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Geographic Inequalities and Access to Higher Education: Is the Proximity to Higher Education Institution Associated with the Probability of Attendance in England?

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Abstract

The relationship between geography and the selection of university is well documented and suggests that a student's location substantially limits their choice of institution. However, there are few studies investigating the interplay between geography and the decision to attend university, particularly in the UK. This study aims to establish if distance to university is associated with the probability of enrolling in higher education in England and forms the quantitative half of a mixed-methods study on the subject. An ordinal logistic regression analysis of HESA enrollment data, which controls for deprivation, is employed. The investigation uses average direct measures of distance between each census area and university campus in England to determine the relationship between distance and enrollment. The findings suggest that geographical distance to university has a negative association with university enrollment. Students within the 10 km measure had a significantly increased odds of enrolling at university than students in the 40 km and above category (odds ratio 10.89; 95% CI 1–2), when controlling for deprivation and population density. It is hoped that the findings of this research will help to raise awareness of geographical inequalities and inform policy on university access.

Keywords Access to higher education · Geographical inequalities · Distance · University enrollment

Introduction

This study aims to investigate the interplay between geography and higher education enrollment, so that access to university may be understood in greater depth.

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This research project addresses the following research question:

Is distance to university associated with the probability of university enrollment in England?¹

There continue to be a substantial minority of students who are denied access to university, generation after generation. Not because they lack skill or strengths but because they have no opportunity. Evidence and awareness of the socio-economic and ethnic inequalities in access to university is well documented (Anders 2012; Boliver 2013; Engberg and Wolniak 2018; Flores and Shepherd 2014; Mangan et al. 2010). However, the potential barrier of distance is rarely discussed and poorly understood in England.

Access to higher education is essential for facilitating social mobility and developing a workforce that is highly skilled and able to adapt. In the UK, calculations of the additional wages a graduate earns over a lifetime range between £160,000 and £400,000 (approx. \$200,000–\$500,000 USD) (Chitty 2014; Singleton 2010). Fair access to the labour market is predicated on fair access to higher education, which is the foundation of a meritocratic society. Social cohesion is dependent on social justice, which is influenced by fair access (Department for Education 2004).

The latest international figures suggest that the UK higher education enrollment rate remains below the levels in the US but above the average of Organization of Economic Co-operation and Development (OECD) and EU 27 countries (OECD 2018). Despite the increasing proportion of young people attending university, there remain concerns that socio-economic biases continue to mediate attendance (Boliver 2013; Mangan et al. 2010). In spite of substantial investment in widening participation through universities and schools, the socio-economic structure of graduates has barely changed over the decades (Morrison 2011). Students in the top fifth income bracket are almost three times more likely to attend university than students in the bottom fifth (Anders 2012). This inequality is attributed to the gap in attainment that emerges between lower and higher Social Economic Status (SES) from a young age by some authors. Anders suggests that access to university is meritocratic but that students from higher SES families have a greater probability of gaining top grades. Inequalities in access to quality primary and secondary education may explain some of these differences. In contrast, several studies expose aspects of university access that are not meritocratic. For example, Sullivan et al. highlight that privately educated students are 2.5 times more likely to attend an elite university than a student with the same entry qualifications from a state school (Sullivan et al. 2014).

Recent research has suggested that access to higher education was the predominant mediating factor in the 2016 EU referendum. A university degree explained 77% of the total variation in the referendum vote in England and Wales, with graduates being significantly more likely to vote to remain in the EU (Zhang 2018). Analysis suggested that a 3% increase in the proportion of British adults that could access higher education would result in a reversal of the referendum result. Accessing a university education is increasingly essential to succeeding in the globalized world, in which employees need to demonstrate that they can learn and adapt and low skilled jobs are increasingly automated.

¹ This paper will focus on England and not the UK because the Scottish, Welsh and Northern Irish devolved governments operate differing funding arrangements, for student loans and tuition fee caps. Some of these differences may incentivize students to remain in their home nation. UK data may be referred to where corresponding English data is not available. England's residents make up 84% of the UK population.

Higher Education in England

For 700 years there were only two locations to obtain a degree in England; Oxford and Cambridge. Consequently, leaving the family home to pursue a degree became normalized (Christie 2005). As more Universities were established in the nineteenth and twentieth century, they were not spread evenly. The imperial capital of London gained establishments such as the School of Oriental and African Studies and Imperial College, which were in part developed to serve the British Empire. Industrial and commercial cities had different educational requirements. English universities seem relatively evenly distributed with population density at a glance but there remain several notable gaps (Gibney 2013). For example, Greater London has twice as many registered higher education institutions per head than Greater Manchester, the second largest conurbation. When the distribution of universities is compared to population, the ratio of undergraduate places to population is highest in the North West and West Midlands (Gibney 2013). These regions are the second and third most urbanized, which highlights how uneven provision has created a more complex distribution than the standard rural, urban dichotomy. Unlike Germany, Britain has not pursued a national program to correct imbalances (Spiess and Wrohlich 2010).

The higher education system in England does not operate a dual or tiered system such as France (Univerités/Grande Écoles) or the United States (Public/Private). Two streams of higher education existed in England for most of the latter half of the twentieth century. After the 1963 Robbins Report a dual system of academic universities and polytechnic institutions was established. Academic universities were more autonomous, as they held the power to accredit their own degrees. Meanwhile, polytechnics had more of a vocational and technical focus, had degrees awarded by a national body and were the responsibility of the local government (Chitty 2014). The 1992 Further and Higher Education Act unified English higher education as polytechnics were transformed into (post'92) universities with degree awarding powers and the same funding structure. In theory the sector was united but gaps remained as the former polytechnics, which were synonymous with good teaching, struggled to compete on research, a field in which they had less experience. England currently has five private universities, most of which specialize in legal or business programs (Fielden 2010). These institutions play a very limited role in the UK higher education sector.

English universities are annually ranked in several published league tables. Older universities tend to score more highly on research and graduate earnings. Differences between teaching quality and students satisfaction are minor (Boliver 2015). Oxford and Cambridge invariably top the league tables and on average older institution perform better in league tables (Boliver 2015). Universities are occasionally defined as 'old' if they were established before the 1992 Further and Higher Education Act, and 'new' if they gained their status post'92. This is a poor distinction as many of the 'new' universities were founded long before several of the 'old'. For example the post'92 Westminster University traces its foundation to 1837, when it was established as the Royal Polytechnic Institution. Conversely, Warwick University, an 'old' university was founded in 1965. A review of university wealth indicates that Oxford and Cambridge are in another league. Each university has approximately £3 billion in assets (approx. \$4bn USD), meanwhile the remainder of the entire UK higher education sector holds a mere £2 billion. At the other end of the scale, around a quarter post'92 institutions form a separate cluster of universities, which are more poorly resourced and serve a less socioeconomically advantaged student population (Boliver 2015). Although, there is a small distinct cluster of universities at the very top and

bottom extremes, the substantial majority in the middle cannot be neatly untangled. This study will therefore conceptualize English universities as of equal value.

The universities of Oxford and Cambridge have acknowledged the need to reach out to all corners of the UK and have established link colleges for every UK Local Authority (University of Oxford 2019). Each university college is allocated a selection of local authorities. Teachers and applicants are encouraged to contact the link college for their locality, and colleges are encouraged to concentrate their outreach initiatives in these areas. Whilst this policy alone may struggle diminish the association between access to Oxbridge and proximity [which is compounded by regional divides in SES (Mangan et al. 2010)] it establishes responsibility of disadvantaged remote regions to a college.

Financial circumstances impact patterns of university enrollment (Frenette 2004; Hemelt and Marcotte 2011; Mangan et al. 2010). Tuition fees have increased dramatically in England over the last twenty years. Free, income assessed university education was replaced by tuition fees in England and Wales in 1999 (Chitty 2014). The 2004 Higher Education Act allowed English universities to triple the fees to up to £3000 per year. The fees were tripled again to £9000 by the coalition government of 2010 and the fee cap rose to £9250 in the 2017/2018 academic year and remains there for 2018/2019. The introduction of tuition fees was intended to create a variable market in which universities competed for students on price and quality. However, the vast majority of Higher Education Institutions (HEIs) have selected to charge the maximum fee since their introduction (Havergal 2016). Only 2 out of 123 intuitions suggested that they would not charge the full fees for the majority of their programs. Scotland, Northern Ireland and Wales have pursued alternative funding arrangements. Scottish students do not pay tuition fees in Scotland but English, Welsh and Northern Irish students pay up to £9250 and the Welsh government offers Welsh students for grants to cover fees (Times Higher Education 2017). The heterogeneity of the UK fee structure creates incentives for students to remain in their home country, which is why this study focuses on England only.

Literature Review

For decades, financial support offered by the UK government to poorer students has been assessed on household income (Weale 2016). In Germany, funding is also provided for relocation and travel, but in England the increased costs of distance are not recognized (Spiess and Wrohlich 2010). The failure to recognize distance as a barrier is a global issue (Frenette 2006; Parker et al. 2015; Turley 2009). Government funding to support students can also support students disadvantaged by their location, but no national or university programs to address the disadvantages of remote students has been found in the substantive literature. Widening participation initiatives in England focus on unrepresented groups but the potential challenges or benefits of distance are not on the agenda (Chowdry et al. 2010).

There is extensive evidence in the substantive literature that proximity to university influences students' selection of course and institution. Evidence of such trends has been noted in studies in Canada, Germany, the Netherlands, Switzerland, the US and the UK (Denzler and Wolter 2010; Frenette 2004; Gibbons and Vignoles 2011; Mangan et al. 2010; Sá et al. 2006; Singleton 2010; Spiess and Wrohlich 2010; Turley 2009). Mangan et al. conducted surveys in two areas in England, with 1272 students aged 16–19 from ten institutions. Their results suggested that institutional choice was strongly influenced by proximity, demonstrating that students living nearer to “high ranking” universities had

a 12% increase in the probability of applying to these institutions (Mangan et al. 2010). In a larger English study that employed the National Pupil Database (N=400,000), Gibbons and Vignoles conclude that “geographical distance has a strong influence on institutional choice” (Gibbons and Vignoles 2011). There is also a growing body of evidence that students from higher SES backgrounds will on average attend a HEI further away from the family home and this trend is becoming more entrenched (Callender and Jackson 2008).

Several studies that use substantial samples and rigorous quantitative methods confirm a negative association between distance and university enrollment. Frenette examined a Canadian national dataset with a regression analysis and concluded that students living beyond commuting distance (80 km) were 37% less likely to attend than those living within commuting distance (Frenette 2004). Distance played a more substantial role in low-income students’ likelihood of attending university. Therefore Frenette concluded that the mechanism behind the trend was primarily financial. Focusing on Australia, Parker et al. conducted a similar regression analysis on two large cohorts of students (N=11,999) (Parker et al. 2015). Parker et al. measured the distance between the population-weighted centroids of students’ postcodes and all but the most specialized and smallest university campuses. The paper concludes that increased distance is associated with decreased probabilities of university enrollment, but emphasizes the social and emotional costs of moving from intimate rural communities. Indeed social costs are a key theme running through the access to university literature (Christie 2005; Reay et al. 2001). Again, students from low SES were more greatly impacted by distance.

Speiss and Wrohlich conducted a similar regression analysis on a sample of German students (N=1219) who passed their Abitur, which qualifies students to apply to university (Spiess and Wrohlich 2010). Speiss and Wrohlich created their distance variable by measuring the distance between the students’ postcode and their closest public university. The study concludes that “students living farther away are disadvantaged in accessing university” and attribute the trend to transactional costs (Spiess and Wrohlich 2010, p. 476). However, Speiss and Wrohlich emphasize that disadvantages diminish beyond the median distance (12.5 km). Unlike the Canadian and Australian studies, Speiss and Wrohlich do not observe low SES as more greatly impacted by distance. The paper suggests that this may be due to lower fees and more favorable loans for students in Germany (Spiess and Wrohlich 2010, p. 476). Alternatively, this could be driven by the fact that the sample only contained students who had achieved the Abitur, which may mediate for SES through the selective education system.

There is scant research on the impact of distance and university enrollment in England. Gibbon and Vignoles provide the most rigorous and recent study on the subject, which claims to be the first of its kind (Gibbons and Vignoles 2011). The study has the advantage of using a large dataset (N=400,000) of all school leavers in England with individual pupil level data. Using the student attainment data, Gibbon and Vignoles control for nearest feasible institution, omitting universities that have entry tariffs above the students’ age 16 attainment. Such precise data and sophisticated techniques establish a robust regression analysis. The study concludes that, although distance is strongly linked to institutional choice, there is “at most, a very weak link between home and HE distance and the decision to participate” (Gibbons and Vignoles 2011, p. 111). The report also suggests that students from low SES backgrounds and female British Pakistani and Bangladeshi students are more greatly disadvantaged by distance in their institutional choices. It also states that distance “emerges as the most important general factor in institutional choice” and concludes that type and quality of HEI is largely governed by the type and quality of their local university.

Unlike the Australian, Canadian and German studies, Gibbons and Vignoles calculate distance to university via the rail network. The authors justify this method stating it is “to avoid errors arising from infeasible shortcuts across river estuaries and the like”. The penetration of the UK rail network is unevenly distributed due to its history. The English railway network was the first in the world and initially built to transport commodities such as coal and iron (Turnock 1998). Thus regions with these commodities in the North and West have more developed networks than the agricultural East. Distance measurements via a rail network are vulnerable to distortions due to accidents of history, which underlines the need for an alternative study.

Virtually flat fees and relatively standardized institutions in England conveniently controls key variables, which makes it an ideal testbed to investigate the relationship between enrollment and distance. This study benefits from controlling for SES and population density. Gibbon and Vignoles study utilized data that is now over a decade and half old. During this period tuition fees have increased nine fold in England. An updated analysis of the subject is long overdue.

Methodology

This study investigates the relationship of distance and university enrollment in England by employing an ordinal regression analysis of national statistics. Given the dependent variable was bounded, i.e., ranged from a possible 0% to 100%, it was decided to employ an ordinal logistic regression model to overcome the potential problem of predicted values below 0 and above 100 violating an ordinary least squares regression approach. The original dataset is presented in quintiles, which has shaped the concept of participation and the narrative in England and Wales. The association of university attendance and high SES is well documented (Anders 2012; Boliver 2013; Engberg and Wolniak 2018; Flores and Shepherd 2014; Frenette 2006; Mangan et al. 2010). Urban areas are more likely to host universities but they may also allow access to a number of beneficial services for their residents, such as healthcare and employment. The regression analysis is able to determine the unique contribution of SES and population density by including the Office for National Statistics (ONS) Index of Multiple Deprivation (IMD) and the Rural Urban Classification in the analysis. Controlling for SES and population density allows the model to determine the relative impact of distance on university enrollment. Ordinal regression has the advantage of describing the relationship between the variables across the range and allows distance to be conceptualized in more concrete terms.

Data

Data on university enrollment is publically available online via Office for Students.² The data downloaded for this study was aggregated from five pooled cohorts of 18 and 19 year olds, who entered higher education between 2009 and 2014. Using 5 years of aggregated enrollment data ensures that fluctuation in the wake of the financial crisis and substantial changes in tuition fees do not distort the broader trends. The Office for Students label

² Data previously held by HEFCE (Higher Education Funding Council for England).

enrollment rates as ‘the young participation rate’. The young participation rate² is defined as the percentage of 15 year olds registered at state maintained schools, who attended university by age nineteen (Higher Education Funding Council for England 2012). Students are required to enroll and to have been confirmed as attending by their university at the end of the first 2 weeks of the fall term to qualify. These enrollment figures are provided for each ONS middle layer super output areas (MSOAs), which were developed to disseminate geographic census data at a local level (ONS 2012). MSOAs contain, on average, a population of 7787 people and are have been designed to have relatively homogeneous population density and are grouped as exclusively rural or urban. MSOAs are built using the smaller units of the postal code system. The sample contained data for 6791 MSOAs in England. Two MSOAs contained entrant estimates below 10, these were omitted to prevent identification, which reduced the sample size to 6789. Figure 1 in Appendix details the MSOA boundaries in Greater London, which illustrates the size and shape of the units in urban and suburban neighborhoods. Please find the web addresses of all data sources in Table 4.³ The enrollment data was recoded into quintiles.

A list of publically funded higher education institutions which have the power to award degrees, was obtained from the HESA website (Higher Education Statistics Agency 2018). This produced a list of 136 institutions. Specialist, small, postgraduate or distance learning institutions were omitted from the list.⁴ All English private universities were too small and specialist to qualify. Once these institutions are discounted, there remained 90 institutions. These intuitions are mapped in Appendix Figs. 1 and 2. Figure 2 in Appendix highlights a low density of universities across the regions of the South West, East of England and the north half of the North West and a high density of institutions in London, which are mapped in Appendix Fig. 1. A list of omitted specialist and minor universities can be found in Appendix Table 5. This criteria approximately matched similar studies on the topic of geography and university enrollment (Gibbons and Vignoles 2011).

In this study, universities are conceptualized as one site with one address. Minor geographical tweaks to establish a more accurate center of a campus would have a low probability of yielding alternative results as English universities tend to be clustered within a relatively small geographical area. Scottish and Welsh universities may occasionally be the nearest university destinations for English students. Two institutions were identified to be in this category; Wrexham Glyndwr University and the Crichton Campus of the University of Glasgow and University of West Scotland. These HEIs serve as the nearest universities to English students close to the border. These universities have therefore been added to the list of HEIs used in the analysis, which makes a total of 92 institutions.

Undergraduate university tuition fees are currently capped at £9250 in England (Bhardwa 2018). During the period that the university participation data was collected the cap on fees started at £3000 in 2009 and rose to £9000 in the 2010/2011 academic year (Chitty 2014). The cap on fees has created a flat rate of fees, as such a high proportion of institutions have chosen to charge the maximum rate of fees. English HEIs do not have a

³ The young participation rate sample does not include students studying outside of state maintained schools, which represents approximately 6% of students in England (Chitty 2014). Students that chose to study outside of the UK or over the age of nineteen are also not included. There are therefore gaps in this “national” dataset, which have the potential to distort the analysis. However, this is a substantial sample of the complete figure from the state system, and large enough to make statistically significant conclusions.

⁴ Specialist universities were defined by a specific focus towards one discipline or faculty. Small universities with three or less faculties were also omitted due to their limited range of courses. The benefits of proximity to these institutions are limited due to the narrow selection of courses available.

formal two-track system such as in France or the US. Common informal categorizations of status in the wider literature have been undermined by closer analysis (Boliver 2015). Universities are therefore conceptualized as of equal status.

The IMD is a single deprivation score, which includes 38 separate economic, social and housing datasets. The Department of Communities and Local Government (Department for Communities and Local Government 2015) has been developing the indices since the 1970s, which ranks 32, 482 Lower Layer Super Output areas in England by deprivation. Low scores indicate high deprivation. Each Lower Layer Super Output area represents a small neighborhood of 1614 people (Department for Communities and Local Government 2015). These data are routinely updated to ensure that the population of each unit is relatively equal. This negates the need to weight the data by population. The IMD is used widely across disciplines including Economics, Epidemiology, and Geography (Holden and Frankal 2012; Mitchell and Norman 2012; Woods et al. 2005). It remains the UK “government’s preferred measure of material deprivation in England” (Mitchell and Norman 2012).

The ONS website publicly provides IMD scores for all Lower Layer Super Output (LSOA) areas. Each MSOA is divided up into approximately five LSOAs.⁵ The 2015 index was selected because the data was predominantly collected in the 2012/2013 financial year, approximately the middle of the HEFCE data collection window. The index was created by combining the seven transformed domain scores using the following weights; Income (22.5%), Employment (22.5%), Health and Disability (13.5%), Education, Skills and Training (13.5%), Barriers to Housing and Services (9.3%), Crime (9.3%) and Living Environment (9.3%) Each domain score is calculated on several indicators (Department for Communities and Local Government 2015). The income and employment domains dominate the index and make up 45% of the weighting. The income domain reflects the proportion of working age population that are on a low income or out of work. The employment domain reflects the proportion of working age population that are out of work due to either unemployment, caring responsibilities, illness or disability. This data is collected through unemployment benefits and, thus, assumes that all citizens that are entitled are registered and that all that are registered are entitled. One of the many advantages of the indices are their diversity. Although one measure may be biased due to specific circumstances of the locality, it is unlikely that all datasets will be biased. The indices are regularly used by local and national government to inform policy.

The ONS Rural Urban Classification is constructed from census output areas. Output areas attached to settlements with a population over 10,000 people are classified as urban and coded A, B or C. Output attached to settlements with a population below 10, 000 are classified as rural and coded as D or E. The most densely populated neighborhoods are classified ‘A’ and density decreases with each classification. All categories are further subdivided by population density by a number 1 or 2. A1 represents the most densely populated neighborhood and E2, the least. The population within and surrounding the OA will then determine where on the ordinal scale it is classified. Variables were recoded from 0 to 3, with the order reversed to rural to urban. The four categories were labeled Rural, Semi-rural, Suburban and Urban.⁶ Rural was used as the reference category.

⁵ There is no overlap across any of the ONS output areas.

⁶ Recoded ONS Rural Urban Classification were as follows. A1 and B1: Urban, C1 and C2: Suburban, D1 and D2: Semi-rural and E1 and E2: Rural.

Matching and Analysis of Data

HEFCE participation data was matched with IMD scores via the ONS MSOA labels. A lookup for population-weighted centroids obtained the easting and northing geographical coordinates to correspond with each figure of participation data. University postcodes⁷ were used to identify easting and northing figures from a geographic website (Grid Reference Finder 2018). The easting and northing values of all census wards and university addresses were input into a Microsoft Excel worksheet. The distance between every MSOA and university was calculated, as the crow flies, using Pythagoras' theorem, i.e. the corresponding easting and northings were subtracted and squared. The square root of the sum of both figures provided the direct hypotenuse distance. The three nearest HEIs were identified⁸ and the mean of these was calculated. To improve accuracy, the mean figure was used in favor of the distance to nearest university, as not all students benefit from close proximity to all universities. For example a student attending a deprived school has a low probability of benefiting from living near a high tariff university especially if widening participation schemes are limited. This method was inspired by methods in similar studies (Gibbons and Vignoles 2011). The distance measure was then re-coded into five categories 0 to 10 km, 10 to 20 km, 20 to 30 km, 30 to 40 km and 40 km and above.

Alternative measures between university and neighborhoods were explored, considered and rejected. Measuring distances via the road network assumes access to a vehicle. In 2008, within the first half of the data collection window, only 36% of 17–20 years olds in the UK held a driving license (Department for Transport 2011). Thus the majority of sample did not have access to the road network. Public transportation provision is spatially heterogeneous in the UK. London has one of the most extensive public transport systems in the world, which is a stark contrast to the limited provision in regional cities or the total lack of provision in the more remote rural areas of England. Aggregated mixed modal commuting times between neighborhoods and universities would also be problematic as the sample needs to be weighted to younger travelers as they have less access of the road network. Over 80% of UK 30–59 year olds held driving licenses in 2008 (Department for Transport 2011). Complex indices that could calculate mean distance times and control for the considerations above was beyond the scope of this project.

An ordinal regression analysis was employed using Stata SE version 15.1 (StataCorp, College Station, TX), to assess the relative influence of distance. Ordinal logistic regression is an extension of logistic regression and estimates a single regression coefficient over the levels of the dependent variable, (Hosmer and Lemeshow 2000) i.e., reported here as the odds of being in a higher HEI participation group for each unit increase in the independent variable. Nonviolation of the parallel slope assumption of the ordinal logistic models was assessed using the Brant test in Stata. Model 1 included the university enrollment quintiles and categorized distance measures only. SES does not manifest a geographically even spread, (Dorling and Pritchard 2010) therefore IMD data was used as a control for deprivation and was input into model 2 and 3. Controlling for IMD ensured that geographic differences in SES were not mistaken for geographic differences in enrollment. There are higher densities of universities in large urban areas. In order to understand the impact of distance to university on enrollment it was necessary to also control for the urban or rural

⁷ Equivalent to US zip codes but do not overlap.

⁸ Excel's "INDEX MATCH" function was used to identify the three shortest distances from all calculations between the ward and all universities in the sample.

Table 1 Enrollment, distance and IMD descriptives

Enrollment	Mean distance of MSOA (km)	Mean IMD percentile of MSOA (%)	Frequency of MSOA neighborhoods
0 < 20%	27.0	25.0	698
20 < 40%	27.2	49.0	3248
40 < 60%	22.6	66.4	2033
60 < 80%	18.0	76.7	544
80 < 100%	11.8	77.8	266

IMD index of deprivation, *IMD percentile 1* most deprived, *MSOA* middle layer super output area

Table 2 Distance, enrollment and IMD descriptives

Distance	Mean enrollment percentile of MSOA (%)	Mean IMD percentile of MSOA (%)	Population of 18 and 19 year olds
0 < 10 km	45.2	42.5	720,179
10 < 20 km	40.5	59.1	1,012,614
20 < 30 km	37.6	60.5	639,036
30 < 40 km	37.0	60.5	433,757
40 km and above	34.0	55.3	456,650

IMD index of deprivation, *IMD percentile 1* most deprived, *MSOA* middle layer super output area

divide. The rural urban classification data was therefore also included in model 3. Finally, in order to understand which social-economic factors are most influential, the model was amended to include the seven IMD domain scores, which replaced the combined index.

Findings

Descriptives

Enrollment quintiles are cross-tabulated with IMD and distance measures in Table 1 below. As enrollment increases the average distance from HEIs decreases and deprivation has a similarly linear relationship; low enrollment neighborhoods are more likely to be more deprived. Table 2 below displays the mean higher education enrollment rate and IMD percentiles for each bracket of the distance measures. Enrollment rates decrease as the distance measure increases. The mean IMD measures indicate that deprivation doesn't have the same linear relationship with distance from universities. The least deprived distance bracket is on average 20–40 km from HEIs. Commuter towns around London would often fall into this bracket and are identified as the least deprived neighborhoods in England (Department for Communities and Local Government 2015). Greater deprivation is found at both ends of the distance measure. The complexity of the relationship manifested in the contrast between the Tables 1 and 2 may partially explain why the topic is so poorly understood. Table 6 in Appendix below reveals the association between population density and distance to university but also underlines the fact that England is an urbanized nation.

Table 3 Ordinal logistic regression analyses of higher education enrollment quintile

	Model 1	Model 2	Model 3
	Odds ratio (95% confidence interval)		
<i>Distance factor</i>			
Mean distance to HEIs			
0 < 10 km	2.39 (2.08, 2.75) ***	10.72 (9.11, 12.61) ***	10.89 (8.84, 13.41) ***
10 < 20 km	1.72 (1.51, 1.97) ***	1.69 (1.47, 1.95) ***	1.94 (1.64, 2.30) ***
20 < 30 km	1.28 (1.11, 1.48) **	0.96 (0.83, 1.12)	1.35 (1.15, 1.58) ***
30 < 40 km	1.27 (1.09, 1.49) **	0.59 (0.81, 1.13)	1.20 (1.01, 1.43) *
40 km +	Referent	Referent	Referent
<i>Population density factor</i>			
Urban			0.30 (0.24, 0.37) ***
Suburban			0.13 (0.11, 0.16) ***
Semi-rural			0.19 (0.16, 0.23) ***
Rural			Referent
<i>Socio-economic factors</i>			
Index of multiple deprivation		2.10 (2.04, 2.15) ***	2.17 (2.11, 2.22) ***

HEIs higher education institutions

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

There is a small but significant minority of neighborhoods that are near universities but in remote areas, which is a reminder that not all English universities are in the center of cities.

Regression Analysis

Ordinal logistic regression was used to examine the specific influence of proximity to HEIs. The odds ratios displayed in Table 3 below indicate that distance plays a powerful role. Model 1 included only the distance measure and indicated that, with the exception of the 20–30 km bracket, students had a higher probability of living in a high enrollment quintile neighborhood the nearer they were to universities. When compared to the reference group (40 km+), all nearer distance brackets had at least a 27% increased odds of being in a higher enrollment quintile. The 0–10 km distance bracket suggested that there is substantial advantage in living in close proximity to universities, with an odds ratio of 2.39.

The population density and deprivation variables were included in model 3. These predictors strengthened the association between distance and university enrollment, indicating that students in the 0–10 km distance bracket had an adjusted odds of 10.89 of being in a higher enrollment quintile as compared to the reference category (40 km+). Although controlling for deprivation and population density increases the odds ratio in neighborhoods near universities, this also reduces both the statistical significance and odds ratios in neighborhoods that are remote from HEIs. When controlling for deprivation and population density, neighborhoods in the 20 < 30 km category were only 24% more likely to be in a higher enrollment quintile than the reference group. The model indicated that SES has a negative association with enrollment, which complements the findings from numerous other studies (Boliver 2013; Frenette 2006; Mangan et al. 2010). The model reveals that population density

performs a less pronounced role than distance to HEI, but that urban neighborhoods increase the probability of being in a higher enrollment quintile more than other population densities.

The individual IMD domain score regression revealed that all factors of the index were negatively associated with enrollment except barriers to housing. Please see Table 7. Greater London and other cities with high economic growth experience the most marked barriers to housing. London also has the greatest concentration of HEIs and substantial wealth and employment opportunities. The probability of enrolling at university decreases with distance after controlling for all IMD domain scores. Income and Employment domain scores had odds ratios higher than the average factors. The Education, Skills and Training domain score delivered the highest odds ratio of the IMD domain scores, which was not unexpected. Table 8 displays the results of all domains combined on a single model, which indicates that Health and Education play a more substantial role in the relationship.

Research Question Findings

Is distance to university associated with the probability of university enrollment in England?

The ordinal regression analysis of university enrollment suggested that closer proximity to universities increased the odds of being in a higher enrollment quintile. Controlling for deprivation and population density increased the odds for neighborhoods in the 0–20 km range but beyond that the effect was muted.

Discussion

The regression analysis suggests that distance has a negative association with university enrollment. The results of this study complement the findings of similar regression analysis in Australia, Canada, Germany, the Netherlands and the US. (Frenette 2004; Parker et al. 2015; Sá et al. 2006; Spiess and Wrohlich 2010; Turley 2009).

Understanding the distribution of wealth in the UK may help unpick why the model suggests that distance to university is negatively associated with university enrollment yet living in a rural environment has the opposite association. The twelve constituencies where the UK's highest earners most commonly live are all in London and the South East (Dorling and Pritchard 2010). Half of these constituencies are in leafy, low density London boroughs, in which overall enrollment rates are reduced due to inequality. The other half are in rural pockets of the counties bordering London, also known as the Home Counties. 9.5% of neighborhoods of the national sample were categorized as rural yet 36.9% of these rural neighborhoods were in the highest quintile of university enrollment, the highest proportion of any of the population density categories. The contrast of associations of neighborhoods that are rural or remote from universities may in part explain why the topic is so poorly understood.

The negative association between distance from university and enrollment of university has been demonstrated in several international studies. Frenette states that students living over 80 km away from a college are 37% less likely to attend college than those living within 80 km of a college (Frenette 2004). This study demonstrates that students within the 10 km measure, has significantly increased odds (odds ratio 10.89) of enrolling at university than students in the 40 km and above category after controlling for population density and deprivation.

Studies on Continental Europe suggest a more muted effect than those in the Commonwealth. In the Netherlands, Sá et al. emphasized that proximity primarily mediated the type

of institution attended and that the decision to attend university was only marginally associated with distance (Sá et al. 2006). The study on German access to higher education suggested that the benefits of living near a university declined to zero beyond 13 km radius from the universities (Spiess and Wrohlich 2010, p. 474). However, the Netherlands and Germany are relatively densely populated, both provide free public transport, and relatively generous grants and low fees, which may mitigate the negative influence of distance.

Significantly, Commonwealth studies highlight that students from low SES backgrounds experience a more pronounced negative association between distance and university attendance. Frenette suggests that the students from the top income tier are immune to the negative association of enrollment rates that middle and low income tier students appear to manifest (Frenette 2004). Parker et al. are more direct, stating that proximity is substantially associated with university attendance “with an especially large impact upon young people from low socioeconomic backgrounds” (Parker et al. 2015). England’s geographical size and relatively high population density may have more in common with the Netherlands and Germany. However, the similar wealth distributions, coupled with a relatively similar socio-economic history may mean Canadian and Australian conclusions are more relevant (OECD 2015).

Further investigation is required to decipher the mechanism that is driving the association. Inequalities in compulsory education may mediate differences. Professional families may be drawn to cities due to the labor market or enhanced amenities. Alternatively, low SES families may be pushed away from university towns due to rising house prices. Financial transactional costs and social costs were key themes that emerged from previous similar studies.

Financial Transactional Costs

Students living further away from universities incur greater costs in attending university through travel and relocation. Britain is unusual with its tradition of students moving away to university and there is evidence of a rise in students choosing to remain at home to complete their degrees (Christie 2005). The cost of relocation may be avoided if a student remains at home, yet students living in distant localities may not have this option. Of the students that remain at home to study, those living nearer to their university will have lower commuting costs. Relocation costs are increased for more distant students by increased travel costs but also less obvious costs, for example, the ability to use facilities at the family home, such as washing machines etcetera. Finally the cost of visiting home is reduced the closer a student’s university is to their home. Choosing to remain at home for university is a method of controlling risk, suggests Christie, and there is evidence that the proportion of students choosing to remain at home is increasing with the rise in tuition fees (Christie 2005; Gibbons and Vignoles 2011). Students are also increasingly likely to remain in their home region. Between 2002 and 2008 the proportion of students choosing to remain in their home region for university increased in every region and country of the UK (McClelland and Gandy 2011).

The increased financial costs of living remotely are repeatedly cited in the substantive literature as impacting students’ university decisions. Mangan et al. suggested that cost restricted the geographical locus of universities considered for application (Gibbons and Vignoles 2011; Mangan et al. 2010). The wider literature suggests that increased costs though increased tuition fees reduces enrollment rates (Hemelt and Marcotte 2011). Frenette concludes that direct and indirect financial costs contribute not only to lower enrollment from remote regions but also to students from low SES suffering a greater disadvantage from distance (Frenette 2004). Direct costs are identified as transactional costs, such as van hire and purchasing furniture. Indirect costs are more abstract, such as losing

the advantages of pooling resources, such as utilities, groceries and rent, when leaving the family home. Unlike Frenette's Canadian study, Spiess and Wrohlich's German study did not observe the same class differences (Spiess and Wrohlich 2010). Spiess and Wrohlich concluded that the observed effects of distance to university and university participation were primarily due to transactional costs such as "moving costs, rental costs, costs of purchasing new furniture or other items for a new apartment" (Spiess and Wrohlich 2010, p. 471).

Evidence in the substantive literature suggests that low income students geographically restrict their university applications (Mangan et al. 2010). Gibbons and Vignoles demonstrate that low income students travel shorter distances to university in the UK and that this has restricted entry to higher status institutions (Gibbons and Vignoles 2011). Frenette and Parker et al. suggest that low income families are more disadvantaged from their distance to a university (Frenette 2004; Parker et al. 2015). Frenette states "The patterns of university and college participation by family income and distance to school are consistent with the notion that added costs deter students in less favorable economic circumstances from pursuing a university or college education" (Frenette 2004, p. 440).

Social Costs

Distance costs cannot be reduced to purely financial variables. There are less quantifiable social costs that distance may engender. In Christie's qualitative study of students studying from home, participants explain how social and economic costs are calculated citing parental support and averting homesickness as reasons for remaining at home (Christie 2005). Quantitative studies in Germany and Canada identified the emotional cost as students leave "network of family and friends or may be unprepared to leave home" (Frenette 2004, p. 428; Spiess and Wrohlich 2010).

Parker et al. describe the Australian fee structure as "centrally regulated, consistent across universities and were largely covered by government low interest loans with conditional repayments determined by wage" (Parker et al. 2015, p. 1157). These features are comparable to the finances of higher education in England. However, Parker et al. place greater emphasis of the social and emotional costs in their conclusion. The study suggests that students from distant districts are more closely connected to rural communities and therefore pay greater social costs if they move away. English studies indicated that students from lower SES have a stronger desire to remain at home, which has been attributed to a stronger regional identity and positive connection with their local area (Brooks 2002).

Limitations

The decision was made to measure the direct distance between each ward and selected HEIs. This calculates the shortest distance between each ward and HEI but may not reflect the exact distance travelled due to local geography. There are strengths and weaknesses in all forms of measurement. An aggregation of all modes of transport or a more sophisticated model may be a superior measurement tool. Unfortunately, due to the complexity of the variables, this was beyond the scope of the study. Direct distance measures have been revealed to be highly correlated with other transport network measures (Gibbons and Vignoles 2011). Therefore this method should not threaten the validity of the broader trends.

The regression analysis used aggregated data from students that entered higher education between 2009 and 2014. A more recent dataset with statistics on each student in compulsory education provision, would provide a greater understanding of the topic. Students' opportunities are mediated by their access to compulsory education. The quality of secondary education in England is unequally distributed across the regions and may influence the association (Manley and Johnston 2014). The IMD Education and Skill domain included 7 educational subdomains; one of which was mean Math, and English test scores. Individualized school data could provide a greater depth of understanding on this topic. UK compulsory education was marketized in the 1990s and encouraged choice for families (Chitty 2014). As a consequence, students regularly attend a school that is not their most local in search of a religious, specialist or higher quality education. Local authority averages are problematic due to the polarised outcomes. The complications above and a lack of access to individual level data means that the including primary and secondary school data was unfeasible within the scope of this study.

Policy Implications

In the UK, distance to university is not recognized as a disadvantage. There are therefore several policy implications in light of the association that this study suggests. If the government wished to provide equal access to university across the country it could implement a number of changes to support students with poor access in higher education 'cold spots' (Else 2014). Raising awareness is a policy implication in itself. The issue needs to be better understood and recognized before it can be tackled.

Access could be improved by opening universities in regions with disproportionately few higher education institutions. Encouraging local colleges to offer basic degree courses could be a sustainable method to achieve this goal. Coastal communities have been identified as disproportionately economically deprived. Many are too far from universities to commute and rely on a seasonal economy. Expanding their colleges to offer university courses or establishing a university may have immeasurable benefits.

It is well evidenced that reducing costs boosts access (Dynarski and Scott-Clayton 2013). In the Netherlands all students are entitled to a free rail pass and the association between distance and attendance is not observed (Sá et al. 2006). Offering subsidies or free transport to students to allow travel to and from university could be explored as a policy option if further research confirmed distance to be a barrier. This may appear to be a substantial cost but the cost of a low skilled workforce may cost more. Grants to students from communities that are distant from universities may not only provide an incentive but also raise awareness of the issue.

Financial support could be assessed on not only income but also locality. Spiess and Wrohlich note that the stronger negative association between university participation and distance for low income families does not feature in Germany as it does elsewhere (Spiess and Wrohlich 2010). Financial support that is dependent on relocation costs and parental income is suggested as the reason for this disparity. Before such policy proposals are made, more considerable research would need to be undertaken.

The Oxbridge model of link colleges cannot be replicated by universities without a collegiate system and no UK universities have comparable resources to implement substantial nation programs. However, encouraging universities to publish where they operate their widening participation schemes could help identify and address underserved communities. Large universities could be encouraged to replicate the a link colleges or link faculty scheme. Legislating universities to publish such information could prompt cooperation

between the Office for Students and HEIs to ensure that all communities have fair access to university outreach and widening participation programs.

Further Research

The findings suggest that as distance from universities increases the probability of attending university decreases. Studies suggest that as fees increase the number of students choosing to remain at home is increasing (Callender and Jackson 2008; Gibbons and Vignoles 2011). Further research could investigate if the association of distance and participation is increasing and determine if financial circumstances impact the association. Additional datasets could more simply be utilized to establish trends in the relationship explored in this paper, which were unfortunately beyond the scope of the paper.

Datasets that more accurately measure the complexities of distance, accounting for time and cost of most common means of travel, could help to further our understanding of the topic. Similarly, individual level data on access to compulsory education would allow a greater understanding of the impact of prior education. Further data could ultimately be used to establish the causality and the direction of the relationship.

Greater detail on regional patterns could help identify which regions have the greatest influence on the association. This article is focused on the national narrative for England but future research may find that regional analysis enhances the understanding of the relationship. Disaggregating the model by IMD or MSOA may also help determine the mechanism of the association. Further models were not included as it was felt that they would distract from the focus of the paper. Contextualizing the quantitative data with qualitative data, particularly on the social costs could also provide greater insight.

Conclusion

This research paper has investigated the relationship between geographical distance to university and participation. The study employed a regression analysis of national participation data. The research questions aimed to quantify the association between distance and university participation.

University access has important implications for social mobility and training a workforce for the globalized economy. Fair access is the cornerstone of an egalitarian society and engenders social cohesion. Programs aimed at widening participation among unrepresented groups have increased alongside tuition fees but current initiatives do not recognize remote students as an unrepresented group (Chowdry et al. 2010; Morrison 2011; Turley 2009). Grants to cover relocation or financial support to cover travel to HEIs do not exist in England as they do in other European countries (Spiess and Wrohlich 2010).

The regression analysis revealed a negative association between mean distance to HEI and university participation, after controlling for deprivation and population density. For students within 10 km of an HEI, the odds of being in a higher participation group is 10.9 times that of those students who are more than 40 km away (reference group). The project was inspired by concerns that large northern towns without universities were disadvantaged but the implications of proximity appears to be a more broad and complex topic. Widening participation initiatives aimed at supporting disadvantaged groups routinely fail to recognize the obstacle of geography. The implications of this paper suggest that

priorities need to be revised and universities need to be encouraged to coordinate how they promote higher education in their hinterlands.

The investigation provided a further indication that measures of deprivation correlate with university participation. The finding that the probability of attending university diminishes with distance to HEI is particularly important because geography is underreported and an unacknowledged barrier. This may be particularly topical in light of the Brexit referendum vote, in which rural regions predominantly voted “Leave” in contrast to urban areas with better access to higher education. The vote has been interpreted as a protest against a “metropolitan elite” and anger at poorer access to university places, and subsequent opportunities, may form part of this debate (The Economist 2016).

This paper builds on a mixed methods thesis which can be accessed via the following link: <https://ora.ox.ac.uk/objects/uuid:a5c6f013-9110-4a74-a850-deb8f33e4b34>.

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Appendix

See Figs. 1, 2 and Tables 4, 5, 6, 7 and 8.

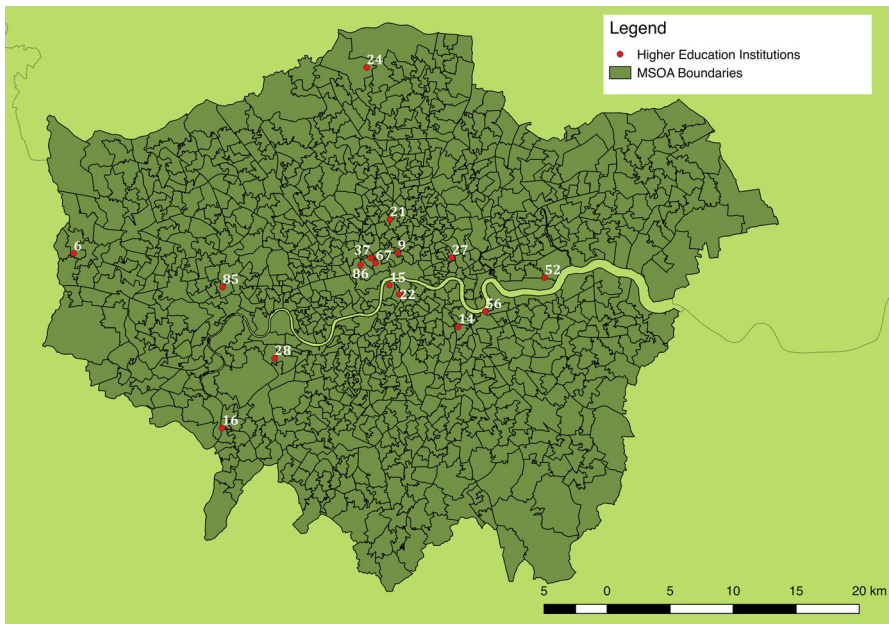
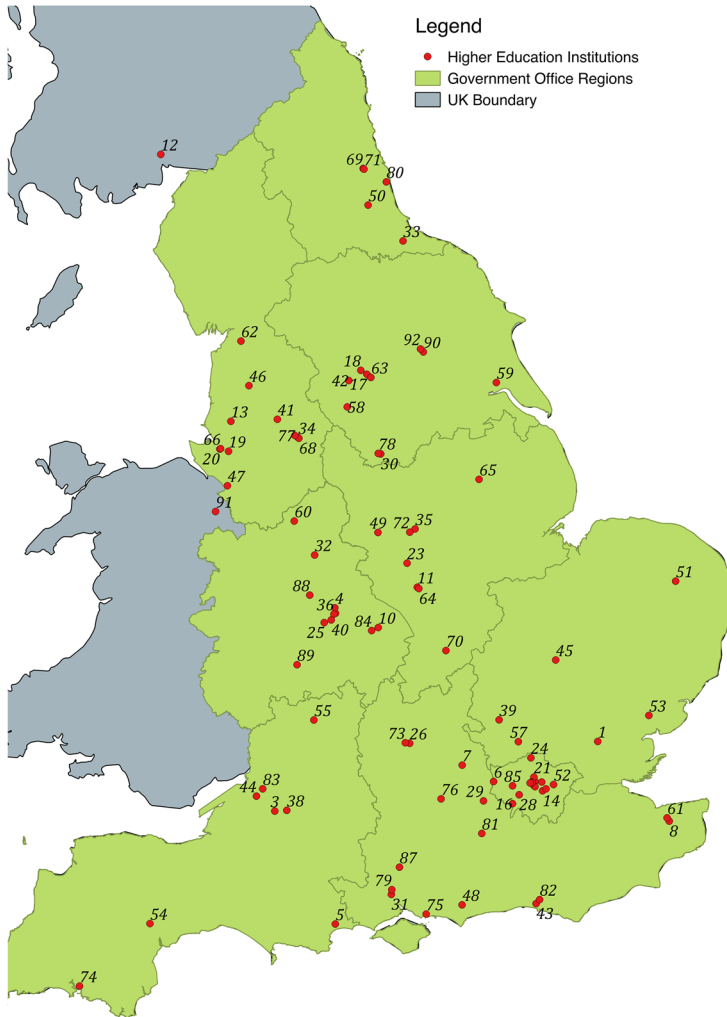


Fig. 1 Map of greater London higher education institutions with MSOA BOUNDARIES displayed



Key

No. University

- | | | | |
|---|---|--------------------------------------|---|
| 1 Anglia Ruskin University | 24 Middlesex University | 47 University of Chester | 70 University of Northampton |
| 2 Aston University | 25 Newman University College | 48 University of Chichester | 71 University of Northumbria At Newcastle |
| 3 Bath Spa University | 26 Oxford Brookes University | 49 University of Derby | 72 University of Nottingham |
| 4 Birmingham City University | 27 Queen Mary and Westfield College | 50 University of Durham | 73 University of Oxford |
| 5 Bournemouth University | 28 Roehampton University | 51 University of East Anglia | 74 University of Plymouth |
| 6 Brunel University | 29 Royal Holloway and Bedford New College | 52 University of East London | 75 University of Portsmouth |
| 7 Buckinghamshire New University | 30 Sheffield Hallam University | 53 University of Essex | 76 University of Reading |
| 8 Canterbury Christ Church University | 31 Southampton Solent University | 54 University of Exeter | 77 University of Salford |
| 9 City University | 32 Staffordshire University | 55 University of Gloucestershire | 78 University of Sheffield |
| 10 Coventry University | 33 Teesside University | 56 University of Greenwich | 79 University of Southampton |
| 11 De Montfort University | 34 The Manchester Metropolitan University | 57 University of Hertfordshire | 80 University of Sunderland |
| 12 Crichton Campus Dumfries | 35 The Nottingham Trent University | 58 University of Huddersfield | 81 University of Surrey |
| 13 Edge Hill University | 36 University College Birmingham | 59 University of Hull | 82 University of Sussex |
| 14 Goldsmiths College, University of London | 37 University College London | 60 University of Keele | 83 University of the West of England, Bristol |
| 15 King's College London | 38 University of Bath | 61 University of Kent | 84 University of Warwick |
| 16 Kingston University | 39 University of Bedfordshire | 62 University of Lancaster | 85 University of West London |
| 17 Leeds Beckett University | 40 University of Birmingham | 63 University of Leeds | 86 University of Westminster |
| 18 Leeds Trinity University | 41 University of Bolton | 64 University of Leicester | 87 University of Winchester |
| 19 Liverpool Hope University | 42 University of Bradford | 65 University of Lincoln | 88 University of Wolverhampton |
| 20 Liverpool John Moores University | 43 University of Brighton | 66 University of Liverpool | 89 University of Worcester |
| 21 London Metropolitan University | 44 University of Bristol | 67 University of London | 90 University of York |
| 22 London South Bank University | 45 University of Cambridge | 68 University of Manchester | 91 Wrexham Glyndwr University |
| 23 Loughborough University | 46 University of Central Lancashire | 69 University of Newcastle Upon Tyne | 92 York St John University |

Fig. 2 Map of higher education institutions included in the analysis within English government regions

Table 4 Data sources

Data	Smallest level of disaggregation	Source	Source
HEFCE Gaps in Young Participation in higher education	ONS MSOA	Office for Students (formerly held with the Higher Education Funding Council for England)	https://www.officeforstudents.org.uk/data-and-analysis/polar-participation-of-local-areas/
ONS English indices of deprivation	ONS LSOA	UK Governmental Department of Communities and Local Government	https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015
HEFCE registered higher education providers	List of UK registered higher education institutions	Higher Education Statistics Agency (formerly held with the Higher Education Funding Council for England)	https://www.hesa.ac.uk/support/providers
ONS 2011 MSOA population weighted centroids	ONS MSOA based on 2001 census	Office for National Statistics	https://ons.maps.arcgis.com/home/item.html?id=b0a6d8a3dc5d4718b3fd62c548d60f81
ONS 2011 rural urban classification	ONS MSOA based on 2001 census	Office for National Statistics	https://ons.maps.arcgis.com/home/item.html?id=3ce248e9651f44c094f844c5de18655

Table 5 Omitted specialist and minor registered universities

The Arts University College at Bournemouth	Northern School of Contemporary Dance
Birkbeck College	Norwich University of the Arts
Bishop Grosseteste University College Lincoln	Plymouth College of Art
Central School of Speech and Drama	Ravensbourne
College of St Mark & St John	Rose Bruford College
Conservatoire for Dance and Drama	Royal Academy of Music
Courtauld Institute for Art	Royal Agricultural University
Cranfield University	Royal College of Art
Falmouth University	Royal College of Music
Guildhall School of Music and Drama	The Royal College of Nursing
Harper Adams University	The Royal Veterinary College
Heythrop College	St George's Hospital Medical School
Imperial College of Science, Technology and Medicine	St Mary's University, Twickenham
Institute of Cancer research	School of Oriental and African Studies
Institute of Education	The School of Pharmacy
Leeds College of Art	Trinity Laban
Leeds College of Music	University College Birmingham
Leeds Trinity University	University College for the Creative Arts
Liverpool Institute of Performing Arts	University of Buckingham
London Business School	University of Cumbria
London School of Economics and Political Science	University of Arts London
London School of Hygiene & Tropical Medicine	

Table 6 Distance and rural urban classification, percentage of cases

Distance	Rural Urban Classification			
	Rural (%)	Semi-rural (%)	Suburban (%)	Urban (%)
0 < 10 km	0.1	0.3	11.2	88.4
10 < 20 km	3.1	6	36	55
20 < 30 km	10.3	12.8	71	5.9
30 < 40 km	16.2	13.3	67.9	2.7
40 km and beyond	25.4	20.6	54	0

Table 7 Ordinal logistic regression analyses of higher education enrollment quintile, separate models of IMD domains

	Income	Employment	Education, Skills and training	Health deprivation and disability	Crime	Barriers to housing	Living environment
Odds ratio (standard error)							
<i>Distance factor</i>							
Mean distance to HEIs							
0 < 10 km	10.5 (1.1)*	6.2 (0.8)*	4.5 (0.5)*	7.4 (0.8)*	12.3 (1.3)*	5.2 (0.5)*	6.6 (0.7)*
10 < 20 km	2.1 (0.2)*	1.9 (0.2)*	1.7 (0.2)*	2.6 (0.2)*	3.8 (0.3)*	3.5 (0.3)*	3.2 (0.3)*
20 < 30 km	1.5 (0.1)*	1.4 (0.1)*	1.4 (0.1)*	1.7 (0.1)*	2.3 (0.2)*	2.1 (0.2)*	1.9 (0.1)*
30 < 40 km	1.4 (0.1)*	1.1 (0.1)	1.3 (0.1)*	1.2 (0.1)*	2.2 (0.2)*	1.8 (0.1)*	1.7 (0.1)*
40 km +	Referent	Referent	Referent	Referent	Referent	Referent	Referent
<i>Socio-economic factors</i>							
IMD Domain:	2.2 (0.0)*	2.4 (0.0)*	4.0 (0.1)*	2.0 (0.0)*	1.5 (0.2)*	1.0 (0.1)*	1.1 (0.0)*

Regression controlled for population density with Rural Urban classification measure

HEIs higher education institutions, *IMD* index of multiple deprivation

*p < 0.05

Table 8 Ordinal logistic regression analyses of higher education enrollment quintile single model of IMD domains

	Odds ratio (95% confidence interval)
<i>Distance factor</i>	
Mean distance to HEIs	
0 < 10 km	2.24 (1.73, 2.89) ***
10 < 20 km	2.05 (1.67, 2.51) ***
20 < 30 km	1.81 (1.49, 2.19) ***
30 < 40 km	1.52 (1.24, 1.86) ***
40 km +	Referent
<i>Population density factor</i>	
Urban	0.98 (0.73, 1.32)
Suburban	0.62 (0.49, 0.80) ***
Semi-rural	0.90 (0.69, 1.18)
Rural	Referent
<i>Socio-economic factors</i>	
Income	0.80 (0.72, 0.89) ***
Employment	1.00 (0.90, 1.12)
Education, skills and training	5.48 (5.13, 5.85) ***
Health, deprivation and disability	2.12 (1.15, 1.28) ***
Crime	0.91 (0.87, 0.95) ***
Barriers to housing	0.79 (0.76, 0.81) ***
Living environment	0.84 (0.81, 0.86) ***

Notes: HEIs = Higher Education Institutions

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

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