

Annex B: Details of modelling technique

1. This annex details the modelling techniques used in this report.
2. This report used a multi-level logistic regression model for the probability of a student gaining a first or upper second class degree, to take account of a variety of factors. These factors are modelled with a random intercept that varies by institution, and by department within an institution. Therefore the multi-level elements of this model are entrants nested within departments within institutions.
3. The setup of the model used for the 2013-14 graduates is shown in Equation B1.

Equation B1: Model format for 2013-14 graduates

First or Upper Second \sim *Binomial*(*const*_{ijk}, π_{ijk})

$$\begin{aligned} \text{logit}(\pi_{ijk}) = & \beta_{0jk} \text{const} + \beta_1 \text{best} + \beta_2 \text{entryquals} + \beta_3 \text{fitt.tariff} \\ & + \beta_4 \text{fitt.tariff.tariff} + \beta_5 \text{age} + \beta_6 \text{subject} + \beta_8 \text{ethnicity} + \beta_{10} \text{polar} \\ & + \beta_{11} \text{sex} + \beta_{12} \text{previoussschool} + \beta_{13} \text{modeofstudy} + \beta_{14} \text{disability} \end{aligned}$$

$$\beta_{0jkl} = \beta_0 + u_{0k} + v_{0jk}$$

u_{0k} refers to institutional characteristics

v_{0jk} refers to departmental characteristics

4. The variables in the model are defined in Table B1.

Table B1: Variables used in the model

Type of variable	Model variable name	Description
Continuous	Tariff	Tariff score on entry
Dummy or Categorical	Best	Whether a student has three known A-level grades on entry: Fewer than three known A-level grades (ref) Three known A-level grades (1)
		Entryquals

Type of variable	Model variable name	Description
		<p>BCC (9)</p> <p>CCC (10)</p> <p>Higher education (11)</p> <p>None (12)</p> <p>Unknown (13)</p>
	Fitt	Whether a student does not have three known A level grades on entry but has tariff points
	Subject	<p>Subject studied:</p> <p>Medicine, dentistry and veterinary science (ref)</p> <p>Subjects allied to medicine (1)</p> <p>Biological sciences (2)</p> <p>Agriculture and related subjects (3)</p> <p>Physical sciences (4)</p> <p>Mathematical sciences (5)</p> <p>Computer science (6)</p> <p>Engineering and technology (7)</p> <p>Architecture, building and planning (8)</p> <p>Social studies (9)</p> <p>Law (10)</p> <p>Business and administrative studies (11)</p> <p>Mass communication and documentation (12)</p> <p>Languages (13)</p> <p>Historical and philosophical studies (14)</p> <p>Creative arts and design (15)</p> <p>Education (16)</p> <p>Combined subjects (17)</p>
	Ethnicity	<p>Ethnicity of student:</p> <p>White (ref)</p> <p>Asian (1)</p> <p>Black (2)</p> <p>Mixed or Other (3)</p> <p>Unknown (4)</p>
	Polar	Young participation quintile of student:

Type of variable	Model variable name	Description
		Quintile 1 (ref) Quintile 2 (1) Quintile 3 (2) Quintile 4 (3) Quintile 5 (4) Unknown (5)
	Age	Age of student on entry: Young (ref) Mature (1) Unknown (2)
	Sex	Sex of student: Female (ref) Male (1)
	Previous school	Previous school of student: State school (ref) Independent school (1) Unknown (2)
	Disability	Disability status of graduate No disability specified (0) Disability specified (1) Unknown disability status (2)
	Mode	Mode of student of graduate: Full-time (0) Part-time (1)
Structural	Const	One for all individuals
	U	Random effect relating to a particular institution
	V	Random effect relating to a particular department within an institution

Notes: Those categories marked with '(ref)' are the reference categories for each categorical or dummy variable and are not formally included in the model structure.

Table B2: Fixed parameter estimates from the model

Effect group	Effect	Parameter	Standard deviation	p-value
Intercept		0.2949	0.1792	0.1023
Entry qualifications: whether a student has three known A-level grades on entry	Fewer than three known A-level grades	Baseline		
	Three known A-level grades	2.6999	0.05640	<0.0001
Entry qualifications: entry qualifications of an individual with known A-level grades	AAAA	Baseline		
	AAA	-0.2829	0.05560	<0.0001
	AAB	-0.8670	0.05672	<0.0001
	AAC	-1.1476	0.07595	<0.0001
	ABB	-1.1824	0.05718	<0.0001
	ABC	-1.3961	0.05994	<0.0001
	BBB	-1.4773	0.06031	<0.0001
	ACC	-1.5996	0.07107	<0.0001
	BBC	-1.6644	0.05814	<0.0001
	BCC	-1.8494	0.05828	<0.0001
	CCC	-2.1783	0.06185	<0.0001
	HE	0.1920	0.01865	<0.0001
	None	0.1533	0.05469	0.0051
	Unknown	0.1611	0.02389	<0.0001
Entry qualifications: tariff score	Tariff	-0.00013	0.000148	0.3887
	Tariff*Tariff	0	0	<0.0001
Age	Young	Baseline		
	Mature	0.3847	0.01558	<0.0001
	Unknown	0		
Subject	Medicine, dentistry and veterinary science	Baseline		
	Subjects allied to medicine	0.01937	0.1816	0.9151
	Biological sciences	-0.1569	0.1809	0.3858
	Agriculture and related subjects	-0.1896	0.1999	0.3429

Effect group	Effect	Parameter	Standard deviation	p-value
	Physical sciences	-0.3202	0.1831	0.0804
	Mathematical sciences	-0.4686	0.1851	0.0113
	Computer science	0.06476	0.1827	0.7230
	Engineering and technology	0.1675	0.1831	0.3603
	Architecture, building and planning	0.1187	0.1881	0.5279
	Social studies	-0.01967	0.1809	0.9134
	Law	-0.2822	0.1824	0.1219
	Business and administrative studies	0.1994	0.1812	0.2712
	Mass communication and documentation	0.2166	0.1842	0.2396
	Languages	0.1713	0.1818	0.3461
	Historical and philosophical studies	0.2323	0.1830	0.2043
	Creative arts and design	0.1904	0.1814	0.2938
	Education	-0.03196	0.1844	0.8624
	Combined subjects	-0.3520	0.2337	0.1319
Ethnicity	White	Baseline		
	Asian	-0.7254	0.01557	<0.0001
	Black	-1.0795	0.01806	<0.0001
	Mixed or Other	-0.4432	0.02112	<0.0001
	Unknown	-0.2819	0.03488	<0.0001
Participation of Local Areas (POLAR) measure	Quintile 1	Baseline		
	Quintile 2	0.08483	0.01687	<0.0001
	Quintile 3	0.1206	0.01627	<0.0001
	Quintile 4	0.1837	0.01613	<0.0001
	Quintile 5	0.2170	0.01603	<0.0001
	Unknown	-0.2144	0.07376	0.0037
Mode of study	Full-time	Baseline		
	Part-time	-0.6494	0.01954	<0.0001

Effect group	Effect	Parameter	Standard deviation	p-value
	Unknown	-1.4857	0.03000	<0.0001
Previous school	Independent school	Baseline		
	State school	0.1840	0.02097	<0.0001
	Unknown	0.2744	0.02474	<0.0001
Gender	Female	Baseline		
	Male	-0.2749	0.01003	<0.0001
Disability	No known disability	Baseline		
	Disability specified	-0.1648	0.01541	<0.0001
	Unknown	-0.1165	0.04601	0.0114

Table B3: Covariance estimates for random effects

Effect	Parameter	Standard deviation
Institution	0.05007	0.01027
Department	0.1631	0.009521

5. The setup of the model used for the comparison of the 2010-11 graduates with the 2013-14 graduates is shown in Equation B2. This model differs from that shown in Equation B1 in that it does not have an institutional or departmental random effect associated with it.

Equation B2: Model format for 2010-11 to 2013-14 graduates

First or Upper Second \sim *Binomial*(*const_{ijk}*, π_{ijk})

$$\begin{aligned} \text{logit}(\pi_{ijk}) = & \beta_0 \text{const} + \beta_1 \text{best} + \beta_2 \text{entryquals} + \beta_3 \text{fitt.tariff} \\ & + \beta_4 \text{fitt.tariff.tariff} + \beta_5 \text{age} + \beta_6 \text{subject} + \beta_8 \text{ethnicity} + \beta_{10} \text{polar} \\ & + \beta_{11} \text{sex} + \beta_{12} \text{previoussschool} + \beta_{13} \text{modeofstudy} + \beta_{14} \text{disability} \end{aligned}$$

Table B4: Fixed parameter estimates from the model

Effect group	Effect	Parameter	Standard deviation	p-value
Intercept		0.2339	0.0712	0.0010
Entry qualifications: whether a student has three known A-level grades on entry	Fewer than three known A-level grades	Baseline		
	Three known A-level grades	2.3814	0.0328	<0.0001
Entry qualifications: entry qualifications of an individual with known A-level grades	AAAA	Baseline		
	AAA	-0.1274	0.0370	0.0006
	AAB	-0.6570	0.0354	<0.0001
	AAC	-0.9285	0.0497	<0.0001
	ABB	-0.9890	0.0351	<0.0001
	ABC	-1.2199	0.0368	<0.0001
	BBB	-1.3012	0.0372	<0.0001
	ACC	-1.4493	0.0454	<0.0001
	BBC	-1.5165	0.0350	<0.0001
	BCC	-1.7472	0.0350	<0.0001
	CCC	-2.0243	0.0381	<0.0001
	HE	0.0590	0.0116	<0.0001
	None	0.0732	0.0354	0.0387
	Unknown	0.0556	0.0184	0.0025
Entry qualifications: tariff score	Tariff	-0.00156	0.000098	<0.0001
	Tariff*Tariff	7.765E-6	2.558E-7	<0.0001
Age	Young	Baseline		
	Mature	0.3943	0.0103	<0.0001
	Unknown	0.5865	1.0816	0.5877
Subject	Medicine, dentistry and veterinary science	Baseline		
	Subjects allied to medicine	-0.1664	0.0697	0.0169
	Biological sciences	-0.3117	0.0696	<0.0001
	Agriculture and related	-0.4353	0.0770	<0.0001

Effect group	Effect	Parameter	Standard deviation	p-value
	subjects			
	Physical sciences	-0.4398	0.0706	<0.0001
	Mathematical sciences	-0.6556	0.0722	<0.0001
	Computer science	-0.0675	0.0707	0.3397
	Engineering and technology	0.0872	0.0705	0.2165
	Architecture, building and planning	-0.00536	0.0718	0.9404
	Social studies	-0.2216	0.0696	0.0014
	Law	-0.4836	0.0705	<0.0001
	Business and administrative studies	-0.0408	0.0696	0.5576
	Mass communication and documentation	-0.0304	0.0711	0.6693
	Languages	0.0443	0.0703	0.5285
	Historical and philosophical studies	0.0769	0.0709	0.2779
	Creative arts and design	-0.0948	0.0696	0.1730
	Education	-0.2824	0.0704	<0.0001
	Combined subjects	-0.4452	0.0773	<0.0001
Ethnicity	White	Baseline		
	Asian	-0.6482	0.0102	<0.0001
	Black	-0.9912	0.0125	<0.0001
	Mixed or Other	-0.3970	0.0151	<0.0001
	Unknown	-0.3767	0.0213	<0.0001
POLAR	Quintile 1	Baseline		
	Quintile 2	0.1019	0.0121	<0.0001
	Quintile 3	0.1496	0.0115	<0.0001
	Quintile 4	0.2173	0.0114	<0.0001
	Quintile 5	0.2481	0.0112	<0.0001
	Unknown	-0.00919	0.0398	0.8173
Mode of study	Full-time	Baseline		

Effect group	Effect	Parameter	Standard deviation	p-value
	Part-time	-0.5728	0.0121	<0.0001
	Unknown	-1.2584	0.0190	<0.0001
Previous school	Independent school	Baseline		
	State school	0.1820	0.0140	<0.0001
	Unknown	0.3252	0.0155	<0.0001
Gender	Female	Baseline		
	Male	-0.2411	0.00693	<0.0001
Disability	No known disability	Baseline		
	Disability specified	-0.1769	0.0111	<0.0001
	Unknown	-0.00650	0.0235	0.7822