11** | −4.05* | −4.36* | −3.94* | −3.34 |
| | | | | (2.36) | (2.20) | (2.23) | (2.12) | (2.11) |
| Low SES | | | 1.24 | 0.14 | −0.43 | −0.53 | −0.88 | −1.08 |
| | | | (1.58) | (1.62) | (1.45) | (1.58) | (1.45) | (1.45) |
| 2024 | 2.98** | 2.64** | 3.05** | 2.61** | 3.99*** | 2.13* | 3.24*** | 2.89** |
| | (1.26) | (1.26) | (1.26) | (1.26) | (1.16) | (1.27) | (1.19) | (1.21) |
| 2025 | −3.47*** | −4.00*** | −3.49*** | −3.98*** | −1.12 | −3.23*** | −1.19 | −1.58 |
| | (1.21) | (1.22) | (1.22) | (1.22) | (1.17) | (1.23) | (1.21) | (1.22) |
| Direct Adm | −10.04*** | −6.88*** | −9.88*** | −6.38*** | −3.98** | −5.51*** | −3.75* | −4.66** |
| | (1.78) | (2.07) | (1.80) | (2.06) | (2.01) | (2.13) | (2.06) | (2.15) |
| Repeat | −14.63*** | −12.98*** | −14.44*** | −12.73*** | −9.15*** | −10.06*** | −7.67*** | −7.64*** |
| | (2.54) | (2.75) | (2.55) | (2.75) | (2.67) | (2.70) | (2.56) | (2.53) |
| A Lvl Maths A+ | | | | | 12.02*** | | 10.03*** | 8.98*** |
| | | | | | (1.07) | | (1.09) | (1.11) |
| A Lvl Econ A+ | | | | | 5.39*** | | 5.05*** | 4.26*** |
| | | | | | (1.29) | | (1.31) | (1.33) |
| A Lvl Econ B | | | | | 2.49* | | 1.61 | 0.97 |
| | | | | | (1.32) | | (1.29) | (1.30) |
| A Lvl Fth Math | | | | | 8.22*** | | 6.65*** | 6.01*** |
| | | | | | (1.67) | | (1.70) | (1.73) |
| Test Arith 1 | | | | | | −0.08 | −0.54 | −0.37 |
| | | | | | | (1.08) | (1.01) | (1.00) |
| Test Arith 2 | | | | | | 5.61*** | 4.06*** | 4.11*** |
| | | | | | | (1.13) | (1.08) | (1.07) |
| Test Arith 3 | | | | | | −0.42 | −0.35 | −0.79 |
| | | | | | | (1.94) | (1.86) | (1.83) |
| Test Algeb 1 | | | | | | 2.48** | 1.98* | 1.92* |
| | | | | | | (1.13) | (1.09) | (1.08) |
| Test Algeb 2 ptl | | | | | | −3.84** | −3.82** | −4.18** |
| | | | | | | (1.93) | (1.88) | (1.86) |
| Test Algeb 2 all | | | | | | 3.09* | 1.67 | 1.30 |
| | | | | | | (1.75) | (1.70) | (1.69) |
| Test Algeb 4 ptl | | | | | | −0.30 | 1.07 | 1.04 |
| | | | | | | (5.85) | (5.69) | (5.70) |
| Test Algeb 4 all | | | | | | 4.23*** | 4.19*** | 4.53*** |
| | | | | | | (1.28) | (1.24) | (1.24) |
| Test Funct 1 ptl | | | | | | 1.19 | 0.86 | 0.69 |
| | | | | | | (1.31) | (1.28) | (1.26) |
| Test Funct 1 all | | | | | | −2.05 | −1.66 | −1.89 |
| | | | | | | (1.73) | (1.60) | (1.57) |
| Test Funct 3 | | | | | | 1.46 | 1.52 | 1.65* |
| | | | | | | (1.01) | (0.95) | (0.93) |
| Test Funct 4 | | | | | | 4.21*** | 3.13** | 3.42*** |
| | | | | | | (1.34) | (1.28) | (1.26) |
| Test Proba 1 | | | | | | −1.83* | −1.49 | −1.23 |
| | | | | | | (1.04) | (0.99) | (0.8) |
| Test Proba 3 | | | | | | −0.42 | −1.04 | −1.01 |
| | | | | | | (1.08) | (1.03) | (1.02) |
| Test Proba 4 | | | | | | −0.30 | −0.23 | −0.41 |
| | | | | | | (1.16) | (1.11) | (1.11) |
| Test Stats 1 | | | | | | 0.68 | 0.54 | 0.35 |
| | | | | | | (1.02) | (0.98) | (0.97) |
| Test Stats 2 ptl | | | | | | 2.56** | 2.45** | 2.31* |
| | | | | | | (1.27) | (1.21) | (1.20) |
| Test Stats 2 all | | | | | | 3.81*** | 3.13** | 3.10** |
| | | | | | | (1.34) | (1.28) | (1.27) |
| Test Stats 4 ptl | | | | | | 0.87 | 0.14 | 0.30 |
| | | | | | | (1.18) | (1.13) | (1.11) |
| Test Stats 4 all | | | | | | 0.32 | −0.55 | −0.32 |
| | | | | | | (1.28) | (1.20) | (1.20) |

(*continued on next page*)

**Table 23** (*continued*).

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Economics | | | | | | | | 5.54*** |
| | | | | | | | | (1.44) |
| Econ & Fin | | | | | | | | 2.36 |
| | | | | | | | | (1.56) |
| Econ & Stats | | | | | | | | 7.44*** |
| | | | | | | | | (1.85) |
| Econ & Bus | | | | | | | | 5.10*** |
| | | | | | | | | (1.85) |
| Obs | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 | 1051 |
| $R^2$ | 0.06 | 0.07 | 0.06 | 0.08 | 0.22 | 0.19 | 0.29 | 0.30 |
| F Stat | 18.55 | 20.49 | 17.91 | 14.43 | 34.85 | 9.14 | 15.61 | 14.44 |
| LL | −4462.60 | −4457.09 | −4463.20 | −4452.85 | −4366.00 | −438.23 | −4320.68 | −4308.47 |

*Notes:* Robust standard errors in parentheses, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Economics includes BSc Econ, MEcon. Econ & Fin is BSc Economics and Finance. Econ & Stats: BSc Econ & Actuarial Science, BSc Econ with Data Science. Economics & Bus: BSc Econ & Business Management, BSc Econ & Accounting. Omitted category is PPE: BA Philosophy, Politics & Econ, BA Politics & Econ, BA Philosophy & Econ.

**Table 24**
Mean square errors of alternative prediction models.

| | Out of sample | | Within sample | |
|---|---|---|---|---|
| Mathematics | | | | |
| Prediction Model | Obs. | MSE | Obs. | MSE |
| LASSO | 752 | 276.31 | 299 | 143.46 |
| SVM | 752 | 342.97 | 299 | 195.03 |
| RF | 752 | 285.51 | 299 | 25.26 |
| Microeconomics | | | | |
| Prediction Model | Obs. | MSE | Obs. | MSE |
| LASSO | 752 | 216.24 | 299 | 115.72 |
| SVM | 752 | 313.77 | 299 | 177.30 |
| RF | 752 | 217.56 | 299 | 19.60 |

*Notes:* Training sample year = 2023, test sample year = 2024, 2025; using admissions and test data.
LASSO: Adaptive LASSO with cross-validation.
SVM: Support Vector Machine Regression
RF: Random Forest Regression

**Table 25**
Mean square errors of the prediction models.

| | Out of sample | | Within sample | |
|---|---|---|---|---|
| Mathematics | | | | |
| Prediction Model | Obs. | MSE | Obs. | MSE |
| Admissions Data | 752 | 291.37 | 299 | 162.77 |
| Adm & Test Data | 752 | 279.02 | 299 | 142.34 |
| Microeconomics | | | | |
| Prediction Model | Obs. | MSE | Obs. | MSE |
| Admissions Data | 752 | 212.61 | 299 | 120.43 |
| Adm & Test Data | 752 | 209.08 | 299 | 110.17 |

*Notes:* Training sample year = 2023, test sample year = 2024, 2025.

## Appendix B. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.iree.2026.100356.

## Data availability

Data will be made available on request.

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