3 Is Educational Tracking a Level Playing Field? An Empirical Analysis[1]

3.1 Introduction

Equal educational access is an ongoing debate – the trade-off between equality, i.e. lowering the entry requirement to provide disadvantaged students with more opportunities, and efficiency in terms of academic productivity and talent allocation (Schaede & Mankki, 2022). Former prime minister Theresa May proposed to end the ban on new grammar schools to open elite education to the UK's most socioeconomically disadvantaged (Stewart & Walker, 2016). More recently, when the UK government set a minimum grade requirement to restrict student loan, critics argued that more hurdles to university entrance would harm disadvantaged students most (Rana, 2022). Facing the same entry requirement regardless of ethics, family background, and socioeconomic status, disadvantaged students would reach the university's entry requirements through better individual ability, making privileged pupils underperform in the university (Crawford, 2014). Meanwhile, parents from privileged backgrounds worry that society's growing anger about inequality in selection standards is at the cost of education quality, for instance, Oxford and Cambridge giving more credits to disadvantaged students harms privileged students with middle-level performance (Masters, 2021).

The majority of literature has focused on the outcomes of selective education in terms of equality (Galindo-Rueda & Vignoles, 2005; Pischke & Manning, 2006). Different from previous studies, Morgan et al. (2013) imply that this might be misleading, as the selection process with an objective achievement standard could bring unequal access to disadvantaged students. They theoretically show ability distribution difference among disadvantaged and privileged under different conditions. This chapter aims to use the UK medical education database (UKMED), which contains successful applicants of UK medical schools, to empirically test the theory.

Educational tracking allocates students into different tracks, usually academic (i.e. upper

[1] This chapter is based on joint work with Thomas P. Triebs and Justin Tumlinson.

track) and vocational (i.e. lower track) in secondary education in Europe (Brunello & Checchi, 2007).[2] Standardised tests performance, a proxy for ability to assign students into different tracks, favour the criterion of privileged students who have access to high-quality education (Croizet & Dutrévis, 2004; B. C. Rubin & Noguera, 2004). However, Morgan et al. (2013) argue that even the objective standard brings unequal access to disadvantaged students, who suffer from early childhood challenges such as poor family background and little preschool exposure. To meet objective entry criteria – the same threshold as privileged students – to attend the upper track, disadvantaged students must overcome initial knowledge gaps through higher individual ability. Disadvantaged students, who are less likely to attend the upper track, would outperform privileged students assigned to the same track.

To test the theory, I use the UK medical education database (UKMED), assuming that it has a comparable setting to the theory. I use a probit model and an OLS regression model combining with Matching methods. The empirical results indicate that given ability, disadvantaged students have lower probability of attending the upper track than privileged students. Across different models, disadvantaged students have higher ability than privileged students assigned to the same track. To meet objective admission requirements to attend medical schools, disadvantaged students have to compensate for the initial knowledge gap through higher ability, thus revealing higher average ability than privileged students. I partially find empirical support for the theory, as only the coefficient of variable of interest in the upper track shows significant difference compared to the coefficient before tracking. There is no significant coefficient difference for the lower track, which is due to the UKMED only includes individuals who successfully attend medical schools.[3]

This chapter contributes to the literature on the debate on educational selection standards. Brunello and Checchi (2007) show that standardised tests benefit educational resource allocation, because teachers could target homogeneous groups based on academic

[2]According to Brunello and Checchi (2007), age of tracking varies among European countries, for instance, 10 years old in Germany and 11 years old in Britain. Countries might use different terms regarding tracks, for instance, Britain uses grammar schools (i.e. upper track) and secondary modern schools (i.e. lower track). In the United States, tracking happens within a comprehensive school system.

[3]Two main data limitations are: (1) the data only includes individuals who successfully enter into medical school programs, and (2) available tests might not be early enough to measure ability, making the current analysis difficult to distinguish between ability and knowledge. For future research, I might be able to map the UKMED to earlier childhood data from the Department of Education (DfE) to generate more appropriate proxies for the empirical test.

performance. Others argue that standardised tests only benefit privileged students who receive consistent high-quality education, but harm disadvantaged students with lower family income and worse socioeconomic status (Croizet & Dutrévis, 2004; Zeidner, 1986). Schaede and Mankki (2022) show that affirmative actions, such as a higher share of male quota teachers in Finland primary schools, benefit pupils' long-run outcomes. This chapter provides empirical evidence that the objective achievement standard in educational selection brings unequal access to disadvantaged students, and that disadvantaged students show higher ability than privileged students in the upper track.

This chapter contributes to a small literature on educational tracking and individual academic outputs. Galindo-Rueda and Vignoles (2005) argue that the UK selective school system disproportionately benefits privileged students with lower ability, while disadvantaged students with high potential ability unequally face with greater obstacles. I confirm the unlevel playing field in educational tracking by quantitatively comparing the ability distribution of different groups.

This chapter also relates to a broader literature on workforce diversity and productivity, for instance, the impact of gender and racial diversity on organisational productivity (Cui et al., 2022; Zhang, 2020). I show how diverse groups present different ability distributions, and the importance of identifying certain types of disadvantages when setting up selection criteria.

The remainder of the chapter proceeds as follows. Section 3.2 describes the theoretical background and the empirical model to test the theory. Section 3.3 shows how I map the UKMED data to the empirical model. Section 3.4 discusses the results. Section 3.5 concludes.

3.2 Identification

3.2.1 Theoretical Background

Figure 3.1 and Figure 3.2 illustrate the theory by Morgan et al. (2013). The horizontal axis is time t, where $t = 0$ is the starting point of knowledge acquisition process. The slope represents i's ability θ_i, independent of individual's status s_i, where $s_i \in \{D, P\}$. D is disadvantaged, and P is privileged. The vertical axis is individual i's performance Y_i, a proxy for knowledge, where $Y_i(t, y_0, \theta) = y_0 + y(t, \theta) = y_{0s} + \theta t$. Knowledge at time t is a combination of initial knowledge y_0, depending on individual's status s_i, and knowledge acquisition $y(t, \theta)$, a linear function of time t and ability θ.[4] The horizontal black line is the tracking threshold, where $Y(\hat{t}, y_0, \theta) \equiv y_{\hat{t}}$, to assign individuals into track $\tau \in \{u, l\}$. u is upper track, and l is lower track. At time $\hat{t}$ when the tracking decision happens, individuals with knowledge acquisition above the threshold $y_{\hat{t}}$ enter the upper track u, and those below $y_{\hat{t}}$ enter the lower track l.

The theory indicates that unconditionally (pre-tracking period), disadvantaged (red) and privileged (blue) have identical ability (same slope). Due to early childhood challenges, disadvantaged lags in initial knowledge y_0. With a given ability θ, disadvantaged D is less likely to attend the upper track u than privileged P with the same ability, i.e. $Pr[u|\theta, D] < Pr[u|\theta, P]$ (**Proposition 1**). To meet entry requirement $y_{\hat{t}}$ to the upper track, disadvantaged needs to compensate for initial knowledge gap through higher individual ability. Thus, in the tracking period, disadvantaged presents higher ability than privileged in the upper track (steeper slope in Figure 3.1). Figure 3.2 implies that for lower track, the greater proportion of able disadvantaged drives higher average ability (**Proposition 2**).

Figure 3.3 and Figure 3.4 show some descriptive evidence by plotting ability distribution of disadvantaged and privileged students from the data.[5] I identify disadvantaged as low

[4] Morgan et al. (2013) assume that knowledge acquisition is (1) strictly positive for all abilities over time, (2) strictly greater for more able individuals, (3) concave in ability, i.e. $y(t, \theta) = \theta t$.

[5] To show descriptive evidence, I use students academic outcomes, i.e. admissions tests score (the UK Clinical Aptitude Test score), to generate ability distribution figure. Theoretically, a good proxy for ability would be independent of individual's socioeconomic status and not used in the selection process. For this chapter's empirical analysis, I proxy ability for the difference between late and early test scores. This is based on the theory that ability is the slope in Figure 3.1, which could be measured by knowledge difference at two time points. For future

education area. I proxy tracks for medical schools, where the upper track consists of higher-rank medical schools. The figures support the theory that before tracking, disadvantaged and privileged students have identical ability distribution (solid lines). After tracking, only Figure 3.3 for the upper track supports the theory that disadvantaged students (red dashed line) outperform privileged students (blue dashed line). There is no significant supportive evidence for the lower track, i.e. Figure 3.4 implies that disadvantaged students (red dashed line) underperform privileged students (blue dashed line). This is likely due to the fact that the UKMED only includes students who successfully enter into medical schools.

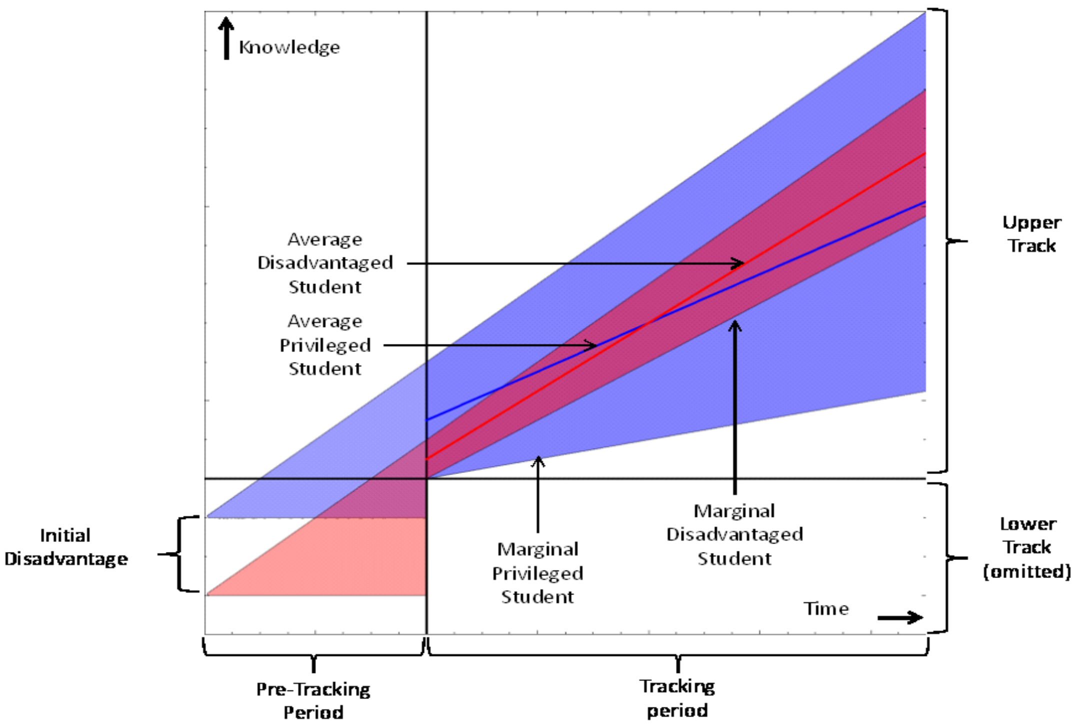

Figure 3.1: Disadvantaged Students Better in Upper Track

research, I might be able to combine the UKMED data to early childhood data from the Centre for Longitudinal Studies (CLS) to get better proxies for ability.

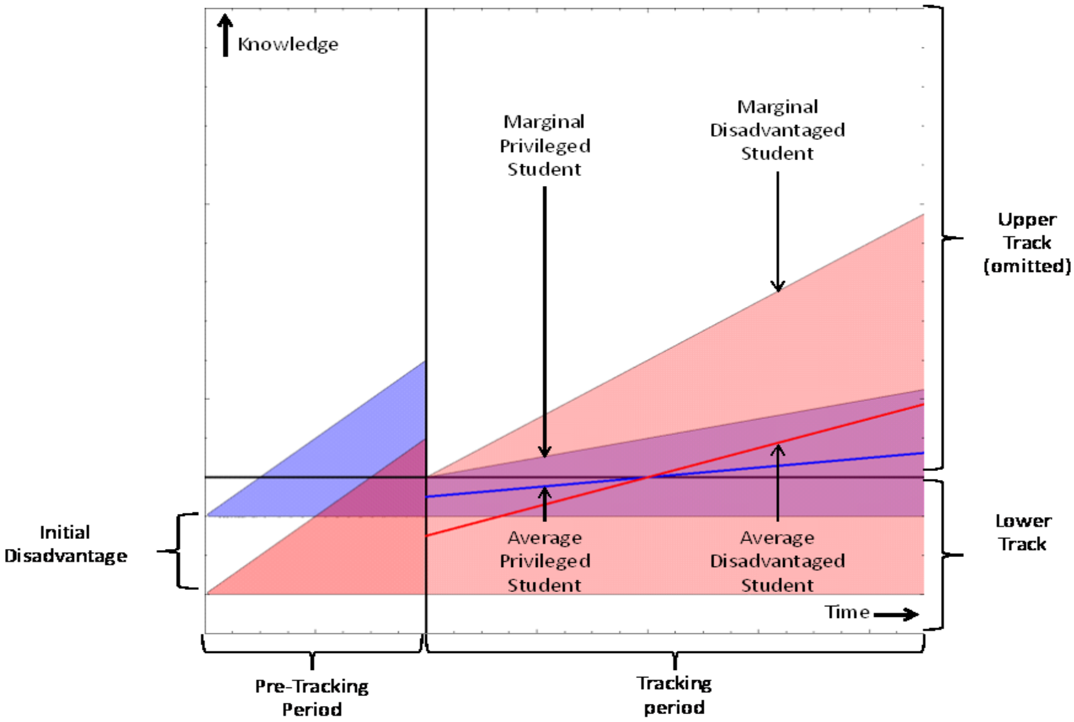

Figure 3.2: Disadvantaged Students Better in Lower Track

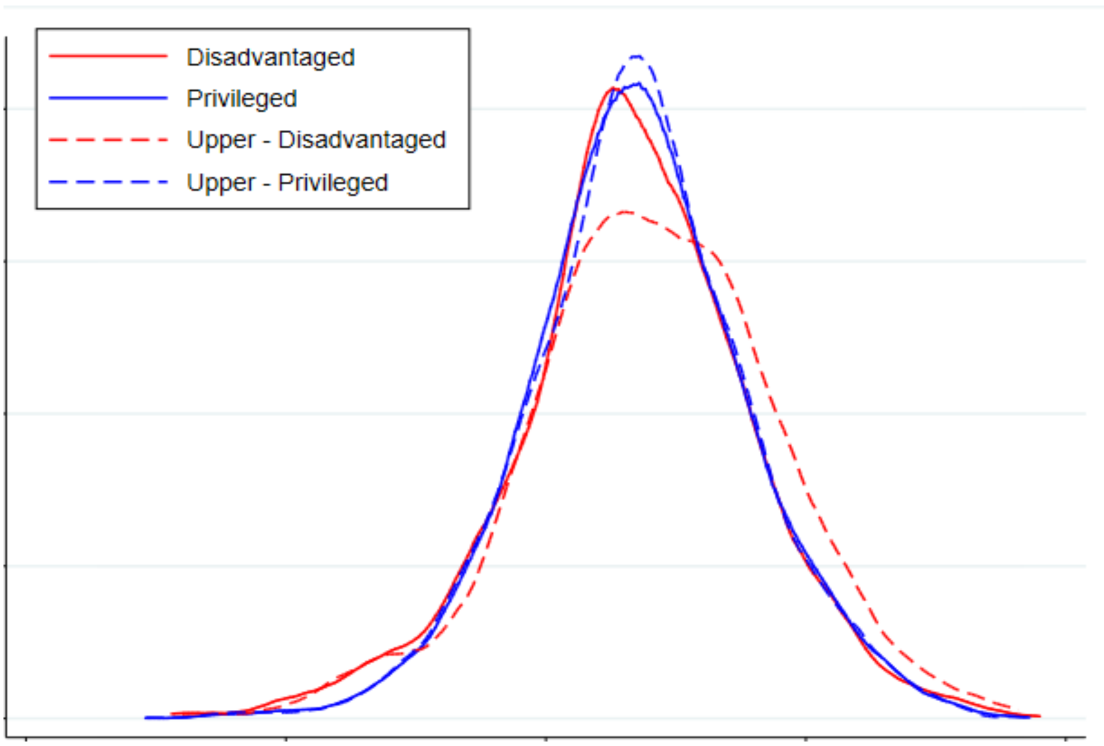

Figure 3.3: Ability Distribution of Upper Track

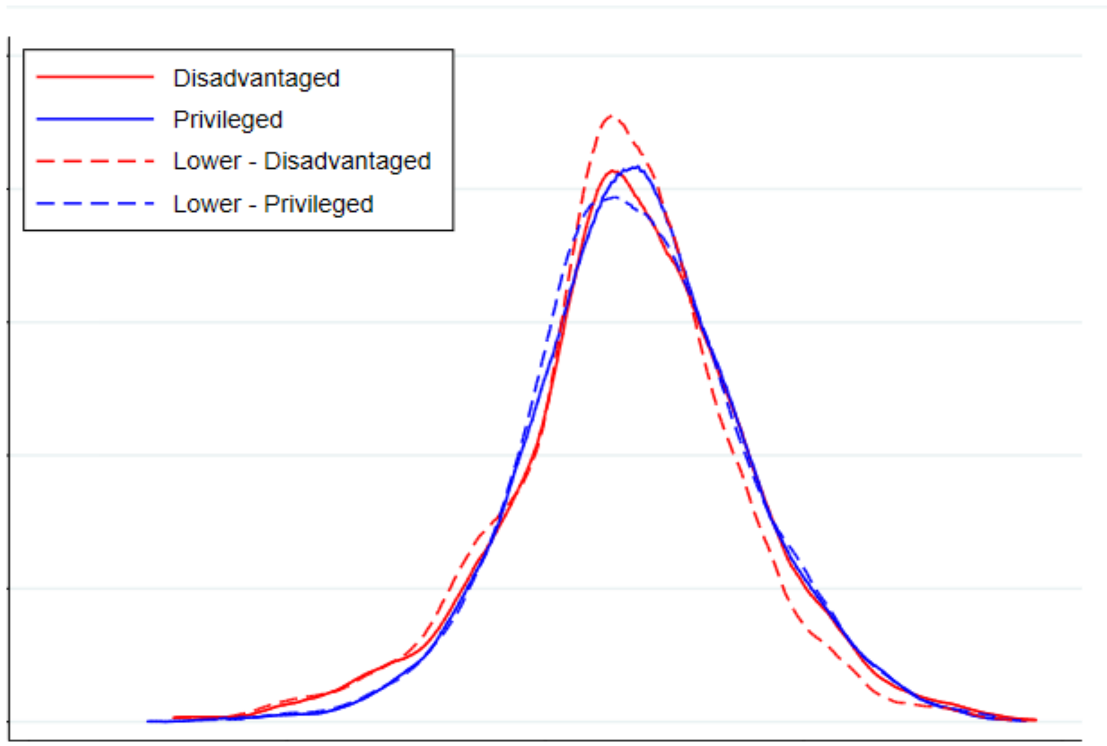

Figure 3.4: Ability Distribution of Lower Track

3.2.2 Empirical Model

In the theory by Morgan et al. (2013), **Proposition 1** argues that given ability, disadvantaged students have lower probability of attending the upper track. I use a probit model to test it:

$$Prob(u_i = 1) = \beta_1 D_i + \sigma A_i + \lambda X_i + \delta_t + \epsilon_i \tag{3.1}$$

where student i's probability of attending specific track u is a function of disadvantaged D and ability measure A. I define disadvantaged D as students from low education area. I assume regional education level as a reasonable proxy for initial disadvantage.[6] It relates to the probability of attending different tracks, but should be independent of individual ability. I add

[6]Hubble et al. (2021) consider higher education participation of local area as one of socioeconomic disadvantages.

a set of control variables X_i that might relate to disadvantaged and affect the probability of attending tracks, i.e. individual characteristics (gender and ethnics), parental characteristics (parents' education level and socioeconomic status), school characteristics (whether being private schools and UK schools), and regional characteristics (deprivation level). I further include year FEs δ_t to control for unobserved time-varying factors correlating with the probability of attending tracks. Hence, $\beta_1 < 0$ implies that given ability A, disadvantaged students have lower probability of attending track u. For future research, I consider using the conditional (fixed effects) logit model, which would control for university and year fixed effects that might correlate with student's probability of attending a specific track.

Following above, **Proposition 2** argues that given track u, disadvantaged students would have higher ability than privileged students. I use an OLS regression model to test it:

$$A_i = \beta_2 D_i + \phi u_i + \lambda X_i + \gamma_s + \delta_t + \epsilon_i \tag{3.2}$$

where student i's ability A is a function of the disadvantaged D. I add the same controls X_i as in model (3.1), i.e. a set of confounding factors that might correlate with regional education level and drive individual ability. For instance, parental socioeconomic status and local economic conditions relate to education level in an area, and might affect individual's ability measure. I further control for university fixed effects (FEs) γ_s and year FEs δ_t. The former control for time-invariant university characteristics that might correlate with tracking, for instance, universities set up different benchmarks in selection process. The latter account for national characteristics that potentially correlate with the proxy for ability that vary with time – there might be grade inflation over years. Hence, $\beta_2 > 0$ indicates that conditional on track u, disadvantaged students have higher ability than privileged students. This could only occur if the empirical hypothesis in model (3.1) is satisfied.

The OLS model estimates the average effect through controlling for observed confounding factors, based on the conditional independence assumption (CIA).[7] There might be selection

[7] According to D. B. Rubin (1974), the OLS model estimates the outcome by $E(Y_i|D_i = 1) - E(Y_i|D_i = 0) = E(Y_i(1) - Y_i(0)|D_i = 1) + E(Y_i(0)|D_i = 1) - E(Y_i(0)|D_i = 0)$.

bias if, in the absence of regional education difference, disadvantaged students and privileged students would have systematically achieved different ability outcomes. Other characteristics, such as ethnics, socioeconomic status, and regional deprivation level, might correlate to regional education level and ability distribution, thus making the observations not as randomly assigned.

To make disadvantaged students and privileged students more comparable, I consider two different Matching methods.[8] I first follow a common approach – the propensity score matching (PSM) – to construct propensity scores for a relevant set of covariates to make disadvantaged and privileged groups statistically more equivalent (Fan & Nowell, 2011). Using the PSM might reduce the information in the data, as it only retains observations that satisfy conditions such as common support and balance check (Caliendo & Kopeinig, 2008). I also consider the coarsened exacting matching (CEM), which retains more information in the data with less sensitivity to measure error (Iacus et al., 2011; King & Nielsen, 2019). I use coarsened covariates such as ethnics, gender, parents' education level, and socioeconomic status to match disadvantaged and privileged students through the coarsened scale (Blackwell et al., 2009).[9]

3.3 Data

The data is from the UK medical education database (UKMED), which is a research database commencing with all entrants (58232) to UK medical schools from 2007 (6505) to 2015 (6217) on a rolling basis. For this chapter's research purpose, I restrict to: (1) primary medical qualification (PMQ) awarding body in UK (53663); (2) individuals taking standard entry medicine course (49826); (3) individuals finish medical courses at the same school (47035);

[8] Despite various applications, the fundamental idea of matching follows: (1) choose a set of covariates, which relate to both the treatment selection and the outcome variable, to evaluate treated and control groups; (2) match treated and control groups through a given metric; (3) estimate the causality through matching treated and control groups (Costalli & Negri, 2021).

[9] The CEM is approximately a fully blocked randomized experimental design, where treated and control groups are blocked at the start exactly on the observed covariates (King & Nielsen, 2019). It follows four steps: (1) the covariates are coarsened; (2) exact matching is implemented with the coarsened data; (3) unmatched units which do not contain treated or control group are eliminated; (4) the sample average treatment effect on the treated (SATT) is estimated using the matched dataset (Booysen & Guvuriro, 2021).

(4) universities require admissions tests (47006), i.e. the UK Clinical Aptitude Test (UKCAT, also known as UCAT) and the BioMedical Admissions Test (BMAT).[10]

Figure 3.5 shows how I map the data to empirical hypotheses in model (3.1) and model (3.2). Pre-tracking tests include General Certificate of Secondary Education (GCSE), usually taken at age 15 or 16, and A-Level (Advanced Level, a subject-based qualification as part of the General Certificate of Education), usually taken at age 16 to 18. The tracking decision happens when students take objective admission tests such as the UKCAT and the BMAT, which are used to select students (Garrud & McManus, 2018).[11] Students then attend different medical schools for a 5-year Standard Entry Medicine program.[12] Afterwards, they are eligible to apply for a Foundation Program (FP), based on the Situational Judgement Test (SJT) and the Educational Performance Measure (EPM) score.

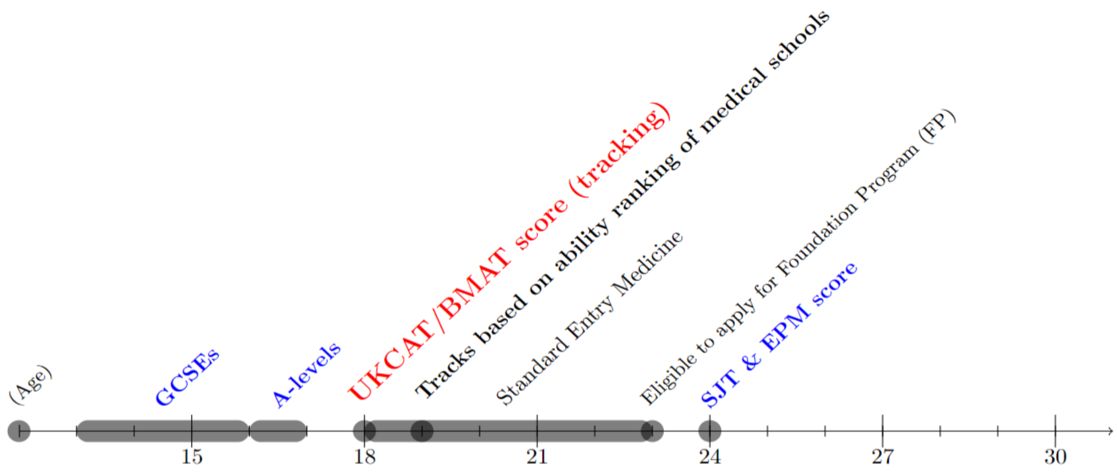

Figure 3.5: Timeline of UK Medical School Programs

[10]University of Central Lancashire and the University of Buckingham Medical School do not require admissions tests.

[11]Depending on different medical schools, selection criteria might include predicted A-levels, GCSEs, international baccalaureate, personal statement, and admissions test (Garrud & McManus, 2018).

[12]Standard Entry Medicine is usually five years long, but in some institutions it is six. All result in a bachelor's degree in medicine.

Theoretically, a good proxy for unobserved ability A in empirical models (3.1) and (3.2) would be some measure that is early enough, independent of an individual's socioeconomic status, and not used in the selection process. The current data only provides two pre-tracking measures, i.e. GCSEs and A-levels. While GCSEs score is the earliest available measure, it has less variation than A-levels. Medical schools might use predicted A-levels score and GCSEs score as part of their selection process. Morgan et al. (2013) indicate in the theory that ability is the slope in Figure 3.1, i.e. the difference of knowledge acquisition at two different time points. I consider the difference between A-levels and GCSEs scores as a proxy for ability. In particular, *A-levels average = total score of A-levels taken / number of A-levels taken (excluding general studies)*, and *GCSEs average = total score of best GCSEs / number of best GCSEs*. These two scores have different scales, i.e. A-levels average ranges from 2 to 24, and GCSEs average ranges from 0.6 to 9. To make them comparable in terms of scales, I rank both GCSEs average and A-levels average from 1 (lowest score level) to 10 (highest score level).[13] I then calculate the difference of their ranks as a proxy for ability, i.e. *Rank difference = A-levels rank - GCSEs rank*, which implies the slope in Figure 3.1. A more positive rank difference means a greater slope, thus higher ability. One potential issue of this proxy is that the rank difference could be negative, i.e. individuals might perform worse in A-levels than GCSEs. While theoretically, the slope of ability should be positive. An alternative proxy would be generating a new rank of the rank difference.[14] I leave this for future research.

I identify disadvantaged D by the education level in an area – a categorical variable, ranging from 1 (lowest rate of adults in the area holding higher education (HE) level qualifications) to 5 (highest rate of adults in the area holding HE level qualifications). Previous literature implies that higher education participation of local area is one of socioeconomic disadvantages (Hubble et al., 2021). I transfer the categorical variable into a dummy indicator – low education area equals one if the categorical variable education level values 1, 2 or 3 (i.e. disadvantaged), and zero if education level values 4 or 5 (i.e. privileged).

[13] I use *xtile* command in Stata to generate a categorical variable with 10 quantiles, e.g. 10th percentile indicates the lowest score level, and 90th percentile indicates the highest score level.

[14] Using rank difference generates about 44% negative value of the whole sample. Using the rank of the rank difference would help to make the proxy for ability closer to the theoretical model, as the rank should have all positive values. As ability measure is an index, this would not change the statistical or economical interpretation of the coefficients of variable of interest.

I identify tracks u through medical school ranking. I rank 30 medical schools from the highest to the lowest average A-levels score (see Table 3.A.1 for details). I proxy the upper track for medical schools rank 1 to 10, and the lower track for medical schools rank 11 to 30.[15]

Table 3.1 gives the variable description and Table 3.2 gives the summary statistics. The last column in Table 3.2 compares the mean difference between disadvantaged and privileged students for each variable. Disadvantaged students in general have a 0.23 higher rank difference than privileged students. This relates to one of the main limitations of the UKMED, i.e. it does not collect data on individuals who apply but fail to enter UK medical schools. This might cause selection bias, as those who admit to medical schools are a limited subset of the population as a whole. Table 3.A.1 provides evidence that students who attend UK medical schools outperform the general population, i.e. the average A-levels score in each medical school is higher that the average A-levels entry requirement for each university. Thus for this chapter's analysis, I speculate that students from low education area need to compensate for the initial knowledge gap to successfully enter into medical schools, making them present higher ability in the whole sample. In future research, there is possibility to combine the UKMED data with the early childhood data from the Centre for Longitudinal Studies (CLS) and the Department for Education (DfE). I could then use some earlier performance measures, which are more accurate proxy for ability with greater variation.

[15]This chapter divides medicals schools into two literal tracks. Theoretically, disadvantaged will outperform conditional on each track, i.e. each medical school rank. Appendix 3.B presents part of the results for each medical school rank. I leave more detailed analysis for future research.

Table 3.1: Variable Description

Variable	Description
Ability	I proxy ability for the difference between A-levels average rank and GCSEs average rank. Both are categorical variables ranging from 1 (lowest score level) to 10 (highest score level). A more positive rank difference implies higher ability.
Low education area	A dummy variable equals one if the categorical variable *ADULT_HE_QUINTILE* (the proportion of adults in the area that hold a Higher Education (HE) level qualification) values 1 (lowest rate of adults in the area holding HE level qualifications), 2 or 3. It equals zero if the categorical variable values 4 or 5 (highest rate of adults in the area holding HE level qualifications).
British-BME	A dummy variable equals one if students being Asian or Asian British and Black or Black British
Female	A dummy variable equals one if students being female
Parent no HE	A dummy variable equals one if students' parents having no higher education qualifications
State-funded school	A dummy variable equals one if students attending state-funded schools between age 11 and 16
Socioeconomic (SEC)	A categorical variable for students (under 21) parents socioeconomic background, 8 the lowest level (never worked & long-term unemployed), 1 the highest level classification (higher managerial & professional occupations)
Regional deprivation	A categorical variable indicating regional deprivation, 5 the most deprived, 1 the least deprived

Table 3.2: Summary Statistics

	Disadvantaged (Low education area)					**Privileged (High education area)**					
	observations	*mean*	*sd*	*min*	*max*	*observations*	*mean*	*sd*	*min*	*max*	*mean diff.*
Ability	12213	0	4.12	-9	9	23498	-0.23	3.86	-9	9	0.23***
British-BME (==1)	10321	0.34	0.47	0	1	20221	0.28	0.45	0	1	0.05***
Female (==1)	12281	0.55	0.50	0	1	23704	0.56	0.50	0	1	-0.01**
Parent no HE (==1)	10489	0.33	0.47	0	1	20167	0.16	0.36	0	1	0.18***
State-funded school (==1)	12133	0.81	0.39	0	1	23427	0.65	0.48	0	1	0.17***
Socioeconomic (SEC)	10585	2.50	1.76	1	8	20668	1.92	1.40	1	8	0.58***
Regional deprivation	12281	2.84	1.30	1	5	23704	1.88	1.09	1	5	0.97***

* p <0.05, ** p <0.01, *** p <0.001

I proxy ability for rank difference between A-levels and GCSEs scores, where a more positive rank difference implies higher ability.

The last column is the t-test mean difference between disadvantaged and privileged group for each variable.

3.4 Results

Table 3.3 shows the average marginal effects of the probability of disadvantaged students attending the upper track. As predicted, the negative coefficients indicate that given ability and controlling for confounding factors, disadvantaged students are statistically less likely to attend the upper track than privileged students. In particular, the coefficient of the variable of interest in column (1) as the baseline model implies that given ability, the probability of attending the upper track for disadvantaged students from low education area is 4.6 per cent lower, compared to students from high education area. Column (2) to (4) add different control variables. Across different models, the probability of attending the upper track is between 0.3 and 3.3 per cent lower for students from low education area. Column (5) further controls for year fixed effects by using the conditional logit model. The statistical significance drops when adding more controls in column (3) to (5). This might result from other potential disadvantages, such as parents without higher education and state-funded schools, driving the probability of attending the upper track.

Table 3.4 shows ability difference conditional on tracks, using the OLS baseline in model (3.2). The bottom row compares the difference between the coefficient of variable of interest in each track to that in column (1), unconditionally before tracking. It indicates that disadvantaged students from low education area significantly outperform privileged students in both tracks. In particular, disadvantaged students achieve a 0.1 to 0.4 greater rank difference compared to privileged students who attend the same track, implying higher ability in terms of slope. Comparing the coefficient difference of variable of interest to column (1), only upper track shows significantly positive difference. The coefficient difference between lower track and unconditional is not significant. The coefficient in column (1) indicates that unconditionally, disadvantaged students have a 0.2 greater rank difference than privileged students. This is due to the data only includes students who successfully enter medical schools. Students from low education area but successfully entering medical schools would have higher ability than those from high education area. I speculate that disadvantaged students need to compensate for initial knowledge gap to successfully enter medical schools, making them outperform unconditionally.[16]

[16]Theoretically, in an ideal setup, ability should be independent of socioeconomic status, i.e. unconditionally

Table 3.5 includes confounding factors in model (3.2). For categorical variables socioeconomic (SEC) and regional deprivation, I generate dummies for each category to reduce bias from a single value. Table 3.6 further controls for university fixed effects and year fixed effects. Disadvantaged students achieve a 0.5 greater rank difference in the upper track, and a 0.2 greater rank difference in the lower track. Comparing the coefficient difference to column (1), only the upper track presents positive difference. The coefficient difference between the lower track and the unconditional is not significant. The coefficient in column (1) indicates that unconditionally, disadvantaged students have a 0.3 greater rank difference than privileged students. This is again due to the data only includes individuals who successfully enter medical schools. Individuals from low education area but successfully attend medical schools would have higher ability. Across different models, female students have lower ability, while students from state-funded schools have higher ability. This might indicate that disadvantaged and privileged students are not randomly assigned.

As the data is on a rolling basis from 2007 to 2015, i.e. different individuals sit in exams every year, year-related factors should not bias the results. I check the robustness by comparing the ability difference conditional on tracks for each year. Table 3.7 indicates that in general, the effect is more robust in the upper track.[17]

This chapter divides medical schools into two literal tracks, where upper track consists of medical schools rank 1 to 10, and lower track consists of those rank 11 to 30. Table 3.8 checks the robustness by using alternative 'cut' for upper and lower track, i.e. upper track consists of medical schools rank 1 to 7, and lower track consists of those rank 8 to 19. As predicted, the coefficient difference is significant for the upper track, while theoretically, disadvantaged should outperform in each track. Appendix 3.B further shows ability difference conditional on each medical school, i.e. each medical school is a proxy for track. Disadvantaged students have higher ability in some tracks, which partially supports the theory.

I then introduce two matching methods to make disadvantaged and privileged groups more comparable. Table 3.9 shows the results combining the PSM and the OLS. Compared to the main results in Table 3.6, the impact size of disadvantaged on ability distribution slightly

there is no significant effect in column (1).

[17] The table reports coefficients of variable of interest using model (3.2) without year FEs.

decreases. The treated-off support is about 23% of all treated observations, implying that the information in the data reduces. Table 3.10 shows the regression results after using the CEM. The main results remain the same after using matching – the coefficient difference compared to unconditional column (1) is significantly positive for the upper track. There is no significant coefficient difference for the lower track. Students from low education area but successfully enter into medical schools have higher ability than those from high education area across different models.

Generally, the above results provide empirical evidence for the theory by Morgan et al. (2013). Disadvantaged students, who are less likely to attend the upper track, have higher ability than privileged students assigned to the same track. Students from low education area face initial disadvantages – lacking education resource, unstable studying environment, and poor economic condition – which make them less likely to attend the upper track. The upper track shows significantly positive difference of coefficient of variable of interest, compared to that unconditionally. There is no significant difference for the lower track. The results also imply that disadvantaged students outperform even unconditionally. This is due to the data only includes individuals who successfully enter medical schools. I speculate that to meet objective entry requirements of attending medical schools, students from low education area need to compensate for initial disadvantages through higher individual ability, making them outperform privileged students in each condition. The effect is robust across different models and combining OLS with matching methods.

Table 3.3: Probability of Attending the Upper Track

	(1)	(2)	(3)	(4)	(5)
Low education area (==1)	-0.046***	-0.033***	-0.015*	-0.005	-0.003
	(0.000)	(0.000)	(0.029)	(0.509)	(0.069)
Ability	0.008***	0.006***	0.006***	0.006***	0.017***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
British-BME		-0.078***	-0.086***	-0.078***	-0.018***
		(0.000)	(0.000)	(0.000)	(0.000)
Female		0.008	0.008	0.006	-0.000
		(0.171)	(0.173)	(0.334)	(0.889)
Parent no HE			-0.042***	-0.030**	-0.006**
			(0.000)	(0.001)	(0.009)
State-funded school			-0.060***	-0.060***	-0.018***
			(0.000)	(0.000)	(0.000)
Socioeconomic (SEC)				-0.004	-0.000
				(0.105)	(0.637)
Regional deprivation				-0.010**	-0.002*
				(0.002)	(0.001)
Year FEs					✓
Observations	35711	30336	25871	22859	22859

[1] p-values in brackets, * p <0.05, ** p <0.01, *** p <0.001. The coefficient is the average marginal effect.
[2] I proxy ability for rank difference between A-levels and GCSEs scores, where a more positive rank difference implies higher ability. I proxy disadvantaged for low education area. I rank 30 medical schools from the highest to the lowest average A-levels score. Upper track consists of medical schools rank 1 to 10, and lower track consists of medical schools rank 11 to 30.

Table 3.4: Ability Conditional on Tracks

	Dep. Var. = Ability		
	Unconditional	Upper Track	Lower Track
	(1)	(2)	(3)
Low education area (==1)	0.228***	0.444***	0.126*
	(0.044)	(0.070)	(0.057)
Constant	-0.232***	0.000	-0.399***
	(0.026)	(0.039)	(0.034)
Observations	35711	14452	21259
R-squared	0.001	0.003	0.000
Adjusted R-squared	0.001	0.003	0.000
Coef. diff. to (1)		0.22**	-0.10

[1] Standard errors in brackets, * p <0.05, ** p <0.01, *** p <0.001. Coef. diff. compares each column's coefficient difference to column (1).
[2] I proxy ability for rank difference between A-levels and GCSEs scores, where a more positive rank difference implies higher ability. I proxy disadvantaged for low education area. I rank 30 medical schools from the highest to the lowest average A-levels score. Upper track consists of medical schools rank 1 to 10, and lower track consists of medical schools rank 11 to 30.

Table 3.5: Ability Conditional on Tracks (incl. Controls)

	Dep. Var. = Ability		
	Unconditional	Upper Track	Lower Track
	(1)	(2)	(3)
Low education area (==1)	0.331***	0.434***	0.254**
	(0.060)	(0.093)	(0.078)
British-BME (==1)	0.080	0.244*	0.024
	(0.060)	(0.096)	(0.078)
Female (==1)	-0.820***	-0.764***	-0.861***
	(0.052)	(0.079)	(0.069)
Parent no HE (==1)	0.008	-0.142	0.111
	(0.073)	(0.116)	(0.094)
State-funded school (==1)	0.744***	0.757***	0.772***
	(0.058)	(0.086)	(0.079)
Socioeconomic (SEC) dummy	✓	✓	✓
Regional deprivation dummy	✓	✓	✓
Constant	9.835***	10.647***	10.125***
	(0.678)	(0.117)	(0.091)
Observations	22859	9648	13211
R-squared	0.023	0.025	0.023
Adjusted R-squared	0.022	0.024	0.022
Coef. diff. to (1)		0.10	-0.08

[1] Standard errors in brackets, * p <0.05, ** p <0.01, *** p <0.001. Coef. diff. compares each column's coefficient difference to column (1).

[2] I proxy ability for rank difference between A-levels and GCSEs scores, where a more positive rank difference implies higher ability. I proxy disadvantaged for low education area. I rank 30 medical schools from the highest to the lowest average A-levels score. Upper track consists of medical schools rank 1 to 10, and lower track consists of medical schools rank 11 to 30.

Table 3.6: Ability Conditional on Tracks (incl. Controls & FEs)

	Dep. Var. = Ability		
	Unconditional	Upper Track	Lower Track
	(1)	(2)	(3)
Low education area (==1)	0.353***	0.503***	0.246***
	(0.055)	(0.085)	(0.072)
British-BME (==1)	0.002	0.165	-0.117
	(0.059)	(0.090)	(0.078)
Female (==1)	-0.711***	-0.572***	-0.805***
	(0.048)	(0.073)	(0.064)
Parent no HE (==1)	-0.020	-0.140	0.045
	(0.067)	(0.106)	(0.087)
State-funded school (==1)	0.609***	0.556***	0.647***
	(0.054)	(0.079)	(0.074)
Socioeconomic (SEC) dummy	✓	✓	✓
Regional deprivation dummy	✓	✓	✓
University FEs	✓	✓	✓
Year FEs	✓	✓	✓
Constant	-1.152***	-1.456***	-1.041***
	(0.162)	(0.191)	(0.210)
Observations	22859	9648	13211
R-squared	0.023	0.201	0.177
Adjusted R-squared	0.185	0.198	0.175
Coef. diff. to (1)		0.15	-0.11

[1] Standard errors in brackets, * p <0.05, ** p <0.01, *** p <0.001. Coef. diff. compares each column's coefficient difference to column (1).

[2] I proxy ability for rank difference between A-levels and GCSEs scores, where a more positive rank difference implies higher ability. I proxy disadvantaged for low education area. I rank 30 medical schools from the highest to the lowest average A-levels score. Upper track consists of medical schools rank 1 to 10, and lower track consists of medical schools rank 11 to 30.

Table 3.7: Ability Conditional on Tracks for Each Year (incl. Controls)

	Dep. Var. = Ability				
	Unconditional	Upper Track	Lower Track	Observations	% of Upper
2007	0.267	0.910*	-0.150	2120	0.41
	(0.218)	(0.355)	(0.278)		
2008	0.449*	0.731*	0.238	2757	0.43
	(0.183)	(0.300)	(0.231)		
2009	0.635***	1.007***	0.345	2650	0.41
	(0.189)	(0.300)	(0.243)		
2010	0.320*	0.250	0.368	2697	0.44
	(0.145)	(0.216)	(0.197)		
2011	0.231	0.085	0.346	2545	0.41
	(0.064)	(0.107)	(0.078)		
2012	0.252	0.806***	-0.113	2647	0.41
	(0.147)	(0.218)	(0.198)		
2013	0.419**	0.170	0.546**	2693	0.42
	(0.144)	(0.216)	(0.194)		
2014	0.274*	0.343	0.246	2687	0.44
	(0.139)	(0.200)	(0.194)		
2015	0.140	0.255	0.046	2063	0.43
	(0.165)	(0.236)	(0.231)		

[1] Standard errors in brackets, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

[2] I proxy ability for rank difference between A-levels and GCSEs scores, where a more positive rank difference implies higher ability. I proxy disadvantaged for low education area. I rank 30 medical schools from the highest to the lowest average A-levels score. Upper track consists of medical schools rank 1 to 10, and lower track consists of medical schools rank 11 to 30. The table reports coefficients of variable of interest using regression model (3.2) without year FEs.

Table 3.8: Ability Conditional on Different Tracks (incl. Controls & FEs)

	Dep. Var. = Ability		
	Unconditional	Upper Track Rank1-7	Lower Track Rank8-19
	(1)	(2)	(3)
Low education area (==1)	0.353***	0.461***	0.414***
	(0.055)	(0.098)	(0.083)
British-BME (==1)	0.002	0.207*	-0.117
	(0.059)	(0.100)	(0.088)
Female (==1)	-0.711***	-0.525***	-0.737***
	(0.048)	(0.084)	(0.072)
Parent no HE (==1)	-0.020	-0.223	-0.021
	(0.067)	(0.125)	(0.098)
State-funded school (==1)	0.609***	0.466***	0.700***
	(0.054)	(0.089)	(0.081)
Socioeconomic (SEC) dummy	✓	✓	✓
Regional deprivation dummy	✓	✓	✓
University FEs	✓	✓	✓
Year FEs	✓	✓	✓
Constant	-1.152***	-1.545***	-1.929***
	(0.162)	(0.199)	(0.194)
Observations	22859	6938	10878
R-squared	0.186	0.231	0.168
Adjusted R-squared	0.185	0.228	0.166
Coef. diff. to (1)		0.11	0.06

[1] Standard errors in brackets, * p <0.05, ** p <0.01, *** p <0.001. Coef. diff. compares each column's coefficient difference to column (1).

[2] I proxy ability for rank difference between A-levels and GCSEs scores, where a more positive rank difference implies higher ability. I proxy disadvantaged for low education area. I rank 30 medical schools from the highest to the lowest average A-levels score. Upper track consists of medical schools rank 1 to 7, and lower track consists of medical schools rank 8 to 19.

Table 3.9: Ability Conditional on Tracks (PSM)

	Dep. Var. = Ability		
	Unconditional	Upper Track	Lower Track
	(1)	(2)	(3)
Low education area (==1)	0.317***	0.446***	0.228***
	(0.070)	(0.109)	(0.093)
British-BME	✓	✓	✓
Female	✓	✓	✓
Parent no HE	✓	✓	✓
State-funded school	✓	✓	✓
Socioeconomic (SEC)	✓	✓	✓
Regional deprivation	✓	✓	✓
University FEs	✓	✓	✓
Year FEs	✓	✓	✓
Pseudo R-squared	0.144	0.151	0.140
Treated-On support	5925	2393	3512
Treated-Off support	1746	677	1089
Untreated-On support	15188	6578	8610
Untreated-Off support	0	0	0

[1] Standard errors in brackets, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
[2] I proxy ability for rank difference between A-levels and GCSEs scores, where a more positive rank difference implies higher ability. I proxy disadvantaged for low education area. I rank 30 medical schools from the highest to the lowest average A-levels score. Upper track consists of medical schools rank 1 to 10, and lower track consists of medical schools rank 11 to 30.

Table 3.10: Ability Conditional on Tracks (CEM)

	Dep. Var. = Ability		
	Unconditional	Upper Track	Lower Track
	(1)	(2)	(3)
Low education area (==1)	0.352***	0.459***	0.287***
	(0.052)	(0.081)	(0.068)
British-BME (==1)	-0.085	0.050	-0.163*
	(0.061)	(0.097)	(0.079)
Female (==1)	-0.733***	-0.621***	-0.810***
	(0.050)	(0.078)	(0.065)
Parent no HE (==1)	0.032	-0.199*	0.157*
	(0.062)	(0.100)	(0.080)
State-funded school (==1)	0.655***	0.555***	0.737***
	(0.065)	(0.098)	(0.086)
Socioeconomic (SEC)	✓	✓	✓
Regional deprivation	✓	✓	✓
University FEs	✓	✓	✓
Year FEs	✓	✓	✓
Constant	-1.122***	-1.419***	-1.406***
	(0.180)	(0.221)	(0.224)
Observations	22859	8806	13368
R-squared	0.189	0.199	0.183
Adjusted R-squared	0.187	0.197	0.181
Coef. diff. to (1)		0.11	-0.07

[1] Standard errors in brackets, * p <0.05, ** p <0.01, *** p <0.001. Coef. diff. compares each column's coefficient difference to column (1).

[2] I proxy ability for rank difference between A-levels and GCSEs scores, where a more positive rank difference implies higher ability. I proxy disadvantaged for low education area. I rank 30 medical schools from the highest to the lowest average A-levels score. Upper track consists of medical schools rank 1 to 10, and lower track consists of medical schools rank 11 to 30.

[3] I coarsen before conditional on specific tracks, using coarsened covariates British-BME, female, parent no HE, state-funded school, socioeconomic (SEC), and regional deprivation. For the whole sample, treated-matched is 11792, treated-unmatched is 489, untreated-matched is 23098, untreated-unmatched is 606.

3.5 Conclusion

Objective standard does not necessarily bring equal opportunities. This chapter empirically tests the theory by Morgan et al. (2013). To reach the objective admission requirements to successfully attend medical schools, disadvantaged students from low education areas need to overcome initial gaps through higher individual ability. Disadvantaged students, who are less likely to attend the upper track, have higher ability than privileged students in the same track.

Focusing on the equality of outcomes in selection could be misplaced. For instance, the affirmative action, which aims to achieve the equality of outcomes by subsequent testing, might cause similar issues as setting up objective entry requirements in educational tracking. Policy makers should consider the trade-off of affirmative action and quota policies – whether such policies bring more equality is at the cost of knowledge acquisition. They might carefully consider when setting up standards, for instance, using different thresholds for different groups, or adding tracking scores based on the disadvantaged level. Institutions might use area-based participation in higher education to identify disadvantaged students (Turhan & Stevens, 2020).

Researchers often rely on knowledge or academic performance as a proxy for unobserved individual ability. This chapter indicates that it is still arguable whether individual ability is fully independent of knowledge. I leave this for future research consideration.

Appendix to Chapter 3

3.A Appendix to Section 3.3: Medical School & Tracks

Table 3.A.1: Medical School Ranking by Ability

Ability Rank	Medical School	Average A-levels	Observations
1	Cambridge	11.626	1380
2	Oxford	11.449	1001
3	Birmingham	11.209	2627
4	Newcastle	11.060	1565
5	Edinburgh	11.035	870
6	UCL	10.877	2131
7	Nottingham	10.865	1786
8	Leeds	10.845	1540
9	Sheffield	10.838	1626
10	Leicester	10.774	1181
11	Hull York	10.768	765
12	Manchester	10.752	2365
13	King's	10.746	1515
14	Imperial	10.737	2182
15	Liverpool	10.641	2112
16	Lancaster	10.614	328
17	Bristol	10.611	1646
18	Cardiff	10.526	2145
19	Brighton and Sussex	10.520	781
20	Exeter	10.511	299
21	Plymouth	10.469	211
22	Queen's	10.403	1706
23	Southampton	10.402	1178
24	Barts	10.392	1465
25	Norwich	10.375	723
26	Glasgow	10.331	678
27	Keele	10.302	668
28	Aberdeen	10.137	400
29	St George's	10.101	1107
30	Peninsula	9.962	928

[1] Point scores are assigned to A-level grades in 2 point increments, i.e. A*=12, A=10, B=8. C=6, D=4, E=2, else=0. The average entry requirement of universities is between ABB (26/3 = 8.667) and A*AA (32/3 = 10.667). The average A-level of each medical school's students is higher than the average A-level entry requirement for each university.

3.B Appendix to Section 3.4: Ability Conditional on Each Track

Table 3.B.1: Ability Conditional on Each Track

	Dep. Var. = Ability			
Ability Rank	**Coefficient**	**SE**	**Coef. Diff.**	**Observations**
	(1)	(2)	(3)	(4)
1	0.515*	0.239	0.162	714
2	-0.067	0.293	-0.420	504
3	0.615**	0.198	0.262	1764
4	0.346	0.279	-0.007	1116
5	-0.071	0.398	-0.424	494
6	0.660**	0.237	0.307	1112
7	0.435	0.241	0.082	1234
8	0.762*	0.318	0.409	893
9	0.863**	0.272	0.510	1113
10	0.193	0.293	-0.160	704
11	0.993*	0.421	0.640	475
12	0.373	0.232	0.020	1460
13	0.130	0.258	-0.223	992
14	0.212	0.241	-0.141	1112
15	0.554*	0.254	0.201	1323
16	-0.429	0.625	-0.782	213
17	0.254	0.281	-0.099	1003
18	0.109	0.244	-0.244	1195
19	0.127	0.424	-0.226	395
20	-0.043	0.601	-0.396	200
21	0.703	0.609	0.350	137
22	-0.005	0.340	-0.358	567
23	-0.173	0.324	-0.526	761
24	0.412	0.280	0.059	754
25	0.375	0.357	0.022	475
26	-0.551	0.491	-0.904	320
27	-0.323	0.457	-0.676	433
28	-0.450	0.592	-0.803	228
29	0.410	0.308	0.057	603
30	0.004	0.336	-0.349	565

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. I proxy ability for rank difference between A-levels and GCSEs scores, where a more positive rank difference implies higher ability. I proxy disadvantaged for low education area. Column (1) shows the coefficient of the variable of interest for each rank medical school, using the same model as Table 3.6. Column (3) compares the coefficient difference to that unconditionally.