Closing the Gap Between Vocational and General Education? Evidence from University Technical Colleges in England

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Abstract

Vocational education delivery is widely debated, with ongoing efforts to improve its effectiveness. In 2010, England introduced University Technical Colleges (UTCs), hybrid institutions combining general and vocational education. This paper examines the impact of UTC attendance on achievement, university enrolment, and labour market outcomes. For students entering UTCs at the unconventional age 14, enrolment lowers academic achievement at age 16. However, for those entering at the conventional age 16, UTCs improve vocational achievement, enrolment in STEM degrees, and labour market outcomes. Findings highlight the risks of early specialisation and benefits of aligning education with students' interests at a suitable stage.

Keywords: Technical education; School value-added; University Technical Colleges.
JEL codes: I20, I21, I28

Acknowledgements: We thank the Department for Education for funding this work through the Centre for Vocational Education Research (CVER). We acknowledge the support of ESRC through the Centre for Economic Performance (ES/M010341/1 and ES/T014431/1). The authors have no conflict of interest. We are very grateful for helpful comments from participants at seminars at the Centre for Economic Performance LSE; the Humboldt University of Berlin; the CESifo Economics of Education conference; the International Institute of Public Finance Annual Congress; the 5th IZA Workshop on the Economics of Education; the University of Geneva and the University of Gothenburg. In particular, we would like to thank Bernd Fitzenberger, Eric Taylor, and Barbara Wolfe for helpful comments.
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The paper uses confidential data from the Longitudinal Educational Outcomes data set. This can be applied for from the Office for National Statistics, England using the Secure Research Service. The authors are willing to provide assistance for accessing the data and replication files for coding.
Online Appendix included.

doi:10.3368/jhr.0223-12768R1

I. Introduction

High quality vocational and technical education is a key solution to two of the most pressing labour market issues of our times: high youth unemployment and a shortage of skilled workers in fast-growing technical and professional jobs (OECD 2017).[i] However, many countries face challenges in providing strong vocational and technical education, historically prioritizing general education and delaying vocational skill development until after compulsory schooling (OECD 2022; Smithers 2013).[ii] Part of the reluctance to invest in vocational education stems from a perceived trade-off between the immediate employment benefits of vocational specialization and the long-term adaptability and employment stability associated with general education. This trade-off has been well documented empirically (Bertrand, Mogstad and Mountjoy 2021; Alfonsi et al. 2020; Fersterer, Pischke and Winter-Ebmer 2008; Hampf and Woessmann 2017; Hall 2016; Hanushek et al. 2017; Malamud and Pop-Eleches 2010; Zilic 2018).

Yet, recent evidence suggests that this trade-off is not automatic, and that well-designed vocational secondary education can provide sustained economic benefits without compromising adaptability to labour market changes (Silliman and Virtanen 2022). However, there is still limited evidence on the specific features of vocational and technical education that can deliver both short and long-term advantages for students and workers. Two key questions have emerged in the debate on effective vocational education: first, can integrating vocational elements into general education enhance both immediate learning outcomes and longer-term career prospects? Second, does delaying specialization lead to higher educational attainment, ultimately improving labour market opportunities and resilience to economic shocks?

This paper explores both questions by examining the introduction of University Technical Colleges (UTCs) in England, hybrid institutions that integrate general and vocational education while offering two entry points for students at ages 14 and 16. We estimate the causal effect of UTCs on students' achievement and labour market outcomes, providing novel insights on the effectiveness of hybrid models in balancing general and specific skill development. By leveraging the distinct entry ages, we also assess how the timing of specialization influences student short-term attainment and long-term labour market prospects. From this we learn about the potential trade-offs between 'general' (or academic) education and vocational education; the danger of too-early specialisation; and the potential benefits of better matching students to their skills and abilities at a more natural time (when in sync with the rest of the education system).

Several countries have commenced hybrid programs that provide not only high-quality hands-on technical learning, but also rigorous academic foundation, and hence keep the college doors open (Kreisman and Stange 2020; OECD 2014). In the US, about 8.8 million high school students, nearly half the US high school population, are enrolled in one or more 'career and technical education' (CTE) courses.[iii] Similarly, in 2010, England introduced University Technical Colleges' (UTCs), a hybrid educational model including academic and vocational elements as an alternative to traditional secondary schools. Like their counterparts in the US, UTCs have a (technical) subject specialism (typically in STEM) but also require all students to meet the same academic standards as any other school. UTCs also partner with local employers and universities to design their curriculum, deliver the teaching, and provide a broad choice of pathways either to university, apprenticeships, or directly to a career.

To credibly evaluate the causal effect of UTCs on students' achievement and labour market outcomes, we address student endogenous enrolment into UTCs by relying on an instrumental variable approach. We use the interaction between a student's cohort year and his/her distance to a UTC as an instrumental variable.[iv] This approach takes advantage of two important features of UTCs: anyone is eligible to enrol in the schools, but students living close by are much more likely to enrol; and there are years when students are ineligible due to the timing of the schools' opening.[v] Identification is driven by the between-cohort comparison of differences in outcomes between students living closer to a UTC and students living further away. We estimate the effect of enrolling in a UTC on a range of outcomes, including test scores in the national exam taken by all students in England at age 16 (i.e. the General Certificate of General Education at GCSEs); outcomes at age 18 (i.e. the end of post-secondary education), entry to tertiary education, and early labour market outcomes.

A key feature of UTCs is that they offer two entry points: age 14, an unconventional transition point, and age 16, a common stage for switching institutions. Students entering at 14 may stay for up to four years, while those joining at 16 remain for two. This allows for an analysis of UTCs' value-added across both groups. For younger entrants, the alternative is continuing at their original school until age 16, while for older entrants, it is either staying at their secondary school or moving to a Further Education college, which about half of students do.

There are three reasons why UTCs might be less beneficial for age 14 students than for age 16. First, while early exposure to technical learning may help prevent disengagement of less academically oriented students, adding technical classes to an already-demanding curriculum (i.e. preparing for high-stakes national exams at age 16) might be too challenging. Second, transitioning at 14 is uncommon, making it socially and academically challenging for students. [vi] Third, it may also be challenging for UTC teachers to prepare new students for an important (and broad) set of national examinations in only two years. This may explain UTCs' recruitment difficulties and the lower prior attainment of 14-year-old entrants. In contrast, entry at 16 aligns better with natural transition points, potentially allowing students to make more informed educational choices that improve long-term outcomes.

Our results reveal striking differences in UTC performance for students who enter at age 14 and age 16. For the younger entrants, UTCs do very badly at enabling their students to do well at the national GCSE exams at age 16. Students who enrol in UTCs are 19 percentage points less likely to get at least 5 good grades relative to what they would have achieved in another institution. As a benchmark, this negative effect is equivalent to two thirds of the achievement gap between disadvantaged and non-disadvantaged students in England. This negative effect is reflected in students' poor achievement in maths, English, and science. Poor performance has a high cost because good grades at GCSE are a key precursor to educational progression (even within vocational education) and labour market outcomes (e.g. Machin, McNally and Ruiz-Valenzuela 2020). Indeed, we estimate that the fall in achievement in GCSEs as a result of UTC enrolment translates to an 8.4 percent reduction in cumulative earnings by the age of 26.

Interestingly, results are more positive for students who enter at the more usual age 16, although there are trade-offs. Students who enrol in UTCs are just as likely to enrol in academic qualifications, but the achievement rate falls. This is more than compensated by an increase in achievement in advanced vocational qualifications (driven by enrolment). The (negative) effect on academic qualifications is only half the absolute size of the effect on advanced vocational qualifications at the same level. UTCs also lead to a change in direction, as students are much more likely to pursue (and achieve) STEM qualifications at this level. Students attending UTCs are just as likely to go to university (i.e. the fall-off in academic qualifications doesn't hurt them in this respect) and much more likely to pursue STEM at degree-level. Specifically, UTC students are 7.4 percentage points more likely to enter university to do a degree in a STEM subject. This is a particularly interesting result given that STEM fields are associated with occupations that have higher earnings (e.g. Kinsler and Pavan 2015).

Having studied education impacts, the paper moves on to look at early labour market outcomes at age 19. By enrolling in UTCs, students have a higher probability of being in sustained employment, and a (similar) lower probability of 'not being in education, training or employment'. For those in employment, there is a positive earnings return from having attended at UTC. Looking beyond outcomes at age 19, we estimate that the overall effect of UTC enrolment in Year 12 on achievement would translate into positive predicted labour market outcomes by age 26, with a 10 percent increase in earnings at that age. In general, these results are in line with a rich literature that shows positive returns to vocational education (e.g. Silliman and Virtanen 2022; Kreisman and Stange 2020; Stevens, Kurlaender and Grosz 2019).

What drives the striking differences in UTC performance for students who enter at age 14 and age 16? We evaluate the effect of differences in the composition of incoming students and differences in the quality of the fallback institution for these groups. Regarding the former, Year 12 entrants have higher prior attainment at age 11 than Year 10 entrants and are less likely to come from a disadvantaged background. While a difference in the composition of entrants has some role in accounting for the difference in effects (whereas the quality of fallback institution is not relevant), this cannot explain very much of the difference. The most plausible explanation is that simply taking young students away from school (and their peers) to prepare for general exams at a different (more specialist) institution has a very deleterious effect on exam outcomes. In contrast, offering students more choice at age 16 via institutions with a STEM focus (when the whole cohort is making decisions to specialise different ways) enables individuals to make a better match between their skills and interests and educational programmes. This has a material effect on outcomes (in higher education and the labour market).

Beyond its immediate policy relevance in England, our paper contributes to the question of how best to provide vocational and technical education in a context where demand for technical occupations is growing, while the returns to general skills remain high. New hybrid models combining technical and vocational education with a good academic foundation that leaves the door open to university studies could offer a way forward, but they are not without risks. Our paper shows that early specialisation, in a context where this is not the norm for everyone in the school system, can lead to negative consequences for educational outcomes. Even specialisation at a later stage (age 16 in this context) gives rise to potential trade-offs between academic and vocational educational achievement. The overall positive results for

UTC compliers at this later stage shows that hybrid models can secure higher acquisition of STEM skills and a better match in the labour market (as reflected in expected employment and earnings outcomes). Hence, these hybrid models may be particularly promising in countries in which general education has been predominant like the UK or the US, where high returns are associated with university studies (and lower esteem attached to vocational education), putting off students from pursuing more technically oriented alternatives. Even in countries with well-established vocational systems, hybrid institutions have been gaining popularity over recent years as demand for more general skills within technical occupations has intensified.[vii] Pinning down the sources of success and failure of the UTC model is therefore of first-order importance for the development of successful vocational and technical education in the coming years.

This paper contributes to a literature on the efficacy of vocational education (Hampf and Woessmann 2017; Hanushek et al 2017; Kreisman and Stange 2020; Meer 2007; Mane 1999). Many papers leverage reforms that have been adopted through the 1970s to 1990s, usually in the context of the two-track model in which vocational and academic education are distinct and separate and where the latter is usually ranked more highly (Bertrand, Mogstad and Mountjoy 2021; Hall, 2012, 2016; Malamud and Pop-Eleches 2010, 2011; Oosterbeek and Webbink 2007; Zilic, 2018). Our contribution is distinct from this literature because we are investigating the impact of establishing brand-new hybrid institutions that complement the available school offer rather than focusing on the effect of cohort-wide curriculum reforms.

In this respect, the paper closely relates to US research that evaluates the effectiveness of Career and Technical high schools and Career Academies (which includes Brunner, Dougherty and Ross 2023; Dougherty 2018; Hemelt, Lenard and Paeplow 2019; Kemple 2008). Recent studies commissioned by the US Department of Education has found mixed evidence of the effects of these schools on secondary, postsecondary, and labour market outcomes (Department of Education 2012). Dougherty (2018), for example, studied three career academies in Massachusetts that volunteered to be evaluated and finds large high school graduation effects from students who are just accepted into the schools compared with those who just miss the cutoff. Brunner, Dougherty and Ross (2023) evaluate the effect of admission to 16 stand-alone technical high schools within the Connecticut Technical High School System. Using information on admission scores and a regression discontinuity approach, they find positive effects on high school graduation but negative effects on college enrolment. This paper strongly complements and advances this literature by providing the first evaluation of a large-scale and nationwide introduction of hybrid schools that combine vocational and academic education.

By placing a focus on newly set up schools, the analysis also connects to the school effectiveness literature on the value added of new types of educational institution such as charter schools in the US, academy schools in England, or free schools in Sweden (e.g. see Epple, Romano and Zimmer 2016 and Abdulkadiroğlu et al. 2011 for the US; Eyles and Machin 2019 and Eyles, Machin and Silva 2018 for England; Bolhmark and Lindahl 2015 for Sweden). However, and unlike many of these new schools, UTCs are not over-subscribed, thereby ruling out using admission criteria or lotteries to study their impact. How to evaluate the effectiveness of new schools that are not immediately very popular (and therefore not over-subscribed) is an important methodological question to build a more comprehensive picture of school effectiveness (Angrist et al 2024). This study of UTCs offers a different angle and modelling framework that enables evaluation of the effectiveness of new institutions that are under-subscribed.

The remainder of the paper is structured as follows. In Section II, we describe the English Education system and the role of University Technical Colleges. In Section III, we describe the data and we set out the methodology in Section IV. In Section V, we explain the main results and then in Section VI, we explore whether the overall findings mask any heterogeneity across different UTCs and test robustness to alternative specifications. Next, in Section VII we investigate what may explain the results. This includes considering how effects are influenced by the characteristics of the complier groups amongst the two entry cohorts. We also explore whether the effects of UTCs improve over time. We conclude in Section VIII.

II. The English Education System and University Technical Colleges

In England, compulsory full-time school-based education is up until the age of 16, with students entering secondary schools from age 11 (see Figure 1). All students undertake exams for the General Certificate of Secondary Education (GCSEs) at age 16. This consists of about eight subjects, including English and maths. After this exam, students pursue upper secondary education (16-18) either in the same school or in another institution where they undertake either academic subjects (A-levels), vocational subjects, or some combination.[viii] Students who are more academically inclined (and who have sufficiently good grades at GCSE) either stay in the same school or move to a Sixth Form College (i.e. institutions that cater for students of age 16-18, with a focus on academic education or A-levels). The other half of the cohort go to a College of Further Education where they specialize in a vocational programme of study although a minority combine this with academic education (A-levels).[ix] The education system in England is very straightforward for those who go on to the academic track post-16. They study for A-level qualifications, and many go to university afterwards. For the other 50 percent, the system is opaque, as there are many types of educational qualifications and specialisms and few well-known pathways (Hupkau et al 2017).

University Technical Colleges (UTCs) were created as a response to the perception that students do not have good enough options to pursue vocational or technical education in England. Publicly funded with an age range of 14-19, UTCs have a focus on technical education, but they are not intended to be purely specialist. Between age 14 and 16, UTC students combine the main general subjects that are part of the academic curriculum (including English, maths, and science) which they study for 60 per cent of the time with technical subjects (for the remaining 40 per cent). These percentages are reversed from age 16 onwards, with more focus on technical subjects; although they continue to study outside the core technical curriculum, having the opportunity to study A-levels and develop wider employability skills (Baker 2013).

UTCs have some similarities to charter schools in the U.S. and free schools in Sweden, but they are established with the support of employers seeking to fill skills gaps in their local areas. Each UTC specializes in one or more technical specialism such as engineering, manufacturing, computer science, health sciences, digital technologies, and cybersecurity.[x] The opening of UTCs is promoted by a Trust of institutions and/or individuals who believe a new UTC would bring benefits to a local area. As part of the application process, among other general financial and managerial requirements, the Trust needs to provide evidence to the Department for Education (DfE) that (a) local employers are experiencing skill gaps in the specialism the UTC will deliver; (b) there is no pre-existing high quality technical provision in the local area; (c) there is an interest from local pupils and parents to enrol in the UTC.[xi] If successful, the Trust is tasked with setting up the new school. This includes securing a site for the school, hiring the staff and driving recruitment of pupils. To recruit enough pupils, at this stage UTCs commonly invest in marketing and outreach activities targeted at local families through in-person events or local advertisement campaigns and are expected to engage with local schools to develop feeding arrangements.[xii] UTCs are non-selective meaning they accept all students who apply unless they are oversubscribed, which is rare.

An interesting feature of the UTCs is that they have two different entry points at age 14 and 16 (Years 10 and 12 respectively). This allows us to study the implications of introducing more technical specialisation in the school curriculum for different age groups. The first entry point at age 14 coincides with the Key Stage 4 phase of education when students study for two years towards the GCSE exams.[xiii] This is an unconventional enrolment age in the English education system, and is not a standard time for students to transition to a new school as most students stay in the same secondary school between age 11 and 16. Between the age of 14 and 16, students in traditional secondary schools normally focus on general subjects (including English, maths, and science) and have little exposure to more hands-on, technical subjects. In contrast, students enrolling in UTCs at age 14 are taught more specialised technical content two years earlier than other students. However, this is not meant to be at the expense of the traditional academic curriculum, which due in part to a longer school day, still makes up about 60 percent of students' learning.

The second entry point in Year 12, corresponds to the first year of post-compulsory education which normally lasts for two years, between the age of 16 and 18. Students typically move to a new institution to specialise in either academic subjects (A-Levels), mostly studied in schools, or in vocational subjects taught in FE colleges. For this age group, UTCs offer the possibility of better integrating academic and technical subjects as well as the benefit of studying in institutions with a clear technical specialism and the wider support of local employers and universities.

The policy to establish UTCs was announced in 2009 and the first UTC was established in 2010. Since then, 58 more have opened across all regions of England (though only 44 remain in operation in 2024/25 with few having closed or changed status). Yet, despite its fast expansion, the new model has been dogged with controversy (see, for example, Dominguez-Reig and Robinson 2018 and Thorley 2017). UTCs have been criticized for their poor performance in national examinations. Some of this has been borne out by evaluations of the Schools' Inspectorate (OfSTED): On average UTCs lag behind state-funded mainstream institutions in terms of overall effectiveness (Dominguez-Reig and Robinson 2018). Recruitment at age 14 has also proven very challenging, with all UTCs opened by January 2019 operating at an average capacity of 45% (National Audit Office 2019). This has been linked to the non-conventional entry point and lack of publicity: parents might not know about this new type of school opening in the area and existing schools have no incentive to inform them about new competitors. Furthermore, sending their children to a school that specializes in vocational education goes against the grain of a society that tends to value academic education more highly. For a number of UTCs, the low number of students enrolled translated into poor financial viability: in the academic year 2015/16, 63% of UTCs were in deficit with a cumulative net loss of £6.3M (National Audit Office 2019).[xiv]

Of course, part of the poor performance of UTCs might be due to the initial low educational level of the students they enrol. The purpose of this paper is to address this potential negative selection to identify a causal effect of UTCs on student achievement. Yet, when doing so, the fact that UTCs are heavily under-subscribed means that we cannot use admission criteria or lotteries as a source of quasi-random admission to a UTC.[xv] This raises the interesting methodological question of how to evaluate the effectiveness of new schools that are not immediately very popular (and therefore not over-subscribed). This is an important question if we want a comprehensive picture of school effectiveness that is not limited to popular (and, most likely, higher performing) schools. We design a methodology that allows us to evaluate school value added in contexts in which new schools are undersubscribed.

III. Data and descriptive statistics

We use administrative data on the census of students attending state schools in England (the National Pupil Database) linked to data on their later educational outcomes at the age of 16 and 18.[xvi] The former is when they do their GCSE exams, which all students undertake at age 16. The latter is the attainment of further education outcomes (A-levels or the vocational equivalent). We also consider whether students commence an apprenticeship. Finally, for all but the last cohort of students, we look beyond secondary education and consider the following outcomes at the age of 19: whether they remain in education; start a university degree; start a university degree in Science, Technology, Engineering or Maths (STEM); are in 'sustained employment' (which is defined as being observed in employment for at least six months during the year) or are classified as 'not in education, employment or training' (NEET); annual earnings after one year (if in sustained employment). Information on participation into Higher Education comes from the Higher Education Statistics Agency data whereas information on labour market participation and earnings is gathered from tax records linked to education administrative data (Longitudinal Education Outcomes). In addition to information on the educational institution attended and later educational outcomes, we also have data on prior attainment in national tests (e.g. at age 11), the school previously attended, demographics (gender; ethnicity; free school meal eligibility; language spoken at home) and their home post-code, which is an important variable for constructing the distance between each student's home and each University Technical College.

There are two potential entry points to UTCs: the less conventional one in terms of English education at age 14 (Year 10) or the conventional one when compulsory school ends at age 16 (Year 12). We use cohorts of students in Years 10 and 12 between academic years 2007/8 and 2014/15. At this stage, there were 30 UTCs open with a Year 10 intake and 29 UTCs with a Year 12 intake. For students entering in Year 10, we focus on outcomes at age 16 (i.e. GCSEs) whereas for those entering in Year 12, we focus on outcomes at age 18 and 19.[xvii]

Figure 2 shows where UTCs considered in our analysis are located in England. Most students live too far from a UTC to enrol in one. This is reflected in the relationship between distance and the probability of enrolling in a UTC: Figure 3 shows that the probability of enrolling in a UTC predictably declines as students live further away from their closest one and becomes negligible at distances over 25-30 km. Accordingly, to ease computability we restrict our initial sample to all students within the 90th percentile of the home-to-UTC distance distribution for those attending UTCs, with the expectation that students living further away are not responsive to distance. For both Year 10 and Year 12 entrants, this cutoff corresponds to about 23 km. Based on this definition, about half of students are not within reasonable reach of any UTC and are dropped from our main sample. In Section VI, we probe the sensitivity of our main findings to using alternative cutoffs at the 85th or 95th percentile of the distance distribution of UTC students and confirm our main conclusions.

Table 1 shows descriptive statistics of the population of students in schools or colleges (column 1) in either Year 10 (top panel) or Year 12 (bottom panel). These can be compared with the analytical sample in the control group (column 2) or treatment group (column 3). The number of students attending UTCs are only a tiny fraction of the whole population, and they look very different from students in the control group. On the other hand, the control group (column 2) looks broadly representative of the whole population (column 1), with the biggest differences being fewer students who are White British (by about 8 percentage points), fewer students who speak English as a first language (by about 5 percentage points) and live much closer to a UTC (by construction).

The fact that those attending UTCs do not look anything like the average student in the control group (or population) is not surprising given that UTCs, with their specialist approach, will not necessarily be attractive to the typical student. Comparing the treatment and control group for Year 10 entrants shows that 77% of students enrolling in UTCs are male as opposed to 51% for non-UTC students. UTC students are also more likely to speak English as a first language: 91% of students in UTCs compared to 82% among non-UTC students. They are also slightly less likely to be amongst the poorest students (i.e. they are less likely to be eligible to receive free school meals compared to those not attending UTCs). Those attending UTCs have much lower prior attainment in English (they scored 0.20 standard deviations lower than non-UTC students in the national test at age 11) but are more similar with regard to prior attainment in maths.

Similar differences emerge between the treatment and control group among Year 12 students for most variables: 81% of UTC students are male and 90% speak English as a first language compared to 83% of non-UTC students. However, in contrast to Year 10 students, UTC students are better performing in terms of prior attainment in maths than non-UTC students (i.e. 0.20 standard deviations higher in the national test at age 11). They are worse in English (i.e. by 0.12 standard deviations) but this difference is smaller than for Year 10 students. Such differences in who selects to attend a UTC are not surprising given UTCs known focus on STEM and vocational courses.

IV. Methodology

A. Instrumental Variables

1. Leveraging distance to UTC and UTC opening time.

The primary empirical challenge to identify UTC effectiveness is the non-random selection of students into UTCs. The descriptive statistics show that students who attend UTCs differ in several ways from the general pool of students, a fact that may bias naive comparisons of UTC and non-UTC students. For identification, we thus use an instrumental variable approach that leverages variation in the local availability of UTCs across cohorts by interacting students' distance to their closest UTC with indicators for their opening status. In this way, we exploit the role of distance in driving enrolment while netting out any spurious correlation due to the non-random geographic sorting of UTCs.

This approach relaxes the standard IV assumptions invoked in the traditional literature that uses distance to school as an instrument for enrolment (e.g. Booker et al. 2011; Card 1995; Neal 1997; Mountjoy 2022). In our setting, we do not argue that distance is independent of enrolment and unrelated to education outcomes. In fact, while active sorting of students closer to UTCs remains unlikely (the schools are new and under-subscribed, so families have little incentive or time to live closer to them), given their links with local firms, it is not implausible they opened in areas with specific (dis)amenities (e.g. closer to manufacturing clusters), potentially leading to a backdoor correlation between distance and education outcomes (violating the exclusion restriction of the distance IV).[xviii] By comparing students living further away from a UTC before and after each UTC opened, we can difference out any spurious correlation between distance and education outcomes. This strategy is very similar in spirit to that used by Dobbie and Fryer (2011) to evaluate the Harlem Children Zone, except that we use a continuous definition of distance rather than relying on the sharp boundaries of a catchment area. Intuitively, before the UTC opens, distance cannot predict enrolment, so the relationship between outcomes and distance will capture any spurious correlation of distance with outcomes. As long as the correlation is invariant over time, we can use distance after the UTC opens as a valid instrument for UTC enrolment. We carefully assess the validity of this assumption in Section IV.B below.

2. *Accounting for heterogenous treatment effects.*

Given the identification strategy set out above, to recover the effect of enrolment in a single UTC on an education outcome Y, we could estimate the following system of equations:

$$Y_i = \alpha + \beta D_i + \gamma Z_i + \eta \mathrm{Open}_i + \delta' X_i + \varepsilon_i \qquad (1)$$
$$D_i = \lambda + \mu Z_i \mathrm{Open}_i + \rho Z_i + \pi \mathrm{Open}_i + \theta' X_i + \nu_i$$

Here D_i denotes whether student i enrols in a UTC and is instrumented with an interaction between distance to the closest UTC (Z_i) and an indicator for whether the closest UTC is open for student i's cohort (Open_i), while controlling separately for the baseline effect of distance and post-opening status. X_i captures other individual characteristics such as gender and prior attainment. Under the assumption that the interaction term is exogenous (i.e. independent of ε and ν), $\widehat{\beta}$ identifies the effect of enrolment in a UTC on the student's outcome (Y).

Although this specification works well to identify the effect of enrolment in a single UTC, the setting here is richer as we want to estimate the effect of enrolment across 30 different UTCs that may have heterogenous treatment effects. In the presence of group heterogeneity in treatment effects, the simple 2SLS estimator (running equation 1 on a pooled sample across UTC areas) may be inconsistent and/or have large standard errors (Abadie, Gu and Shen 2024).

In our setting, treatment effect heterogeneity could arise naturally across different UTCs as they are run autonomously and offer different specialisms. Moreover, the first stage itself (i.e. how distance affects enrolment) is likely to vary across UTCs as they opened in regions that may exhibit different compliance rates due to socio-geographic factors. To safeguard against heterogeneity across UTCs that may bias our estimates and prevent correct inference, we instead adopt the fully-UTC-interacted 2SLS estimator suggested by Abadie, Gu and Shen (2024):

$$Y_i = \alpha + \beta D_i + \gamma Z_i + \eta Open_i + \delta' X_i + \sum_{j=1}^{J} \theta_j (U_j \times \mathbb{P}_i) + \varepsilon_i \tag{2}$$

$$D_i = \lambda + \mu Z_i Open_i + \rho Z_i + \pi Open_i + \theta' X_i + \sum_{j=1}^{J} \tau_j (U_j \times Z_i \times Open_i) + \sum_{j=1}^{J} \theta_j (U_j \times \mathbb{P}_i) + \nu_i$$

where $\mathbb{P}_i = (X_i + Open_i + Z_i)$

This estimator departs from equation (1) in two straightforward ways: first, all exogenous regressors on the right-hand side (denoted for simplicity by $\mathbb{P}_i$) are interacted with UTC indicators U_j; second, in the first stage equation, UTC enrolment (D_i) is simultaneously instrumented with J interactions between Z_i X $Open_i$ and UTC indicators U_j.

This estimator has a highly desirable property: if treatment effects indeed differ across UTCs, it will consistently identify a weighted average of the UTC-specific treatment effects (where the weights are proportional to the compliance rate in each UTC). Furthermore, under UTC-wise first stage heterogeneity, the estimator will be more efficient than the "pooled" 2SLS estimator in (1).[xix] In practice, this approach results in 30 and 29 instruments for the Year 10 and Year 12 analyses respectively. An analysis of the strength of the first stage (in Section 4.2) dispels any potential concern about weak instruments.

3. *Addressing low UTC enrolment.*

In our analytical sample of students living within around 23 km of a UTC, the proportion of treated students remains small (0.01 % and 0.02 % for Year 10 and Year 12 entrants respectively). Low treatment probabilities are problematic when using linear IV with covariates as it may result in (i) the first stage having a very low coefficient and (ii) the standard errors being very large (Chiburis, Das and Lokshin 2012; Fitzenberger, Furdas and Sajons 2016), partly due to a lack of overlap between the demographic characteristics (the covariates) of the few treated and control students.[xx] To address the low treatment probabilities and to reduce covariate imbalance between UTC and non-UTC students in our sample (see Table 1), we estimate the propensity score for UTC enrolment and use it to weight observations by their inverse propensity score when estimating equation (2). To estimate the propensity score, we use a LASSO logistic regression that first estimates which covariates should enter the propensity score equation and computes the propensity score with the penalized coefficients.[xxi] We run the procedure to choose among the main individual characteristics available in the data (e.g. gender, ethnicity, FSM eligibility, English as first language, end-of-primary-school standardized test scores in English and maths) including any potential first-order interaction. Columns (4) and (5) of Table 1 compare the characteristics of UTC and non-UTC students after weighting using the inverse of their propensity score. In essence, UTC students that look more similar to control students receive a higher weight and this results in a better covariate balance (compare with columns 2 and 3). This is particularly striking for gender and some measures of prior attainment (as measured by tests in primary school).

B. Validity of the research design

1. *First stage results*

As described in equation (2), in our first stage we instrument the indicator for UTC enrolment with a set of interactions between distance-by-opening status and UTC group indicators while also controlling for UTC-by-distance, UTC-by-opening status and controls for prior attainment at age 11, gender, ethnicity, whether eligible for free school meals, and whether English is spoken as a first language (all themselves interacted with UTC indicators). The regression for Year 12 students also controls for GCSE test scores (national exams at age 16).

Figure 4 plots the coefficients on our excluded instruments (i.e. the interactions between post-opening status, distance, and UTC effects). Nearly all coefficients are positive and are individually statistically significant: 28 instruments out of 30 are significantly different from zero at the 95% confidence level for the Year 10 students and 27 out of 29 for the Year 12 students. The figures also report the Montiel and Pflueger (2013) robust F-statistic for weak instruments – 156.1 for Year 10 entrants and 97.7 for Year 12 entrants – which exceeds the critical values at conventional levels, thus ruling out concerns about weak instruments. Differences in strength across coefficients reflect the fact that the relationship between enrolment and distance is stronger for some UTCs than for others. However, our results are not sensitive to the exclusion of weak instruments.[xxii]

2. Validity of identifying assumptions: Ruling out pre-trends in outcomes.

The key identifying assumption of our method is that, for each UTC, conditional on other individual covariates, the interaction between a student's distance to the closest UTC and the post-opening status only affects student outcomes through its effects on the UTC enrolment probability and not through any other unobserved characteristic related to education outcomes. In other words, unobserved characteristics of students are allowed to vary with distance so long as such differences are constant over time (within each UTC).[xxiii] This assumption would be violated if, for example, parents were to selectively move closer to a UTC in the years after its opening based on unobservable characteristics. This is unlikely given that UTCs are not oversubscribed and all students, regardless of their address, are eligible to enrol without parents having to strategically move closer to fall within a catchment area. More generally, UTCs were new schools that had only opened recently and with no established reputation, leaving little time or incentive for parents to undertake the time-consuming business of relocating strategically.[xxiv]

Another concern might be the presence of distance-related trends in education outcomes specific to the areas where the UTC opened. To allay all these concerns, we test whether in the years before the local UTC opened there were significant trends over time in how distance was associated with relevant outcomes. To do so, we estimate a reduced form event-study regression similar to our first stage specification in (2) except that we include lagged indicators for each pre-opening year and lead indicators for each post-opening period.[xxv] The estimated coefficients, plotted in Figures 5 and 6 (for year 10 and year 12 entrants), clearly show a lack of distance-related trend in the years prior to UTC opening, supporting the validity of our research design.

Finally, it is worth stressing that, since our identification procedure does not leverage the staggered opening of UTCs across areas over time, it is exempt from the concerns raised by the recent literature on staggered-DiD (Athey and Imbens 2022; de Chaisemartin and D'Haultfoeuille 2020; Goodman-Bacon 2021; Sun and Abraham 2021). To clarify this point, our identification procedure is equivalent to considering each UTC group separately (i.e. students living within reach of a given UTC) thereby comparing the difference in outcomes as students live further away, before and after that UTC opened. The fully-interacted 2SLS estimator effectively aggregates these UTC-specific effects into an overall average effect. At no point, do we compare students across UTC areas, thus avoiding the 'forbidden comparisons' that emerge in staggered designs (Goodman-Bacon 2021).

V. Results

We present the main estimates of the effect of UTC enrolment on educational outcomes for those entering UTCs at two different points: those entering in Year 10 at age 14, for whom results at the end of Year 11 (GCSEs) are relevant[xxvi] , and those entering in Year 12 at age 16, for whom results at the end of Year 13 are relevant. For the latter group, we also consider higher education and early labour market outcomes for all but the most recent cohort.

A. The Effect of UTCs on Year 10 Entrants

Table 2 reports the OLS and 2SLS estimation results for the main outcomes students are expected to achieve in the national examinations at age 16 (GCSEs), namely whether the student achieved at least 5 "good grades" at GCSE (which corresponds to "Level 2+" in the English system), a "good grade" in English (i.e. Level 2+), maths and science respectively, and whether the student achieves at least two good grades in science subjects. The latter is particularly relevant for UTCs given their specialization in STEM subjects. We find that enrolling in a UTC has a sizeable negative effect on the probability of achieving all these outcomes.

Enrolling in a UTC makes students 19 percentage points less likely to get 5 or more 'good GCSEs'. This large negative effect is two-thirds of the achievement gap between disadvantaged and non-disadvantaged students in England (30 percentage points).[xxvii] Looking at achievement in maths and English separately, we find that enrolling in a UTC reduces students' probability of getting a good grade in English by 19 percentage points and in maths by 15 percentage points. The magnitude of these effects is larger than the raw differences we observe between UTC and non-UTC students (presented in column 2) and the OLS regressions with controls (column 3). These results suggest that UTCs are very bad at preparing students for academic subjects, which is worrying as poor performance at GCSE has damaging consequences for students' educational progression and for their labour market prospects

(Machin, McNally and Ruiz-Valenzuela 2020). There is a strong expectation by policy makers that students should attain a good grade in English and maths. Since 2015, students who fail to get these grades (A*-C) are obliged to repeat maths and English the following year. Machin, McNally and Ruiz-Valenzuela (2020) show that even narrowly missing a grade C in GCSE English can reduce the probability of enrolling in upper secondary education by 9 percentage points and the probability of enrolling in tertiary education by 4 percentage points. Even though UTCs specialise in STEM subjects, the 2SLS results in column (3) suggest that UTCs are equally bad at enabling students to succeed in Science compared to GCSEs more generally.

B. *The Effect of UTCs on Year 12 Entrants*

Most individuals pursue post-compulsory education for two years beginning at age 16 (in Year 12). They face a variety of options in that year. As discussed in Section II, students who pursue an academic education will often only pursue A-levels whereas students on a vocational trajectory will pursue either vocational qualifications (of which there are many) or a combination of A-levels and vocational qualifications.

In Table 3 we consider the effect of entering a UTC to pursue post-compulsory education on the following outcomes: whether they enter at least one A-level; whether they achieve an A-level; whether they enter at least one vocational qualification at Level 3 (i.e. the same level as A-levels) and whether they achieve a vocational Level 3 qualification; whether they enter any STEM qualification (i.e. science, technology, engineering or maths) and whether they achieve any STEM qualification; whether they start an apprenticeship.[xxviii]

With regard to academic qualifications, we find that UTCs have no effect on students' probability of entering at least one A-level and a negative effect on their probability of achieving at least one. This suggests that UTCs are not good at preparing students to pass these demanding qualifications.[xxix]

Moving to vocational qualifications, we find a positive effect of UTCs: UTC students are 29 percentage points more likely to enter Level 3 vocational qualifications, and 31 percentage points more likely to achieve these qualifications. The slightly larger coefficient on achievement than on enrolment suggests that the effect of UTCs on achieving Level 3 vocational qualifications is driven both by encouraging more students to enter for these qualifications and enabling them to succeed conditional on entry. Overall, these findings show that UTCs successfully meet their objective of encouraging students to pursue vocational education at an advanced level.

Students attending UTCs become much more likely to enrol in high-level STEM courses. Specifically, students are 35 percentage points more likely to enter any type of Level 3 STEM course. The effect on achievement is in the same ballpark (though a little lower) at 31 percentage points. This suggests that UTCs do very well at encouraging students to enrol in STEMs courses, but do not boost achievement conditional on enrolment (i.e. they are not necessarily better at teaching such subjects than other types of institution).

UTCs aim to prepare students for the world of work rather than only for skills that can be tested in exams. Even though the OLS estimate (in column 2) suggests a positive correlation between attending at UTC and the probability of starting an apprenticeship, this goes to zero in the 2SLS specification (column 3). Hence the OLS estimate (when conditioning on controls) just shows positive selection into apprenticeships.

Overall, the effects of UTCs are fairly mixed on this range of outcomes. The effect seems to be more driven by what students do (advanced vocational as opposed to A-level qualifications; STEM qualifications) and less by how they do conditional on enrolment. There appears to be a trade-off between the successful achievement of advanced vocational qualifications and equivalent academic qualifications (A-levels), where there is some decline in the success rate for the latter. But the (negative) effect on academic qualifications is only half the absolute size of the effect on advanced vocational qualifications at the same level.

Table 4 shows results for post-18 outcomes for all but the most recent cohort (who are too young). In particular, we consider whether students are in some form of education at the age of 19 (one year after leaving school), whether they started a university degree and whether they started a university degree in Science Technology Engineering and Maths (STEM).

There is no effect on the probability of still being in education at age 19 or the probability of enrolling in a university degree. But there is a large positive effect on the probability of doing a STEM degree at university. UTC students are 7.4 percentage points more likely to enter university to do a degree in a STEM subject, a particularly interesting result given that STEM fields are associated with occupations that have higher earnings, and that STEM degrees are a driver of productivity and economic growth (e.g. Griliches 1992; Jones 1995; Peri, Shih and Sparber 2015). Of course, this effect might not sound so surprising given the large increase in students' likelihood of entering and achieving high-level STEM qualifications while in UTCs. A back-of-envelope calculation suggests that the latter mechanical effect may explain around 32% of UTC students' choice of STEM university subjects.[xxx] This suggests that UTCs develop students' tastes and interest for STEM subjects, above and beyond their effect on enrolment and achievement of STEM qualifications in upper secondary education.

C. The Effect of UTCs on labour market outcomes

1. Effect on short-term labour market outcomes.

Beyond their role in preparing students for Higher Education, post-16 institutions and UTCs are expected to equip non-university-bound students with the skills and attitudes needed for a successful early transition into the labour market. We therefore look at the effect of UTCs on students' labour market outcomes. We use three outcomes: whether students are employed for at least six months (sustained employment), whether students are not in education, training or employment (NEET) and, conditional on being employed (and not in education), their annual earnings at the age of 19.[xxxi] When we look into this, we find that students are 7.2 percentage points less likely to be NEET as a result of enrolling in a UTC in Year 12. This is a large drop compared to the counter-factual outcome of 18.3 percentage points. There is a corresponding increase in the probability of being in sustained employment, which increases by 9 percentage points. Attending a UTC increases earnings by about 28 per cent at this age (conditional on employment). This suggests that UTCs facilitate better technical skills and/or better matches between their students' and employers.

2. *Effect on longer-term labour market outcomes.*

The findings above paint an encouraging picture for the effectiveness of UTCs in improving the immediate labour market outcomes of students. Unfortunately, the limited horizon of our data means we are not able to directly observe the effect of UTC enrolment on longer term labour market outcomes. To address this limitation, we estimate the impact of enrolment on predicted longer-term labour market outcomes: we translate how the UTC effect on education outcomes is predicted to impact labour market later in life. We proceed in two steps. First, we consider the oldest cohort available in our data: students who took GCSEs in 2006/07 (expected to graduate from upper-secondary school in 2008/09) and use OLS to separately estimate the joint conditional associations between Key Stage 4 (Year 10) and Post-16 outcomes (Year 12), and three labour market outcomes of interest (measured at the age of 26). We focus on: (i) whether individuals experience positive pay; (ii) their log annual earnings; (iii) their cumulative earnings up to age 26.[xxxii] These associations are reported in Appendix Table A.1. Next, we multiply the coefficients of the associations with the main direct effects of UTCs from Table 2 and 3 to obtain an overall estimate of how UTC enrolment affects each of these three labour market outcomes. The results are reported in Table 5 separately for Year 10 and Year 12 enrolment (Panels A and B respectively). The estimated 2SLS effects for Year 10 and Year 12 entrants are similar in magnitude and of opposite sign (in column 3). The predicted effect on the probability of employment is positive for Year 12 entrants, increasing by 3.2 percentage points at age 26 (reducing it by 3.3 percentage points for Year 10 entrants). The predicted effect on log earnings (at age 26) or log cumulative earnings is similar. Those entering UTCs in Year 12 are predicted to have higher earnings by almost 10 percent by age 26, in contrast to those entering UTCs in Year 10 (where earnings are predicted to be lower by 8.4 percent).

Taken together, our results suggest that UTCs are completely ineffective for those entering as early as age 14 (which is out of line with when most of their peers move school) but effective for those entering at age 16. The latter is mainly driven by enrolment rather than achievement, meaning that UTCs drive students to make different choices (and perhaps make a better match with their interests and abilities). They are more likely to enrol in advanced vocational qualifications, particularly in STEM subjects. There is something of a trade-off with achievement in A-levels because the achievement rate reduces for these academic qualifications. But enrolment in higher education is the same irrespective of attending a UTC. This suggests that, in this respect, the cost of failing to achieve an A-level is compensated by success in obtaining advanced vocational qualifications that favour progression to higher education, particularly to STEM degrees. The positive effects of attending a UTC (for Year 12 entrants) are also manifest in labour market outcomes at a young age. There is a higher probability of being in 'sustained employment' and having higher earnings and a lower probably of being classified as 'not in education, employment or training'. Together these results suggest that entering UTCs at an appropriate age enables students to match their interests and abilities with what UTCs have to offer, and this has a material impact on later educational and labour market outcomes. This is in line with a rich literature that shows positive returns to vocational education (Kreisman and Stange 2020).

VI. Robustness Checks

A. Potential differences in effectiveness across UTCs.

The analysis has so far focused on the overall effectiveness of UTCs as a novel approach to combining general and technical education within secondary education. In this respect, the Local Average Treatment Effect (LATE) identified by the model in equation (2) represents the main parameter of interest, as it captures how complier students (i.e. students who enroll in UTC as a result of the change in the instruments) benefit from participation in this new programme. At the same time, UTCs are a group of autonomous schools with different specialisms and operating across different socio-geographic contexts. As such, it may well be that average effects across UTCs mask differences across schools in the direction of the effects. To study potential heterogeneity across UTCs, we estimate the simpler regression in equation (1) separately for each UTC area, with $\hat{\beta}$ identifying the LATE of enrolling in the local UTC. As we know already from Figure 4, not all UTCs have a high enough first stage, depending on the local strength of the enrolment-distance relationship. Accordingly, we restrict our analysis only to UTCs whose first stage effective F statistic exceeds 10.[xxxiii] The main estimates for each relevant UTC are plotted in Figure A.1 and A.2 for Year 10 and Year 12 entrants respectively. Overall, there is no significant heterogeneity across UTCs. For Year 10, point estimates tend to be mostly negative across the five outcomes considered, with a single UTC showing a significantly positive effect in Level 2 maths and Level 2 science. For Year 12, point estimates are also largely in line with the main average effect from Table 3, with no UTC showing a clear effect in the opposite direction. This confirms that our findings reflect the general characteristics of the programme and are not the result of other potential sources of variation between these new schools.

B. Alternative sample restrictions and instrument definition

Finally, we briefly discuss the robustness of our main results to alternative sample restrictions and measures. Our only sample restriction consists of excluding students whose closest UTC is further than the 90th percentile of UTC students' home-to-school distance (~23 km). We probe the sensitivity of this choice by using the 85th and 95th percentiles as alternative cutoffs. Columns (2) and (3) in Table A.2 report the alternative estimates alongside the main ones. All the results are quantitively very similar, which is unsurprising as at such far distance from the closest UTC the estimates will not be relying on many fewer (or more) marginal students as we use a closer (further) cutoff.

Next, we show that our estimates are robust to the exclusion of those UTCs that have a weak individual first stage (F statistic below 10). Estimates reported in column (4) are extremely similar, which is to be expected because the excluded UTC will weigh very little in the main specification (as discussed, the UTC-specific weights are proportional to the strength of the underlying first stage).

Finally, in column (5) we test an alternative specification whereby we measure students' proximity to UTCs using driving distance, with the results being comparable to the main specification.

VII. Understanding the effect of UTC enrolment

The negative effects of UTCs for students entering in Year 10 might at first glance seem puzzling, given their relatively good performance for students entering in Year 12. This section sheds light on the origins of the performance gap between Year 10 and Year 12, looking at the role played by student intake quality. As UTCs are all new schools, we also investigate how much of the (under-) performance is driven by a potentially steep learning curve from principals and teachers during the first years of opening, and whether the quality of the fallback schools influences UTC performance.

A. Explaining Differences in UTCs Performance for Year 10 and Year 12 students

Our analysis shows a striking difference in UTC performance for cohorts of students entering in lower secondary school (i.e. at age 14 in Year 10) compared to those entering for post-compulsory education (i.e. at age 16 in Year 12). What can explain such differences given that Year 10 and 12 entrants share the same school-leadership, facilities, and school-values?

1. School Switching and Exam Preparation Time.

A first potential explanation is that Year 10 entrants are penalised by changing school at an atypical transition point in English secondary education.[xxxiv] Students usually study in the same secondary school until they take GCSEs at the age of 16; over the years this has resulted in schools spending more time in teaching the GCSE curriculum in order to improve students' (and schools') performance in these exams.[xxxv] Changing school between Year 9 and Year 10 may therefore disrupt students' preparation for GCSE exams and may not leave UTCs sufficient time (compared to other schools) to teach the curriculum in as much detail. For Year 12 entrants, this risk does not exist as UTCs spend as much time as other institutions in teaching students for age 18 exams (two years). While this explanation may play some role in explaining the difference in outcomes arising from entry to a UTC in Year 10 compared to Year 12, there are other potential explanations (some of which would compound this effect).

2. Differences in the Composition of Incoming Students

A potential explanation is that Year 10 and Year 12 UTC students are different in terms of their individual characteristics, such as prior achievement, socio-economic disadvantage or gender; if the effect of enrolling in a UTC is heterogeneous along any characteristics that differ between these two groups, the differences in UTC performance for these groups might be attributable to this. As reported in Table 1, UTC Year 12 entrants have higher prior-attainment at age 11 than Year 10 entrants and are less-likely to come from a disadvantaged background. To investigate whether these differences can explain differences in UTC performance, we proceed in two steps.

First, we show that UTC performance is partly heterogenous with respect to certain students' characteristics such as their gender and prior attainment in English and maths. We test this by adding an interaction term between UTC enrolment and the individual characteristic to Equation (1). Both UTC enrolment and its interactions are instrumented in the same way as in Equation (2). Table 6 reports the coefficient on the interaction term and shows that, for most GCSE outcomes considered, UTCs are no more effective for students with high prior attainment in maths than for students with low prior attainment. There is a suggestion that those with higher prior attainment in English might have performed better in GCSEs (but this is only statistically significant for science).

A similar exercise for gender does not reveal much heterogeneity along this dimension either – with the exception of two outcomes that are statistically significant. This suggests that UTCs are worse for male achievement in English GCSE scores (for Year 10 entrants) and better for males entering in Year 12 for starting an apprenticeship. This is consistent with UTC reinforcing comparative advantage, as previous research has shown that males are at a disadvantage in English but more likely to enter an apprenticeship (Cavaglia et al. 2020). Furthermore, UTCs (with their STEM specialism) are likely to equip students with the skill set most suited to apprenticeships in sectors like Engineering which have been shown to be very popular with boys but not for girls (Cavaglia, McNally and Ventura 2020). This aligns with a broader literature suggesting that differential sorting by males and females within vocational education is important for opportunities and returns (e.g. Bonilla 2020; Brunner, Dougherty and Ross 2023; Ecton and Dougherty 2023).

Second, we show that compliers have different characteristics in Year 10 and Year 12. Although we do not know who the compliers are, we can estimate their average characteristics using Equation (2) in which we replace the dependent variable (Y_i) by an interaction term between student i's characteristic and an indicator for whether he/she is enrolled in a UTC in Year 10 or Year 12 (C_iD_i).[xxxvi] The right-hand side is the same as in Equation (2) except that the vector of control variables X_i excludes the characteristic on the left-hand side. Using the same first stage as in Equation (2), β will identify the average of X among compliers enrolled in a UTC.

$$C_iD_i = \alpha + \beta D_i + \gamma Z_i + \eta Open_i + \delta' X_i + \sum_{j=1}^{J} \theta_j (U_j \times \mathbb{P}_i) + \varepsilon_i \qquad (3)$$

Table 7 reports the estimates for Year 10 and Year 12 students and the difference between both. Year 10 entrants are 13 percentage points more likely to be eligible for free school meals than Year 12 entrants. There are also differences in terms of prior attainment in national tests at age 11 (called KS2): Year 12 entrants are 0.092 SD better in maths and 0.045 SD better in English than Year 10 entrants. Also, Year 12 entrants are more likely to be male than Year 10 entrants (with a difference of 22 percentage points).

These intake differences raise an interesting question: How much better would UTC performance be for entrants in Year 10 if they had enrolled students with a similar profile to those who entered in Year 12? To answer this question, we make a back-of-the-envelope calculation of UTC performance for Year 10 entrants if they had the same characteristics as Year 12 entrants, in terms of maths achievement (age 11), English achievement (age 11) and gender, holding all other things equal (panels A to C respectively in Table 8).[xxxvii] The last row of each panel in Table 8 reports the counterfactual UTC effect in which we equalise these characteristics in turn. This can be compared with the original UTC effect in the first row. But in general, the results are little different for maths or for English when undertaking this exercise. Had there been more enrolment of boys in Year 10, this exercise suggest that outcomes would have been even worse, especially for English achievement at GCSE (consistent with results reported in Table 6).

Overall, these results suggest that the intake characteristics of students are not sufficient to explain very much of the gap between the performance of UTCs for Year 10 and Year 12 entrants.

3. Differences in Quality of the Fallback Institutions between Y10 and Y12 entrants

Another potential explanation for the difference in UTC performance between the two entry points is that the quality of the fallback institution UTC students would have attended had they not enrolled in a UTC is different for the Year 12 and Year 10 intake. For Year 10 entrants, the fallback institution is observed as it would generally correspond to the school UTC students attended in Year 9 before switching. For Year 12 entrants, the fallback institution is not directly observed and could be either a school or an FE college. Our estimation of fallback institutions' quality thus needs to proceed in two slightly different ways. For Year 10, we follow the same approach as for the estimation of compliers' characteristics, where X_i (interacted on the left-hand side) denotes students' Year 9 school quality (Equation 3). For Year 12, we estimate the average quality of the institution compliers would have attended had they not enrolled in a UTC by estimating a version of Equation 3 where, this time, on the left-hand side we interact institutional quality (S_i) with an indicator for no UTC enrolment $(1 - D_i)$, taking care to replace the UTC enrolment indicator on the right-hand side with $(1 - D_i)$ which is instrumented in the same way. Under the same assumption as for equation (2), the 2SLS coefficient on $(1 - D_i)$ identifies the average quality of the institutions attended by compliers when they do not enrol in a UTC.

$$S_i(1 - D_i) = \alpha + \beta(1 - D_i) + \gamma Z_i + \eta Open_i + \delta' X_i + \sum_{j=1}^{J} \theta_j (U_j \times \mathbb{P}_i) + \varepsilon_i \qquad (4)$$

We focus on two measures of institutional quality. First, we look at the quality of the student intake in fallback institutions as described by the average prior attainment at the end of primary school (separately in English and maths). We can think of this as an indicator of (counterfactual) peer quality as well as an approximation of the institution quality (under sorting). Second, as a more direct measure of institutional quality we consider the official ratings attributed by the UK government School inspectorate (Ofsted). These are measured on a scale from 4 (Inadequate) to 1 (Outstanding).

The results are reported in Panel B of Table 7. The findings suggest that, if anything, Year 10 UTC students would have enrolled in institutions with worse quality than their Year 12 counterparts. Based on this, Year 10 compliers would be poised to benefit more which is not what we find in our main analysis, suggesting that differences in quality of fallback institutions can only play a limited role.

B. ***Changes in UTCs Performance Over Time***

All UTCs are brand new schools. During the first months and years of opening, teachers need to learn how to work together, principals learn how to manage their team, and teachers how to adjust their pedagogical methods to the level of their students. All these adaptation costs might be large, and negatively affect UTC performance in early years, particularly in their first year of opening.[xxxviii] If that is the case, we would expect UTCs to do (at least a little) better in the following years of being open. We test this hypothesis by comparing the effect of enrolling in a UTC opened in its first year compared to the same UTC opened in its second year. We can do this for the 15 UTCs that opened before 2014 and did not close down before their second year of operation.[xxxix] For this subset of UTCs, we estimate UTC-specific effects by opening year (first or second) by estimating Equation 1 on split samples where we only keep cohorts of students whose closest UTC was in its first (or second) year of operation (in addition to all the pre-opening cohorts). In Figure 7 and Figure 8, for each UTC, we plot the effect on a given outcome for students enrolled in the second vs. first year.[xl] This analysis shows that there is no consistent improvement in UTCs' performance from one year to the next: some UTCs perform much better, while other are stable or even worsen.

C. Understanding differences between OLS and 2SLS

Our 2SLS estimates of UTCs' value-added provide a local average treatment effect (LATE) for compliers among students. These estimates are often significantly different from their OLS equivalent. For Year 10, 2SLS estimate are systematically more negative than OLS estimates (though these are negative too). For Year 12, the picture is more mixed as the OLS estimates are more encouraging for academic outcomes (and starting an apprenticeship) but tend to be lower when it comes to achievement of advanced vocational and STEM qualifications. Under effect heterogeneity, these differences could be explained by the fact that compliers differ from the broader population of UTC students in terms of observed or unobserved characteristics. The analysis of compliers' characteristics and effect heterogeneity presented in Section XII.A appears to confirm this is the case.

Notably, Table 7 shows that among Year 10 entrants, compared to UTC students (see column 5 in Table 1), UTC compliers have lower KS2 test scores in math and English (-0.116 SD in maths and -0.182 in English). Lower prior attainment of compliers, along with the fact that low-achieving students benefit less from UTC enrolment (at least in English; see Table 6) can explain why 2SLS are more negative than the OLS estimates.[xli] Similarly, among Year 12 entrants, compliers have lower attainment in English and math compared to UTC students (-0.230 and -0.204 SD respectively) and are much more likely to be male (+21 pp). In Table 6 we can see that both these characteristics are positively associated with higher UTC value-added when it comes to academic outcomes and starting an apprenticeship but not for advanced vocational or STEM qualifications where the correlation goes in the other direction. This may explain why OLS and 2SLS estimates differ across the education outcomes considered.

VIII. Conclusion

With the aim to offer new evidence involving significant reforms to vocational and technical education, this paper studies the arrival of a new type of hybrid school institution, the University Technical College, to England's education landscape. Their initial introduction began in 2010, followed by their setup nationwide. The aims of UTCs are to 'integrate technical, practical and academic learning and create an environment where students can thrive and develop the abilities that industry needs' (Long and Bolton 2017). Interestingly, there are two different entry points for UTCs: age 14, which is an uncommon transition time during secondary school, and age 16, after the end of compulsory education in England, a much more conventional transition time for pupils in the schooling system.

There are striking differences in UTC performance for these two entry points. For students who enter at the non-conventional transition age 14, UTCs have a large detrimental effect on the probability of reaching an acceptable level of English and maths two years later in GCSEs national exams. These results are of great concern because performance at GCSE is crucial not only to continue academic studies, but also for progression within technical education and for the youth labour market (see Machin, McNally and Ruiz-Valenzuela 2020).

For students who enter at the more conventional transition age 16, the results reveal a more positive story. Although UTCs lead to some deterioration in academic achievement at upper secondary level (A-levels), this is far out-weighed by an improvement in vocational qualifications at the same level. UTCs do not influence the probability of going on to university, but they strongly influence the probability of undertaking a STEM degree, an outcome which has been shown to be associated both with higher earnings and with improved productivity and economic growth (see for example, e.g. Kinsler and Pavan 2015; Peri, Shih and Sparber 2015).

With regard to early labour market outcomes (at age 19), UTCs reduce the probability of being 'not in education, employment or training' (NEET), which is important, as youth unemployment has been shown to put people at a high risk of wage scarring effects and crime participation (Gregg and Tominey 2005; Bell, Bindler and Machin 2018). The effect is large relative to the baseline. There is a corresponding increase in the probability of being in sustained employment, which increases by 9 percentage points. There is also a high earnings' return that this stage, for those in employment. Although the limited time horizon of the data means we cannot directly observe the effect of UTC enrolment on longer term labour market outcomes, we estimate the effect on predicted longer-term labour market outcomes (at age 26). This suggests a positive effect on cumulative earnings (of around 10 per cent) of enrolling at age 16 and a negative effect (of similar magnitude) of enrolling at age 14.

Although we explore several mechanisms behind these results, the most plausible reason for the negative results at age 14 is that taking young students away from school (and their peers) to prepare for general exams in new, more specialist, institutions is too demanding for them and their teachers. Even if they improve employability-related skills not tested in these exams (or picked up in our outcome measures), failing to do well in the national exams at age 16 has serious consequences both for educational and labour market outcomes (e.g. as shown by Machin, McNally and Ruiz-Valenzuela 2020). In contrast, the positive results from entering these institutions at a later stage (age 16), a more natural time in the context of the English education system, produces very positive results for compliers. This likely reflects students being able to match their interests and abilities with what these educational institutions have to offer. Our results suggest a material payoff in the labour market.

The results showing promise and disappointment in what the technical education offered by these new forms of hybrid schools has delivered to date are germane for other countries that either have or seek to establish similar institutions. They show the potential trade-off between achievement in vocational and academic achievement when students attend these institutions too early (i.e. out of line with the rest of the cohort and at a time where everyone needs to prepare for challenging national exams at age 16). Such a trade-off is less marked at a later stage, where it is greatly outweighed by facilitating a better match for students in terms of skills and abilities. This has consequences in terms of later educational progression and labour market outcomes.

The relevance of the UTC experience is especially pertinent for countries that have not delivered well on vocational and technical education, and on their balance with general education. One notable example is the US Career and Technical high schools that share several important common features with the UTC model. They combine technical and general education, and many focus on STEM and high-demand skills, and partner with local companies and universities. Pinning down the sources of success and failure of the UTC model is therefore of first-order importance for the development of effective vocational and technical education in other countries in the coming years. Finally, and to conclude, we anticipate there being much more research about the kind of vocational education on offer at the schools considered in this paper, commensurate with the widespread recognition that provision of quality vocational and technical education is essential for skill development required in contemporary labour markets around the world.

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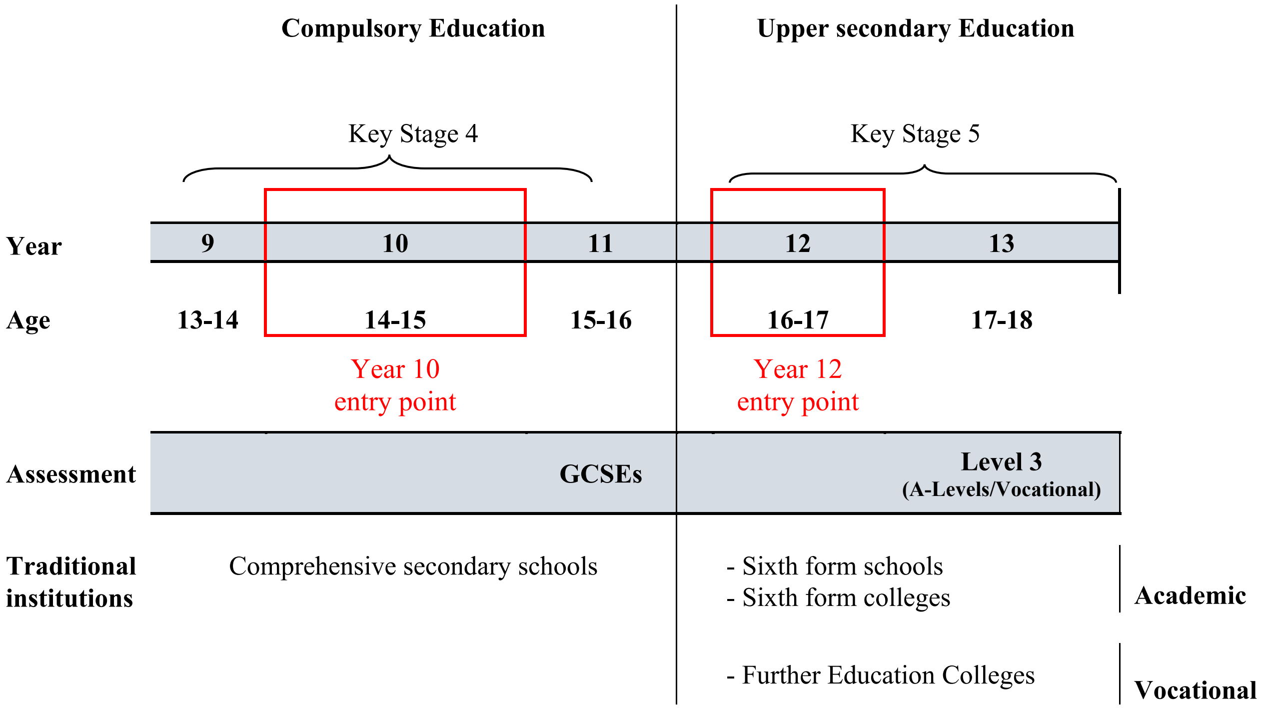

Figure 1
The English Secondary Education System
Notes: This figure describes the English education system between Year 9 and Year 13 (age 14 to 18). The two UTC entry point in Years 10 and 12 are marked in red.

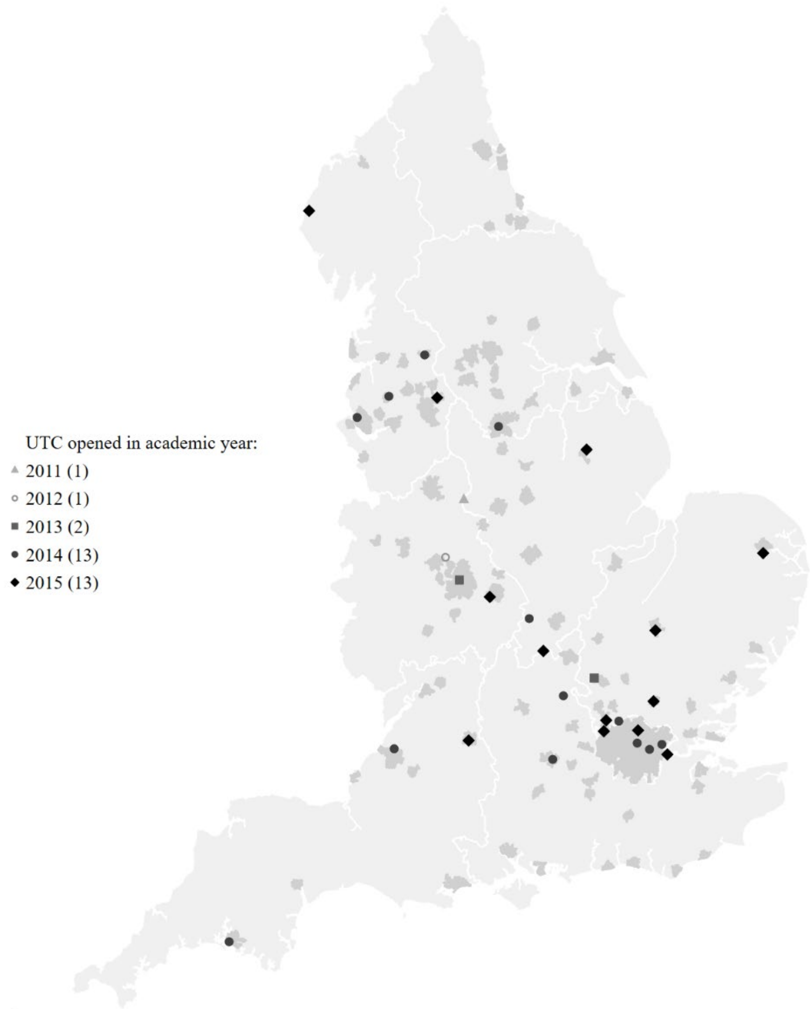

Figure 2

Location of UTCs in England by Year of Opening

Notes: This figure shows the locations of the UTCs that opened between academic year 2010/11 and 2014/15 alongside England's main population centres.

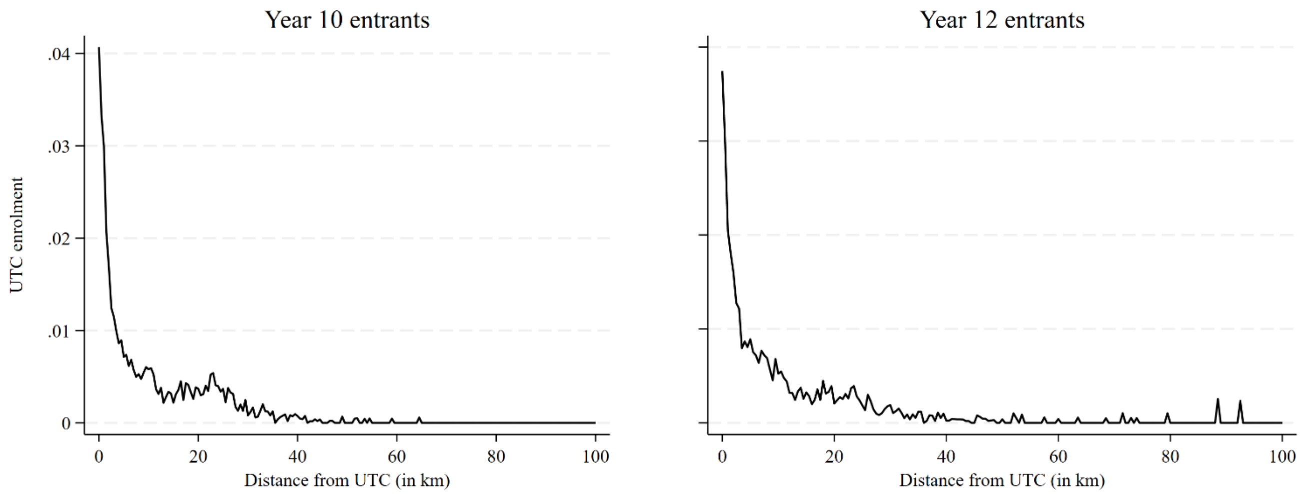

Figure 3

Relationship between probability of enrolment and distance to closest UTC

Notes: These graphs show the relationship between distance (in km) from the local UTC and the probability of enrolling in a UTC for both Year 10 and Year 12 entrants.

Table 1

Descriptive statistics

	Population	Analytical sample		Weighted analytical sample	
		Non-UTC students	UTC students	Non-UTC students	UTC students
	(1)	(2)	(3)	(4)	(5)
A. Year 10					
Enrolled in UTC	0.001	.	.	.	.
Male	0.511	0.51	0.77	0.51	0.559
White British	0.809	0.724	0.714	0.724	0.717
English as first language	0.873	0.815	0.914	0.815	0.854
Free school meal (in Year 10)	0.15	0.174	0.15	0.174	0.17
Maths Key Stage 2 score (std)	-0.015	-0.01	-0.02	-0.01	-0.01
English Key Stage 2 score (std)	-0.016	-0.011	-0.199	-0.011	-0.075
Distance from UTC (in km)	32.3	10.8	7.9	10.8	7.5
Observations	4,583,034	2,372,766	3,603	2,372,766	3,603
B. Year 12					
Enrolled in UTC	0.001	.	.	.	.
Male	0.505	0.503	0.806	0.504	0.549
White British	0.815	0.731	0.695	0.731	0.732
English as first language	0.883	0.829	0.9	0.829	0.869
Free school meal (in Year 11)	0.115	0.137	0.11	0.137	0.116
Maths Key Stage 2 score	0.022	0.021	0.203	0.022	0.078
English Key Stage 2 score	0.023	0.023	-0.097	0.023	-0.027
Distance from UTC (in km)	32.7	10.9	8.0	10.9	7.9
Observations	4,378,340	2,221,166	3,145	2,221,166	3,145

Note: This table reports descriptive statistics for students enrolled in Year 10 and Year 12 between academic years 2007/08 and 2014/15. Column (1) refers to the population of students in state-funded schools in England. Columns (2) and (3) refer to non-UTC and UTC students in the analytical sample defined as the set of students living within the 90th percentile of the overall home-to-UTC distance distribution for those attending UTCs (~23 km). In columns (4) and (5), observations are weighted by the inverse of the propensity score. Key Stage 2 scores are the standardised tests taken by students at the end of primary school (Year 6) and are standardised within cohort to have mean 0 and standard deviation 1.

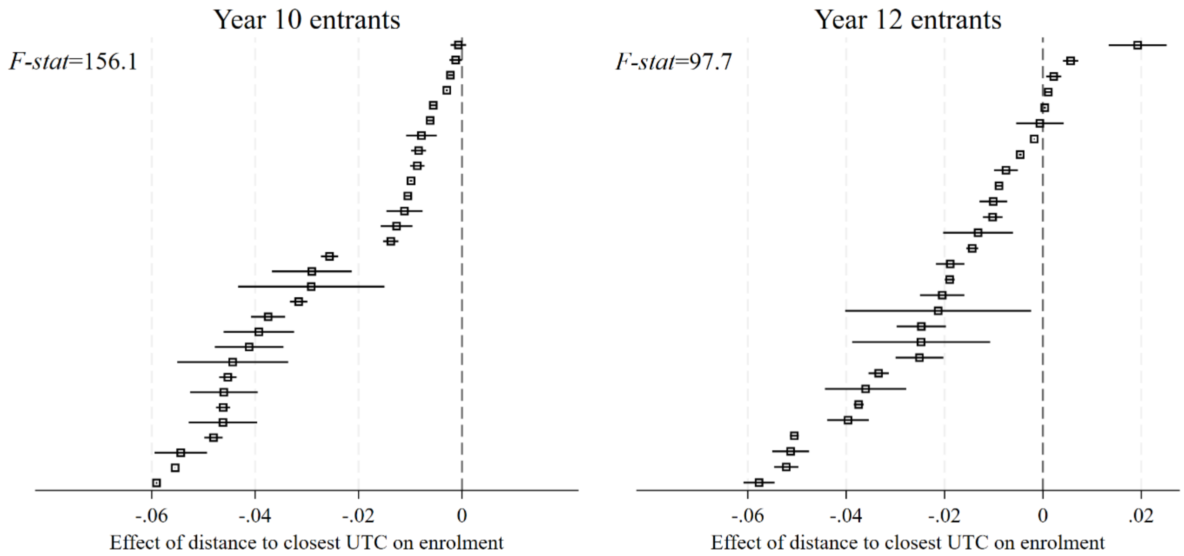

Figure 4
First stage coefficients

Notes: These figures present the results for the first stages. We regress an indicator for UTC enrolment on a set of interactions between distance-by-opening status and UTC group indicators while also controlling for distance-by-UTC indicators, opening status-by-UTC and controls for gender, ethnicity, whether eligible for free school meals, whether English is spoken as a first language and prior attainment in English and math at age 11 (all themselves interacted with UTC indicators). The regression for Year 12 students also controls for GCSE test scores (interacted with UTC indicators). The graphs plot the coefficients on the excluded instruments, i.e., the coefficient of the distance-by-opening variable interacted with each UTC group, alongside Montiel and Pflueger (2013) 'effective' F-stat for weak instruments. Coefficients are sorted by increasing magnitude alongside the corresponding 95% confidence intervals with each coefficient referring to a specific UTC. The left panel plots coefficients for Year 10 students, while the right panel plots coefficients for Year 12 students.

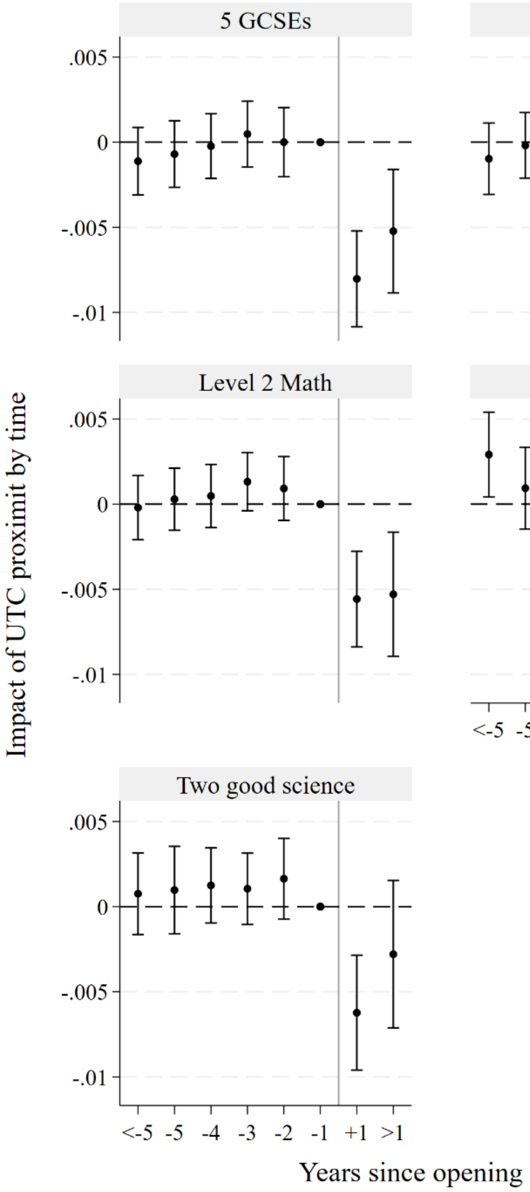

Figure 5
Pre-trend Tests for Year 10 Entrants

Notes: This figure tests whether, in the years before the local UTC opened, there were significant trends over time in how distance was associated with relevant outcomes. To do so, we estimate a reduced form event-study regression similar to our first stage specification in (2) except that we include lagged indicators for each pre-opening year and leads for post-opening years. We regress each of the five outcomes on interactions between distance and opening time indicators while also controlling for distance-by-UTC indicators, opening status-by-UTC and controls for gender, ethnicity, whether eligible for free school meals, whether English is spoken as a first language and prior attainment in English and maths at age 11 (all themselves interacted with UTC indicators). The graph plots the coefficients on the interactions between distance and opening time indicators, alongside the corresponding 95% confidence intervals. To facilitate the interpretation of these reduced form effects vis-à-vis the 2SLS estimates in Table 2, we reverse the sign so that the coefficient can be interpreted as the differential effect on outcome probabilities of living 1km closer to a UTC between t and the year before the local UTC opened.

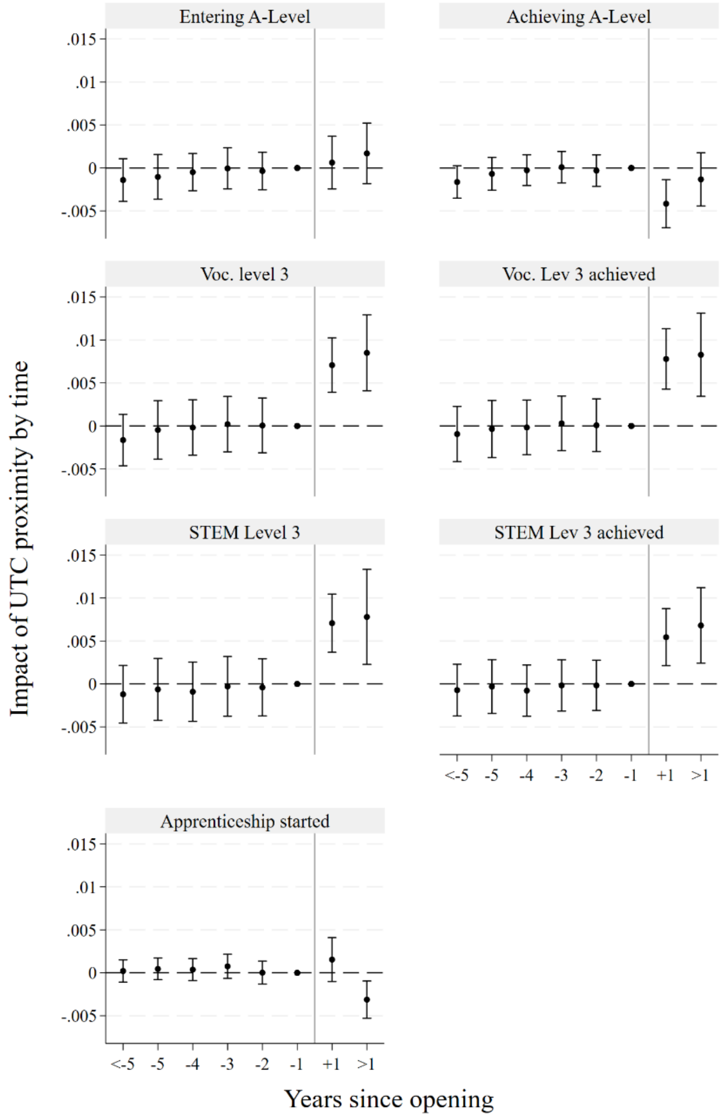

Figure 6
Pre-trend Tests for Year 12 Entrants

Notes: This figure tests whether, in the years before the local UTC opened, there were significant trends over time in how distance was associated with relevant outcomes. To do so, we estimate a reduced form event-study regression similar to our first stage specification in (2) except that we include lagged indicators for each pre-opening year and leads for post-opening years. We regress each of the five outcomes on interactions between distance and opening time indicators while also controlling for distance-by-UTC indicators, opening status-by-UTC and controls for gender, ethnicity, whether eligible for free school meals, whether English is spoken as a first language, prior attainment in English and maths at age 11 and GCSEs total score (all themselves interacted with UTC indicators). The graph plots the coefficients on the interactions between distance and opening time indicators, alongside the corresponding 95% confidence intervals. To facilitate the interpretation of these reduced form effects vis-à-vis the 2SLS estimates in Table 3, we reverse the sign so that the coefficient can be interpreted as the differential effect on outcome probabilities of living 1km closer to a UTC between t and the year before the local UTC opened.

Table 2

Effect of UTC enrolment for Year 10 entrants (age 14) on Key Stage 4 outcomes (age 16)

	Raw OLS	OLS w/ controls	2SLS	Counterfactual outcome
	(1)	(2)	(3)	(4)
Achieved Five GCSEs	-0.105***	-0.156***	-0.193***	0.535
	(0.025)	(0.020)	(0.032)	
Achieved Level 2 in English	-0.123***	-0.136***	-0.193***	0.597
	(0.026)	(0.022)	(0.036)	
Achieved Level 2 in Maths	-0.05	-0.077***	-0.150***	0.595
	(0.026)	(0.017)	(0.027)	
Achieved Level 2 in Science	0.049	-0.063*	-0.147***	0.554
	(0.032)	(0.025)	(0.039)	
Achieved 2 "good" science GCSEs	-0.130***	-0.128***	-0.196***	0.506
	(0.029)	(0.027)	(0.032)	
Effective F-stat			156.1	
Observations	2,327,281	2,327,281	2,327,281	2,327,281

Notes: This table reports coefficients of the effect of UTC enrolment for Year 10 entrants. Column (1), (2), and (3) report OLS and 2SLS estimates of the effect of enrolling in a UTC in Year 10 on Key Stage 4 outcomes (end of secondary school examinations). Each cell reports the coefficient from a separate regression. In column (2), control variables include gender, ethnicity, English as first language, eligibility to free meals at school, standardised end-of-primary school English and maths test scores, all interacted with UTC-group indicators as well as interactions between post-opening status and UTC indicators. In column (3), we use the fully-UTC-interacted 2SLS estimator from equation (2) where we instrument UTC enrolment with interactions between distance-by-post-opening status and UTC indicators, while also for controlling for distance interacted with UTC indicators (as well as all the controls in column 2). Finally, in column (4) we report marginal students' average counterfactual outcome when not enrolled in a UTC. This is estimated using a version of the 2SLS estimator from column (3) where the left-hand side is an interaction between the given education outcome and an indicator for not being enrolled in a UTC. All specifications are weighted using inverse propensity score weighting. The table also reports the 'effective' F-stat by Montiel and Pflueger (2013). Standard errors are clustered at the UTC-by-cohort level. Significance level: * p<0.050, ** p< 0.010, *** p<0.001.

Table 3

Effect of UTC enrolment for Year 12 entrants (age 16) on Post-16 outcomes

	Raw OLS (1)	OLS w/ controls (2)	2SLS (3)	Counterfactual outcome (4)
Academic qualifications (Level 3)				
Entered at least one A-Level	0.151***	0.119***	0.027	0.435
	(0.029)	(0.025)	(0.036)	
Achieved at least one A-Level	0.024	-0.035	-0.121***	0.388
	(0.034)	(0.021)	(0.030)	
Vocational qualifications (Level 3)				
Entered a qualification	0.207***	0.219***	0.294***	0.480
	(0.029)	(0.022)	(0.039)	
Achieved a qualification	0.229***	0.226***	0.306***	0.386
	(0.027)	(0.024)	(0.042)	
STEM qualification (Level 3)				
Entered a qualification	0.242***	0.287***	0.348***	0.334
	(0.054)	(0.026)	(0.036)	
Achieved a qualification	0.208***	0.245***	0.309***	0.262
	(0.050)	(0.027)	(0.032)	
Started an apprenticeship	-0.028	0.035**	-0.004	0.171
	(0.019)	(0.012)	(0.031)	
Effective F-stat			97.7	
Observations	2,191,942	2,191,942	2,191,942	2,191,942

Notes: This table reports coefficients of the effect of UTC enrolment for Year 12 entrants. Column (1), (2), and (3) report OLS and 2SLS estimates of the effect of enrolling in a UTC in Year 12 on Post-16 education outcomes. Each cell reports the coefficient from a separate regression. In column (2), control variables include gender, ethnicity, English as first language, eligibility to free meals at school, standardised end-of-primary school English and maths test scores and the Key Stage 4 points score, all interacted with UTC-group indicators as well as interactions between post-opening status and UTC indicators. In column (3), we use the fully-UTC-interacted 2SLS estimator from equation (2) where we instrument UTC enrolment with interactions between distance-by-post-opening status and UTC indicators, while also for controlling for distance interacted with UTC indicators (as well as all the controls in column 2). Finally, in column (4) we report marginal students' average counterfactual outcome when not enrolled in a UTC. This is estimated using a version of the 2SLS estimator from column (3) where the left-hand side is an interaction between the given education outcome and an indicator for not being enrolled in a UTC. All specifications are weighted using inverse propensity score weighting. The table also reports the 'effective' F-stat by Montiel and Pflueger (2013). Standard errors are clustered at the UTC-by-cohort level. Significance level: * p<0.050, ** p< 0.010, *** p<0.001.

Table 4

Effect of UTC enrolment on Post-18 outcomes for Year 12 entrants (age 16)

	Raw OLS	OLS w/ controls	2SLS	Counterfactual outcome
	(1)	(2)	(3)	(4)
A. Education outcomes (age 19)				
In education at age 19	-0.126*	0.032	0.022	0.461
	(0.057)	(0.022)	(0.038)	
Started university degree	-0.066*	-0.056***	0.005	0.137
	(0.028)	(0.011)	(0.030)	
Started a STEM university degree	0.025	0.036**	0.074**	0.027
	(0.015)	(0.013)	(0.024)	
B. Labour market outcomes (age 19)				
In sustained employment	0.160***	0.058***	0.090**	0.593
	(0.017)	(0.013)	(0.030)	
Not in education, training or employment (NEET)	-0.016	-0.025*	-0.072**	0.183
	(0.022)	(0.012)	(0.024)	
Log pay (if employed)	-0.006	0.068	0.279*	6,810
	(0.074)	(0.057)	(0.120)	
Effective F-stat			75.1	
Observations	269,650	269,650	269,650	269,650

Notes: This table reports coefficients of the effect of UTC enrolment on post-18 education and labour market outcomes for Year 12 entrants (measured one year after the end of upper-secondary education when students are 19). Regressions in this table are estimated omitting students whose closest UTC opened in the last wave we consider (opening in September 2014), as for them we cannot observe outcomes at age 19 due to data limitations. Column (1), (2), and (3) report OLS and 2SLS estimates of the effect of enrolling in a UTC in Year 12 on Post-16 education outcomes. Each cell reports the coefficient from a separate regression. In column (2), control variables include gender, ethnicity, English as first language, eligibility to free meals at school, standardised end-of-primary school English and maths test scores and the Key Stage 4 points score, all interacted with UTC-group indicators as well as interactions between post-opening status and UTC indicators. In column (3), we use the fully-UTC-interacted 2SLS estimator from equation (2) where we instrument UTC enrolment with interactions between distance-by-post-opening status and UTC indicators, while also for controlling for distance interacted with UTC indicators (as well as all the controls in column 2). Finally, in column (4) we report marginal students' average counterfactual outcome when not enrolled in a UTC. This is estimated using a version of the 2SLS estimator from column (3) where the left-hand side is an interaction between the given education outcome and an indicator for not being enrolled in a UTC. All specifications are weighted using inverse propensity score weighting. The table also reports the 'effective' F-stat by Montiel and Pflueger (2013). Standard errors are clustered at the UTC-by-cohort level. Significance level: * p<0.050, ** p< 0.010, *** p<0.001.

Table 5

Effect of UTC enrolment on predicted labour market outcomes

	Raw OLS	OLS w/ controls	2SLS	Counterfactual outcome
	(1)	(2)	(3)	(4)
A. Year 10 entrants				
Positive pay (age 26)	-0.015***	-0.022***	-0.033***	0.750
	(0.004)	(0.003)	(0.006)	
Log pay (age 26)	-0.035**	-0.054***	-0.084***	12,185£
	(0.011)	(0.009)	(0.014)	
Log lifetime pay (by age 26)	-0.060***	-0.074***	-0.105***	40,149£
	(0.013)	(0.010)	(0.017)	
Observations	2,327,281	2,327,281	2,327,281	2,327,281
B. Year 12 entrants				
Positive pay (age 26)	0.031***	0.031***	0.032***	0.752
	(0.004)	(0.003)	(0.005)	
Log pay (age 26)	0.082***	0.089***	0.099***	11,812£
	(0.012)	(0.007)	(0.011)	
Log lifetime pay (by age 26)	0.069***	0.090***	0.073***	42,262£
	(0.015)	(0.010)	(0.019)	
Observations	2,191,942	2,191,942	2,191,942	2,191,942

Notes: This table reports coefficients of the effect of UTC enrolment on predicted longer-term labour market outcomes for Year 10 and Year 12 entrants. Column (1), (2), and (3) report OLS and 2SLS estimates of the effect of enrolling in a UTC in Year 10 (resp. Year 12) on predicted labour market outcomes. For year 10, predicted outcomes are derived by taking the inner product between the estimated effects of UTC enrolment on each of the Key Stage 4 outcomes (column 3 in Table 2) and the conditional associations between these education outcomes and the labour market of interest (reported in Appendix Table A.1). We exclude "achieving 2 good science GCESs" from the analysis as this outcome cannot be defined consistently for the 2006/07 cohort. We do the same for Year 12 but only considering the effects on achievement and starting an apprenticeship (column 3 in Table 3). Each cell reports the coefficient from a separate regression. In column (2), control variables include gender, ethnicity, English as first language, eligibility to free meals at school, standardised end-of-primary school English and maths test scores and the Key Stage 4 points score, all interacted with UTC-group indicators as well as interactions between post-opening status and UTC indicators. In column (3), we use the fully-UTC-interacted 2SLS estimator from equation (2) where we instrument UTC enrolment with interactions between distance-by-post-opening status and UTC indicators, while also for controlling for distance interacted with UTC indicators (as well as all the controls in column 2). Finally, in column (4) we report marginal students' average counterfactual outcome when not enrolled in a UTC. This is estimated using a version of the 2SLS estimator from column (3) where the left-hand side is an interaction between the given education outcome and an indicator for not being enrolled in a UTC. All specifications are weighted using inverse propensity score weighting. Standard errors are clustered at the UTC-by-cohort level. Significance level: * p<0.050, ** p< 0.010, *** p<0.001.

Table 6
Heterogenous effect of UTC enrolment by students' characteristics

	Male	English test score (standardised)	Math test score (standardised)
	(1)	(2)	(3)
A. Year 10 entrants			
Five GCSEs	-0.144	-0.004	0.051
	(0.102)	(0.091)	(0.067)
Level 2 in English	-0.416***	0.206	0.000
	(0.105)	(0.111)	(0.093)
Level 2 in maths	-0.075	0.074	-0.019
	(0.087)	(0.086)	(0.073)
Level 2 in science	-0.177	0.245*	0.058
	(0.147)	(0.114)	(0.074)
Two good science GCSEs	-0.049	0.122	-0.01
	(0.107)	(0.090)	(0.087)
Observations	2,327,281	2,327,281	2,327,281
B. Year 12 entrants			
Entering A-Level	0.057	0.026	0.077
	(0.119)	(0.075)	(0.054)
Achieving A-Level	0.183	0.05	0.09
	(0.124)	(0.095)	(0.078)
Entering Voc. level 3	0.042	0.05	-0.017
	(0.125)	(0.110)	(0.084)
Achieving Voc. level 3	-0.036	-0.003	-0.055
	(0.136)	(0.121)	(0.094)
Entering STEM level 3	-0.001	-0.12	-0.078
	(0.099)	(0.076)	(0.053)
Achieving STEM level 3	-0.067	-0.015	-0.006
	(0.082)	(0.093)	(0.075)
Starting Apprenticeship	0.202**	0.037	0.04
	(0.070)	(0.084)	(0.049)
Observations	2,224,311	2,224,311	2,224,311

Notes: This Table reports heterogenous UTC performance on Key Stage 4 (Year 10) and Post-16 education (Year12) outcomes by gender (column 1), end-of-primary school attainment in English (column 2) and in maths (column 3). We regress each outcome on UTC enrolment and an interaction between UTC enrolment and a male binary variable (column 1), standardised test score in English (column 2) or in maths (column 3). Both UTC enrolment and its interaction are instrumented in the same way as in Equation (2) using interactions between distance-by-post-opening status and UTC indicators (with the number of UTC indicators being 20 or 30 so that the first stage equation is not under-identified). Each cell reports the coefficient on the UTC enrolment interaction term from separate regressions. All specifications are weighted using inverse propensity score weighting. Standard errors are clustered at the UTC-by-cohort level. Significance level: * p<0.050, ** p< 0.010, *** p<0.001.

Table 7

UTC compliers' characteristics

	Year 10 (1)	Year 12 (2)	Difference (3)
Panel A: Students' characteristics			
Male	0.541	0.764	0.223
	(0.064)	(0.034)	
White British	0.376	0.567	0.19
	(0.052)	(0.050)	
English at home	0.6	0.721	0.121
	(0.042)	(0.035)	
Free school meal eligible	0.314	0.181	-0.133
	(0.037)	(0.016)	
KS2 maths score (standardised)	-0.218	-0.126	0.092
	(0.041)	(0.056)	
KS2 English score (standardised)	-0.302	-0.257	0.045
	(0.046)	(0.052)	
Panel B: Counterfactual providers' characteristics			
Avg. KS2 English (standardised)	-0.269	-0.184	0.085
	(0.027)	(0.024)	
Avg. KS2 maths (standardised)	-0.227	-0.162	0.065
	(0.028)	(0.024)	
Ofsted rating	2.512	2.108	-0.404
	(0.110)	(0.053)	
Observations	2,327,281	2,224,311	

Notes: This table reports estimated average characteristics of compliers for Year 10 and Year 12 entrants. Panel A refers to compliers' individual characteristics and Panel B refers to the characteristics of compliers' counterfactual education providers. In Panel A, we estimate compliers' average characteristics using a variation of equation (2) where the dependent variable is an interaction between the individual characteristic of interest and an indicator for whether the student is enrolled in a UTC in Year 10 (or 12 respectively) and the regressors are the same as in equation 2. The coefficient on the UTC enrolment indicator (D_i), instrumented using the full set of triple interactions, will then identify average compliers' characteristics. In Panel B, we proceed in a similar way but replacing the left-hand side with an interaction between education providers' characteristics and an indicator for not being enrolled in a UTC. This is regressed on the no-UTC-enrolment indicator and all the other regressors as in equation 2. The 2SLS coefficient of the no-UTC-enrolment indicator ($1\text{-}D_i$) identifies average providers' characteristics for (untreated) compliers that do not enrol in a UTC, these are the providers compliers would have attended had they not enrolled in a UTC. For providers' characteristics, we consider the average quality of their student intake as measured by their average end-of-primary school (KS2) attainment in English and maths, and the official rating providers receive by the Education Inspectorate (Ofsted) which is rated on a scale from 4 to 1 (1 being the highest). Column (3) reports the difference between columns (2) and (1). Specifications are weighted using inverse propensity scores. Standard errors are clustered at the UTC-by-cohort level. Significance level: * p<0.050, ** p< 0.010, *** p<0.001.

Table 8
UTC effect on Key Stage outcomes (for Year 10 entrants) equalising compliers' characteristics

	Five GCSEs A-C	Level 2 English	Level 2 math	Level 2 science
	(1)	(2)	(3)	(4)
Original UTC effect	-0.193***	-0.193***	-0.150***	-0.147***
	(0.032)	(0.036)	(0.027)	(0.039)
A. Closing gap in maths test score				
Difference in score	0.092	.	.	.
UTC heterogeneous effect (Coefficient UTC interaction term)	0.051	0.000	-0.019	0.058
	(0.067)	(0.093)	(0.073)	(0.074)
Counterfactual UTC effect (Interaction x Difference)	-0.188	-0.193	-0.152	-0.142
B. Closing gap in English test score				
Difference in score	0.045	.	.	.
UTC heterogeneous effect (Coefficient UTC interaction term)	-0.004	0.206	0.074	0.245*
	(0.091)	(0.111)	(0.086)	(0.114)
Counterfactual UTC effect (Interaction x Difference)	-0.193	-0.183	-0.147	-0.136
C. Closing gender gap				
Difference in % boys	0.223	.	.	.
UTC heterogeneous effect (Coefficient UTC interaction term)	-0.144	-0.416***	-0.075	-0.177
	(0.091)	(0.111)	(0.086)	(0.114)
Counterfactual UTC effect (Interaction x Difference)	-0.225	-0.285	-0.167	-0.187

Notes: This table presents the results of an exercise in which we verify how much the effect of UTC enrolment for Year 10 entrants would change if the compliers' characteristics of the Year 10 intake were the same as for Year 12. The top part of the table reports the effect of UTC enrolment on Key Stage 4 outcomes (as reported in column 3 of Table 2). The next three panels each compute how the original effect would change if we closed the gap in: end-of-primary-school maths test score (panel A); equivalent English test score (panel B) and proportion of boys (panel C). For each panel, the first row reports the difference in the average of that characteristic between Year 12 and Year 10 compliers, as reported in column 3 of Table 7. Next, for each Key Stage 4 outcome, we report the coefficient of the interaction term between UTC enrolment and that characteristic (from Table 6). Finally, the last row shows the adjusted UTC effect. This is obtained by multiplying the differences by the interaction coefficient and adding this to the original effect. This assumes that we can alter one characteristic without changing the others. Significance level: * p<0.050, ** p< 0.010, *** p<0.001.

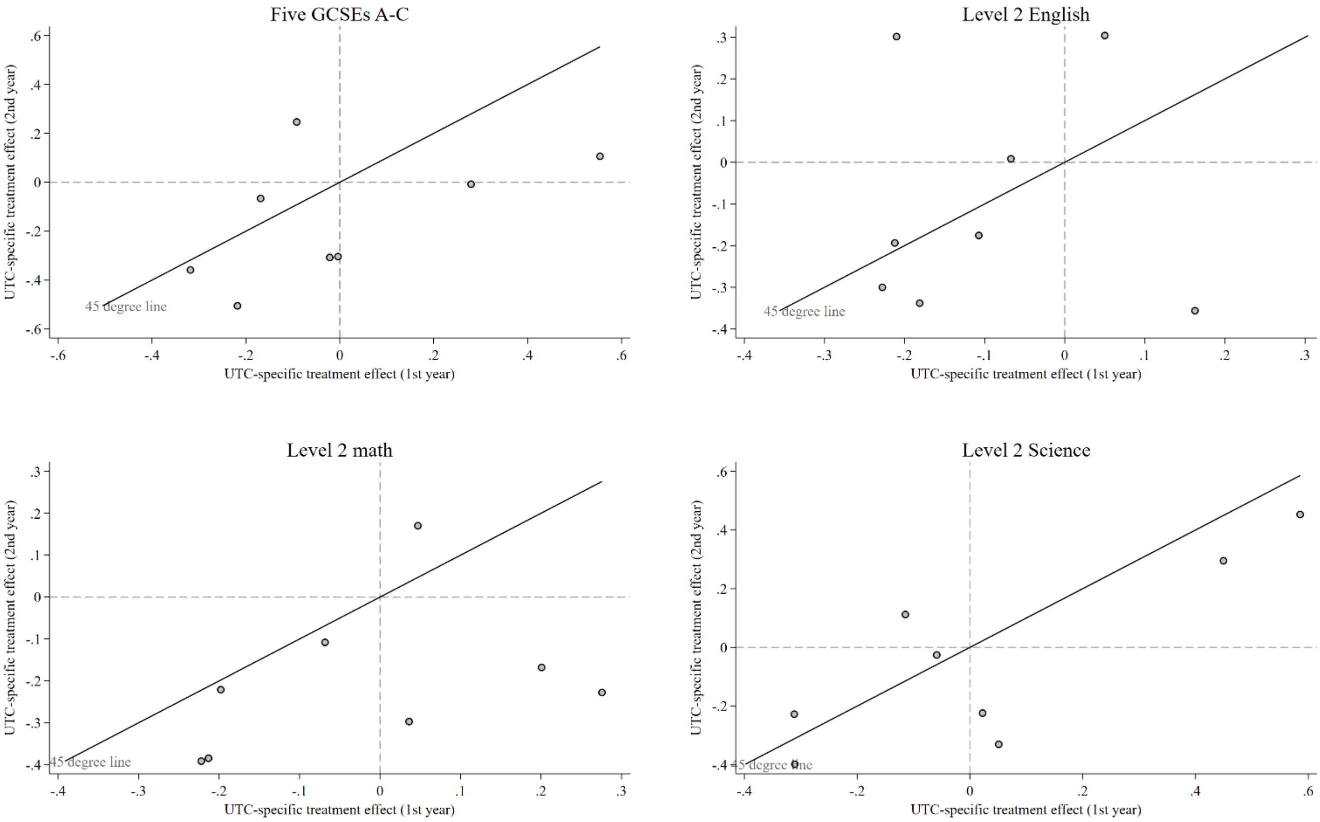

Figure 7

Effect of UTC enrolment (Year 10) by year of operation

Notes: This figure plots the estimates of the effect of enrolling in specific UTCs in Year 10 in their second vs. first year of operation on selected education outcomes of interest. We consider all UTCs that were open for at least two consecutive years and for each of them we split the main sample to only include students whose closest UTC is that. We then estimate two separate regressions by considering students from cohorts eligible to enrol in Year 10 in the local UTC in its first (second) year of opening as well as all the pre-opening cohorts. Following Equation 1, we regress the given outcome on an indicator for enrolling in UTC j which is instrumented with an interaction between students' distance to the UTC and a post-opening status indicator, while controlling separately for distance, post-opening status and the following individual characteristics: gender, ethnicity, English as first language, eligibility to free meals at school, standardised end-of-primary school English and maths test scores. Each graph plots the coefficients on the enrolment indicators for each UTC in the second year (vertical axis) vs. first year (horizontal axis) of operation. The 45-degree line indicates whether UTCs saw the effect of enrolment improving (above) or falling (below). We only include estimates for UTCs whose first-stage is strong enough in both year-of-operation subsamples (defined as having a robust Montiel and Pflueger, 2013 F statistic that exceeds 10).

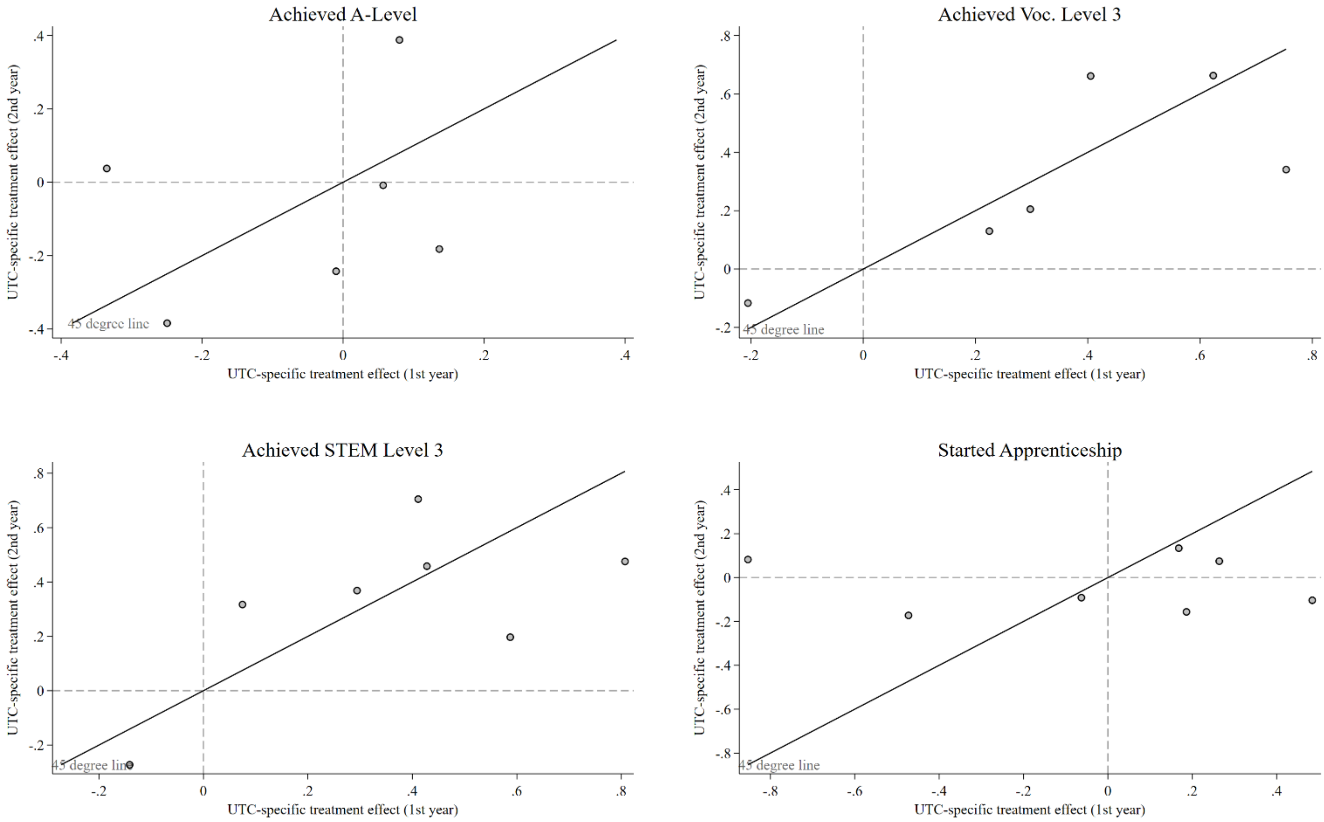

Figure 8

Effect of UTC enrolment (Year 12) by year of operation

Notes: This figure plots the estimates of the effect of enrolling in specific UTCs in Year 12 in their second vs. first year of operation on selected education outcomes of interest. We consider all UTCs that were open for at least two consecutive years and for each of them we split the main sample to only include students whose closest UTC is that. We then estimate two separate regressions by considering students from cohorts eligible to enrol in Year 12 in the local UTC in its first (second) year of opening as well as all the pre-opening cohorts. Following Equation 1, we regress the given outcome on an indicator for enrolling in UTC j which is instrumented with an interaction between students' distance to the UTC and a post-opening status indicator, while controlling separately for distance, post-opening status and the following individual characteristics: gender, ethnicity, English as first language, eligibility to free meals at school, standardised end-of-primary school English and maths test scores and the Key Stage 4 points score. Each graph plots the coefficients on the enrolment indicators for each UTC in the second year (vertical axis) vs. first year (horizontal axis) of operation. The 45-degree line indicates whether UTCs saw the effect of enrolment improving (above) or falling (below). We only include estimates for UTCs whose first-stage is strong enough in both year-of-operation subsamples (defined as having a robust Montiel and Pflueger, 2013 F statistic that exceeds 10).

[i] In 2019, 11.7% of the youth workforce was unemployed in OECD countries, a number that jumps to 14.3% for the countries of the European Union, with high rates in some places like 20.1% in Sweden, 29.2% in Italy, and 32.6% in Spain. The UK has had a persistently high percentage of 16-19 year olds classified as NEETs (not in education, employment or training) by now for several decades. In parallel, some employers cannot fill their vacancies due to a skills mismatch. Among the domains most impacted by shortages are computers and electronics, education and training, math and science, and healthcare (OECD 2017).

[ii] Many European countries, in contrast, have well established tracking systems in secondary school where students select either vocational or academic tracks (OECD 2010).

[iii] In New York City, about 50 of 400 high schools are dedicated exclusively to CTE, nearly half of which are new (Jacoby and Dougherty 2016).

[iv] UTCs are not predominantly oversubscribed which rules out using lotteries to estimate their value-added, as has been used in much of the literature about charter schools (e.g. Abdulkadiroğlu et al 2011; Angrist et al 2010; Hoxby, Murarka and Kang 2009). The instrument we use is close in spirit to the one used by Dobbie and Fryer (2011).

[v] Several papers have shown that distance to a new school can influence preferences to attend. Booker et al. (2011), Dobbie and Fryer (2011) and Walters (2018) used this observation in relation to charter schools as well as earlier literature about enrolment decisions (e.g. Card 1995; Neal 1997).

[vi] Unlike the education system in other countries (where middle schools are a much more important part of the institutional setting and where many school pupils attend three compulsory schools over the course of their studies), compulsory education in England is, for the vast majority of pupils, divided into just two sets of schools to be attended: primary schools (age 5-10) and secondary schools (age 11-16). Almost all students remain in the same school for their lower secondary education (between age 11 and 16). At age 16, over half of a cohort move institutions. The fact that the UTC entry points (at age 14 and 16) are aligned with the national system at age 16 but not at age 14 is important for understanding our findings.

[vii] For example, vocational gymnasiums (*Berufliche gymnasium)* have become more popular across some German States. In Denmark, the so-called EUX upper-secondary track combining general and vocational training was introduced in 2011.

[viii] As a result of legislation introduced in 2013, students in England must be in full-time education or in part-time education and training until the age of 18.

[ix] Colleges of Further Education are very different from UTCs in being much larger institutions (more like universities than schools) who cater for both young and adult learners and unlike UTCs do not have a specific mission with regard to STEM specialism and the integration of academic and vocational study.

[x] For more information, see their website: https://www.utcolleges.org/the-utc-story/

[xi] Detailed requirements for the application process are described in the 'How to apply guide' published by the Department for Education (October 2015 version) [Last accessed on February 10th 2025].

[xii] UTCs pre-opening stage is described in more detail in the guide published by the Department for Education (October 2015 version) [Last accessed on February 10th 2025].

[xiii] There is no grade repetition in the English system.

[xiv] UTCs are publicly funded like other state schools. The funding formula is largely based on pupil numbers. While a school can be in deficit in a given year (supported by government), schools that face deficits for a longer period (over 2 or 3 years) are at risk of closure.

[xv] Abdulkadiroğlu et al. (2016) used a grandfathering instrument to estimate the value-added of charter schools without lotteries. Yet, this instrument can only be used when traditional public schools *convert* to a different school type (charter schools in their case). It cannot be used for brand new schools.

[xvi] Outcomes at age 18 can be ascertained using administrative data in the Individual Learner Record and Key Stage 5 results. These data sets are all linked with the National Pupil Database.

[xvii] For the post-18 analysis we need to exclude the cohort of Year 12 students in academic year 2014/15: these students turn 18 after 2016 but data on higher-education participation and labour market is only available until academic year 2015/16.

[xviii] For example, they might have opened in areas where land was cheaper or with less school density, both of which would be negatively correlated with students' socio-economic background (and school outcomes).

[xix] Section 2 in Abadie, Gu and Shen (2024) covers the issues arising from 2SLS under heterogeneity. We summarise the main points here. (i) If there is group heterogeneity in the effect of interest (and the first stages), a 2SLS estimator where the exogenous variables are *not* group-interacted would not identify a weighted average of the group-specific effects: groups with no first-stage identification would be allowed to influence the 2SLS estimates and some group-specific weights would be negative. (ii) In the presence of first stage heterogeneity across groups, a fully-interacted 2SLS estimator where the instrument is also interacted with group indicators would be more *efficient.*

[xx] Chiburis, Das and Lokshin (2012) show that the use of linear IV estimators with covariates can lead to extremely high standard errors because the asymptotic variance of the IV estimator increases as the treatment probability moves away from 0.5. For instance, in their simulations, a treatment probability of 0.1 is associated with confidence intervals of the IV estimate that are too large for any meaningful hypothesis testing.
[xxi] The purpose of propensity score estimation here is to ensure that treated (UTC) and control (non-UTC) students are well-balanced in their pre-determined characteristics. Goller et al. (2020) find that LASSO improves on traditional propensity score estimation procedures and outperforms random forests approaches (especially when the treatment probability is low, as in our setting).
[xxii] Table A.2 shows results for the sample of UTCs with a strong first stage (column 4). This is defined as a UTC-specific first-stage whose robust Montiel and Pflueger (2013) F statistic exceeds the conventional value of 10 (see discussion in Section VI). The results are almost identical to those we present in the paper based on the entire sample of UTCs. This similarity is unsurprising given that the fully-UTC-interacted specification we use in equation 2 consistently estimates a weighted average of the UTC-specific treatment effects, where the weights are proportional to the strength of the first stage in each UTC. UTCs with a weak first stage have therefore little influence on the overall 2SLS estimates.
[xxiii] The IV identifying assumptions are expected to hold *conditional* on the vector of individual characteristics X_i.
[xxiv] For our cohorts of interest only 4 UTCs had been open long enough for parents to observe the outcomes of the first intake of students.
[xxv] To report the coefficients more compactly, we do not interact the distance-by-pre opening indicators with UTC group indicators (as this would result in 30 coefficients per period). Nevertheless, since we are still interacting all the other exogenous regressors with UTC indicators, the estimated coefficients of the 'pooled' lag terms would still consistently estimate average trends along distance across all UTCs.
[xxvi] There are not enough UTCs open long enough to evaluate their effect on outcomes for those who enter in Year 10 and stay until the end of Year 13.
[xxvii] Disadvantage is measured by eligibility to receive free school meals. Achievement is measured by the probability of achieving 5 GCSEs with good grades including English and maths.
[xxviii] We separately investigate whether enrolment in a UTC in Year 12 affects students' probability of staying in education until Year 13 but find a zero effect (results available upon request). This is unsurprising given that students are required to be in some form of education and training until age 18.
[xxix] All the outcomes related to achievement are measured on the entire student population (rather than the population of students who enrol in A-Levels, vocational qualifications, or STEM qualification). Our identification method is valid for the entire sample of students, but it may provide biased estimates when applied on a selected sample of students who enrol in a qualification.
[xxx] 8.5 percent of the students who achieve a STEM level 3 qualification choose a STEM degree at university, versus 0.8 percent for students who do not achieve a STEM level 3 qualification, which represents a 7.7 point gap. Enrolling in a UTC increases students' probability of achieving a STEM Level 3 qualification by 30.9 percentage points which would result in a mechanical increase of 2.4 percentage points in the probability of choosing a STEM degree at university. This represents 32% the overall effect we observe (of 7.4 points).
[xxxi] We restrict the sample to students who are employed as otherwise we do not observe their earnings. We additionally exclude students in education to avoid measuring earnings accruing from 'student part-time jobs' (which we cannot identify). This inevitably introduces a selection issue implies caution in the causal interpretation of the earnings results.
[xxxii] For consistency, we estimate these conditional associations using the same weighting scheme as in our main results to make the two samples more comparable.
[xxxiii] The effects for the UTCs with a weak first stage are not well-identified as they are not bounded between -1 and 1 and have very large standard errors (and would thus be hard to visualise). The effects for the UTCs not reported are, in any case, not particularly informative of the overall effect as, having a low first stage, they receive a very low weight in the UTC-wise interacted 2SLS estimation (equation 2). This is confirmed by Table A.2 in the Appendix where we show that the overall effect of UTC enrolment when excluding these UTCs is very similar to our main estimates.
[xxxiv] There is evidence of the disruptive effect of schools transition in the U.S. Hanushek, Kain, and Rivkin (2004) estimate that switching reduces maths achievement by 0.03 standard deviation on average.
[xxxv] Normally, students spend Year 10 and Year 11 studying in preparation for GCSEs; however, over the years, it has become increasingly common for schools to start the GCSE curriculum in Year 9 and to cover it in three rather than two years.
[xxxvi] This approach follows from Abadie (2002); Abdulkadiroğlu, Pathak and Walters (2018) present an interesting application in which they estimate average characteristics of the schools that compliers would have attended if they had not been assigned a voucher to enrol in private schools. For a more general discussion of how to estimate compliers' characteristics, see Angrist and Pischke (2008).
[xxxvii] This calculation provides suggestive results based on the assumption that Year 10 and Year 12 compliers differ in terms of prior attainment, but not in terms of unobserved characteristics.

[xxxviii] A few studies have examined differences in performance between conversion and start-up charter schools in the U.S, finding mixed results (Buddin and Zimmer 2005). Imberman (2011) finds that schools that begin as charters generate large improvements in discipline and attendance, while no such effect was observed for conversion charter schools.

[xxxix] Only 4 UTCs were open for more than two years in the data interval we can consider, so we cannot reliably look at what happens beyond the second year of opening.

[xl] Consistently with the analysis in Section VI.A, we only plot the estimates for UTCs whose first stage is strong enough as the other UTCs do not affect the main estimates.

[xli] Another reason for the OLS to be less negative than the 2SLS would be if students were positively selected into UTCs, but the descriptive statistics reported in Table 1 do not support this explanation. Year 10 students who enrol in UTCs are *not* positively selected based on their social background (eligibility to receive free school meals), language spoken at home, and prior maths achievement.