

SOCIAL NETWORK ANALYSIS METHODS AND THE GEOGRAPHY OF EDUCATION: REGIONAL DIVIDES AND ELITE CIRCUITS IN THE SCHOOL TO UNIVERSITY TRANSITION IN THE UK

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ABSTRACT

This paper uses social network analysis methods to explore how the spatial mobility of students to attend university creates regional divisions and socio-spatial hierarchies of schools and universities. Using community detection methods as our methodological lens we stitch together regional economic geography, the student mobilities literature and the sociological and geographical analysis of elite education. Combining these statistical techniques with qualitative data from our broader study, we explore student flows between different geographical areas in the UK for universities. The clusters or ‘communities’ of areas underline how student migration to attend university in the UK is a moment which reflects and re-creates regional and national boundaries. The second part of the paper examines school to university student flows, highlighting a distinctive, predominantly English cluster of elite schools and universities. Examining student mobility patterns with network methods allows us to distinguish a distinctive archipelagic geography of elite formation through higher education.

Key words: elites; spatial mobility; geography of education; higher education; regions, social network analysis

INTRODUCTION

In this paper we explore how social network analysis (SNA) can be used to examine how the spatial transition between school and university is a moment of regional boundary and elite formation. Regional circuits of higher education involving mostly newer, less prestigious universities and state schools sit alongside a distinctive national set of elite English universities and elite private and state schools. These distinctive patterns of recruitment by elite universities from elite schools suggest distinctive ‘circuits of power’ running between certain de facto ‘feeder schools’ and particular universities. Using SNA techniques alongside rich qualitative data allows

us to develop a detailed picture of the relational construction of place and the distinct geographies of class formation within the spatial transition from home to university.

From a theoretical and empirical perspective, our analysis seeks to tie together analyses of student mobility (Holdsworth 2009; Holton & Finn 2018), regional geography (Massey 1995; Paasi 2003) and the analysis of elite formation through education (Maxwell & Aggleton 2015; Reeves *et al.* 2017; Wakeling & Savage 2015; van Zanten *et al.* 2015). The approach taken here seeks to develop an approach to analysing how the geographies of higher education are embedded in the political economy of regional economic division and the geographies of class

formation (Donnelly & Gamsu 2018). Until now, regional geographies of higher education have largely focused on the economic role of universities within their own region (Boucher *et al.* 2003; Bramwell & Wolfe 2008). Graduate migration patterns have received substantial attention (Hoare & Corver 2010; Venhorst *et al.* 2010), as has the analysis of youth migration for university (Faggian *et al.* 2006; Ciriaci 2014; Liu *et al.* 2017). The analysis of higher education and the region has not often sought to understand the role universities play in reinforcing cultural differences and regional divides; Vandermotten's (2017) analysis of Belgian student recruitment and French/Flemish regional divisions is an exception we seek to build on. What we explore here is the way in which spatial transition to university represents a moment of creation of regional boundaries and how these are tied into patterns of class formation. The mass movement of students from home to university in the UK is precisely a moment during which historical and cultural regional divisions both shape students' choices and are in turn re-created among a new generation of young people.

Among the regional divisions evident in the transition to university, we also examine the distinctive patterns of spatial movement between elite schools and universities. The patterns of mobility that we explore here may be something that is specific to the UK system of higher education, and particularly England (this is not true for Scotland) (Holdsworth 2009). The legacy of boarding and grammar school education reinforced the pattern of leaving home as a key element of elite formation (Musgrove 1963). Many provincial English universities founded from the late nineteenth until the mid-twentieth century saw rising national, as opposed to local, recruitment as a marker of status and achieving the ideal and status of a 'residential' university which adhered to the Oxford/Cambridge (Oxbridge) ideal (Musgrove 1963; Anderson 1995). Spatial mobility to attend an elite university is not unusual internationally, with attending an Ivy League university in the US, a Parisian *Grande École* or Tsinghua or Beijing university likely to involve considerable spatial mobility for non-metropolitan students. However, we lack an empirical comparative study of how class formation, spatial mobility and higher education intersect. It is perhaps

the scale and influence of institutional and class mimesis in aping the residential model of HE that sets the English system apart but this paper can only underline the need for broader comparative work in this area.

The patterns we analyse here suggest that, in England at least, elite reproduction through the education system occurs in ways that are not strictly embedded within a particular region, though they are undoubtedly strongest in London and the South-East. Recent analyses of elite education have begun to explore the geography of elite education (Giesecking 2007; Koh & Kenway 2016; Kenway *et al.* 2017), but this research has not been able to explore these geographies without anonymising schools and locales. Our analysis thus seeks to explore the school to university geography of elite university attendance which has been implied but not explored empirically in recent papers within the sociology of elite formation (Reeves *et al.* 2017; Wakeling & Savage 2015). Using social network methods as our methodological lens we stitch together regional economic geography, the student mobilities literature and the sociological and geographical analysis of elite education. This requires combining a range of theoretical and empirical literature to develop a rich geographical, historical and sociological analysis of how the moment of transition to university represents an intertwined moment of regional and class boundary formation.

Theorising Education Through the Geography of Regions and Class Formation – The geography of class formation and the formation of regional boundaries are interwoven processes, but exploration of this in relation to education has been limited. In geography, debates over the 1980s and 1990s explored how the geography of class formation was interwoven with the geography of uneven economic development (Martin 1988; Massey 1995; Savage *et al.* 1995; Allen *et al.* 1998). In noting the particular effect of the concentration of industries in the formation of regional boundaries in South Wales, Cooke (1985, p. 211) argued that 'regional boundaries are largely coterminous with the limits of dominant class practices'. This is particularly important to our understanding of the geography of education more broadly

and the spatial transition to higher education specifically. National recruitment of students educated at boarding schools from elite and middle-class backgrounds was the paradigmatic model of higher education within the English system set by Oxbridge which newer universities sought to replicate over the twentieth century (Musgrove 1963; Holdsworth 2009). Compared to the other countries of the UK, in the English model of higher education this historic class binary remains strongly associated with white middle-class students (Holdsworth 2009; Khambhaita & Bhopal 2015). While we do not measure class directly here, the geographies which we examine below underline how the formation of regional boundaries is tied into particular cultural practices which are associated with the exercise of power and the creation of distinction through education. As Massey (1993, p. 60, original emphasis) notes, what matters is 'not merely the issue of who moves and who doesn't [...] it is also about power in relation to the flows and movement'.

What we propose here is to firmly embed the analysis of the geography of education within an understanding of uneven economic development and patterns of class formation. In the UK, a central focus of this debate examined how London and the South-East was the centre of neoliberal forms of economic development and had a large concentration of managerial and professional occupations than other regions (Savage *et al.* 1995; Allen *et al.* 2012). More recent research has examined the London-centred geography of the British elite (Cunningham & Savage 2015), with the older universities of London alongside Oxbridge forming a 'Golden Triangle' closely associated with this London elite (Wakeling & Savage 2015). Aside from this implicit geography of elite formation through higher education developed by Wakeling and Savage, there has been little attempt to examine how regional geography is interwoven with patterns of class formation through education. Bourdieu's (1996) analysis of the formation of the French elite emphasised the dominance of the Parisian *grandes écoles vis-à-vis* their provincial counterparts, and the predominantly Parisian intake of the Parisian schools. Beyond this however, Bourdieu's analysis does not attend to the geography of educational institutions as a central

concern. In this paper we seek to embed an understanding of education during the school to university transition in an understanding of regions and spatial patterns of class formation.

We approach these questions by combining the relational understanding of place presented by Massey (2005) with concepts from the sociology of education. In Massey's (2005, pp. 138–139) terms, place forms 'where the successions of meetings, the accumulation of weavings and encounters build up a history'. Universities are one such location where repeated movements of individuals re-occur. These socio-spatial trajectories of young people from home to university, can be understood by combining Massey's theory of place formation with concepts developed within the sociology of education. Ball *et al.* (1995), developed the concept of circuits of schooling to describe how secondary school choices were affected by class differences in attitudes towards, and capacities for, spatial mobility. Working-class students tended to attend their local school while middle-class parents sought out prestigious schools which often involved travelling considerable distance. These socio-spatial patterns in home to school movements are paralleled in the literature examining higher education. In England, working-class students tend to stay local for university, sometimes living at home, while normative middle-class trajectories for university study involve moving away from home and attending university some distance away from home (Holdsworth 2009; Khambhaita & Bhopal 2015; Patiniotis & Holdsworth 2005). This simple binary hides more complex patterns of mobility in students' everyday lives (Holton & Finn 2018). Nonetheless, these classed divisions structure the major flows of students between home/school and university.

To describe these collective flows of students from home to university, we use the term, 'circuits of education'; the collective socio-spatial patterns of movement between places and institutions that occur in the transition from school to university (Gamsu 2017). As we have argued elsewhere, these circuits of education do not simply occur on one occasion but are repeated year after year, 'layered over time and meshed with particular regional and local structures of class', race and gender (Gamsu 2017). These 'accretions of meetings' (Massey 2005) between

students, town and university create and re-create particular institutional identities for certain universities, with movements from schools/colleges to universities of different levels of cultural and symbolic prestige. Equally important here is how the moment of spatial transition to university creates and reflects regional boundaries. Attending university is a moment of mass migration and students' decisions and spatial trajectories to university suggest particular regional boundaries in young peoples' migration patterns. Beyond the official UK Government Office Regions (see Figure 1), we explore how

flows of students in the transition to university create regional boundaries. These regional boundaries overlap with distinct socio-spatial hierarchies of schools and universities and geographies of class formation.

In this paper we use SNA techniques, combined with qualitative interview and mapping data, to understand how circuits of education create particular regional divisions and suggest a spatial hierarchy of universities and schools. We apply the methods explained below to a highly detailed dataset including all UK students who began their first year of undergraduate study in



Figure 1. *Official nations and regions of the United Kingdom. Contains national statistics data © Crown copyright and database right.*

2014–2015. This dataset includes approximately 412,697 students, excluding international students from our analysis. The data was extensively

cleaned and individuals were aggregated to produce two matrices, first showing local authority to local authority (LA) movement, used for the

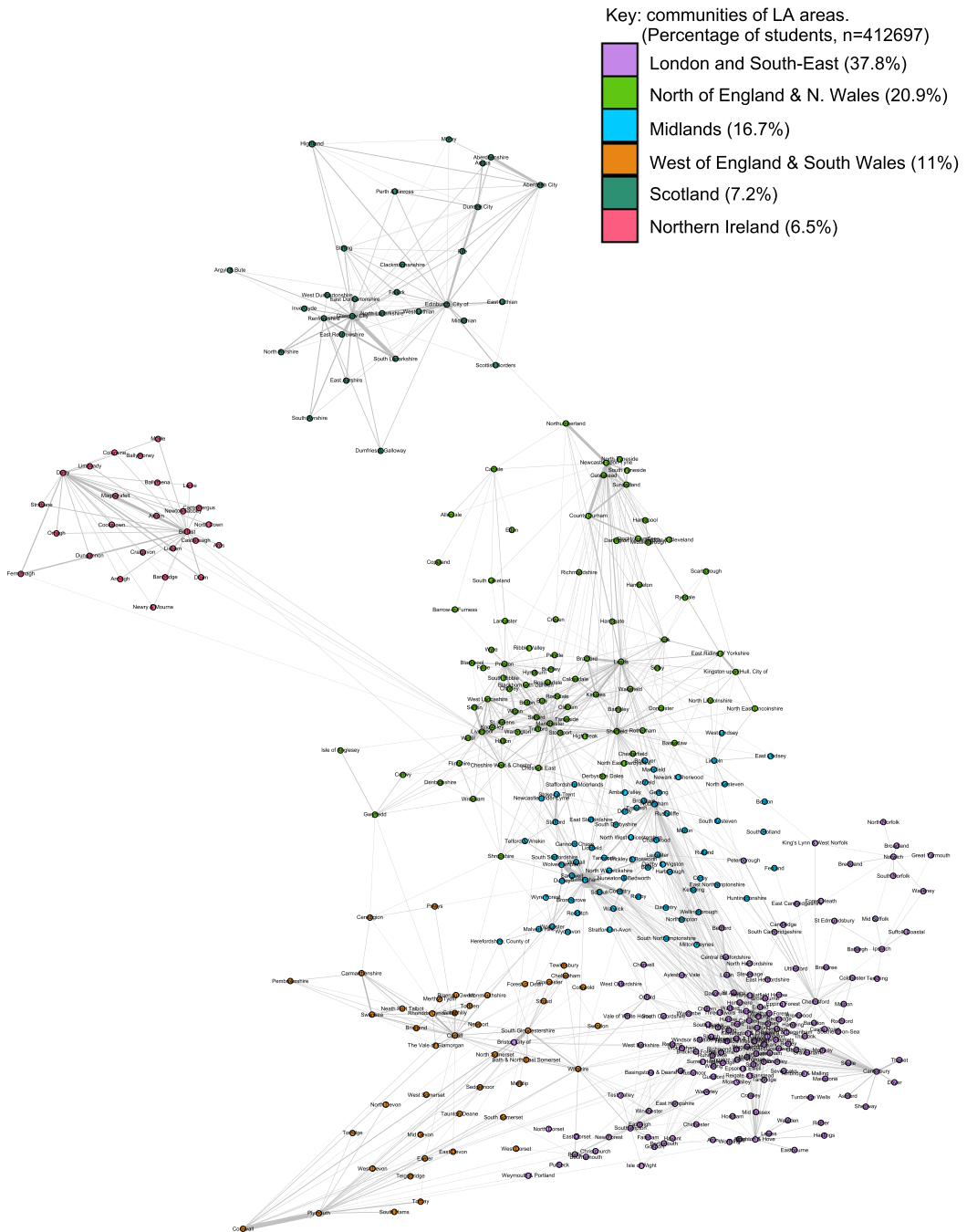


Figure 2. Graph showing local authority to local authority student movements with community detection applied showing communities by node colour

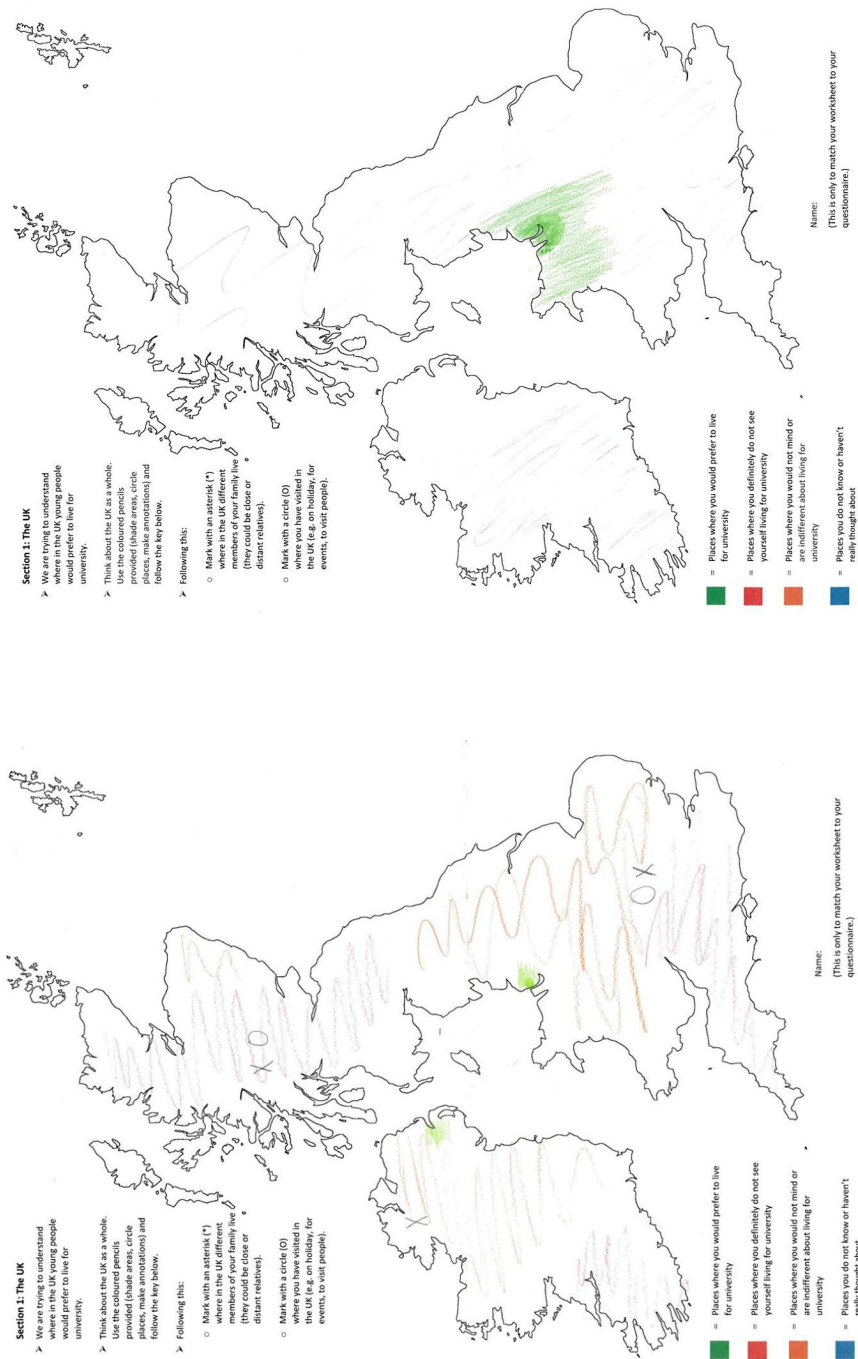


Figure 3. Spatial maps of HE choices by students at Northern Irish case study schools

first SNA analysis (Figure 2), and second school to university movement (Figure 3). For the first analysis we used the full cohort of 412,697 students. Missing data for school attended prior to entering university meant for the second analysis $n = 363422$. Within the geography of education SNA methods have been used to visualise the movement of students between primary and secondary school on two occasions (Donoso Díaz & Arias Rojas 2012; Harris 2013), but beyond these visualisations SNA methods have not been used in greater analytical depth for spatial analyses of education. We use community detection methods, also known as 'modularity analysis', to analyse the movements of students between different localities and between school or college and university. This is not the first study to have used this technique to analyse regional divisions; Ratti *et al.* (2010) used community detection methods to explore regional boundaries suggested by telephone call data. Comber *et al.* (2012a) also used these methods to examine the communities suggested among twitter users in London. Within the geography of education however, SNA has received little attention. Our analysis here builds on earlier work using community detection methods to observe hierarchies of schools in London at the point of school to university transition (Gamsu 2017).

Modularity analysis is a method for discovering how networks are organised in clusters or 'communities' of nodes. Within these communities there are a greater number of links or edges between members of the community than to other nodes within the network than would be expected at random (Fortunato 2010). In this context, the communities suggest either groups of LA districts where students are more likely to move within these areas than to surrounding districts, or particular clusters of schools/colleges and universities which suggest spatial and hierarchical patterns of school to university recruitment. These techniques are used by other authors in the special issue and a more detailed exposition of modularity analysis is provided in a paper within the issue. For this reason we do not provide a detailed description of these methods here, but particular algorithms were used over the two parts of the analysis.

In the first case (Figure 2), flows of students between different areas, we use Newman and

Girvan's (2004) definition of modularity as operationalised in Gephi using the algorithm developed by Blondel *et al.* (2008). These are flows of students from the LA area of their home address prior to university and the LA in which their university was located. For the second case (Figure 4), showing flows of students from schools to universities, the network is bipartite in structure as students cannot move from school to school only school to university. This means a different set of community detection methods are necessary. To account for the bi-partite nature of the graph, Dorman and Strauss's (2013, 2014) R package, 'bipartite' was used to provide an alternative measure of modularity which accounts for weighted, directed, two-mode (i.e. bi-partite) data. They use Beckett's (2016) algorithm which is specifically designed to analyse modularity in this type of network. Modularity analysis works by 'assessing whether the interactions [in our case the number of students moving between schools and universities] in a network occur within modules rather than between modules, relative to a null model' (Beckett 2016, p. 2). The measure of modularity used by Dorman and Strauss (2013) and Beckett (2016) is that outlined for weighted bipartite networks by Barber (2007) and it varies between 0 and 1, with a higher Q indicating greater evidence of network division into modules. Newman and Girvan (2004) define Q as measuring the proportion of edges in the network that link to nodes of the same community minus the expected value in a network with the same communities but with random connections between nodes. These Q -values must be compared with several runs of modularity values for a randomised version of the same graph. To achieve this, we use the metaComputeModules command within 'bipartite' to run the algorithm several times and returning the most modular result. Nonetheless, as with cluster analysis techniques used to explore university hierarchies (Boliver 2015), these analyses are iterative and exploratory, with community structure tending to vary slightly between runs (Dormann & Strauss 2013).

We complement the community structures of regional division and spatial institutional hierarchy, by drawing on the qualitative material

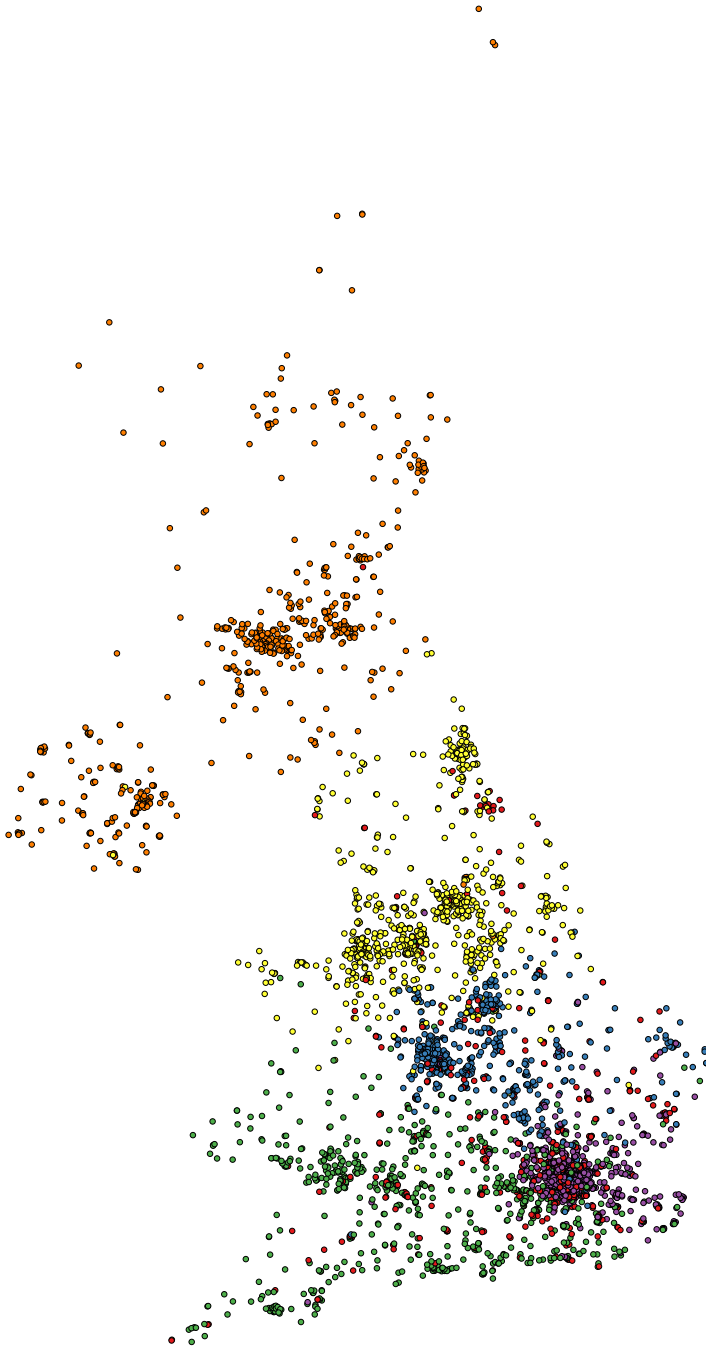


Figure 4. *Graph of school to university movements with community detection applied showing communities by node colour (Note: edges not shown for legibility)*

collected within our broader study. Alongside the quantitative analysis of HESA data, our research involved interviews, surveys and spatial mapping exercises with young people across

twenty schools across the UK. The schools included cut across geographical, institutional and cultural differences to allow us to explore the spatial imaginaries and geographic knowledge of young people across various settings. Our research included schools across Scotland, Wales, Northern Ireland and the English regions, private and state schools, selective and non-selective, Protestant and Catholic, rural and urban. From April 2017 to January 2018, we surveyed all students in either their final or penultimate year (aged 17/18) as they were deciding where to study for university (For details, see: Donnelly *et al.* 2020). This survey was complemented by a spatial mapping exercise where students were asked to highlight areas they would consider as potential locations that they would like to study in, those that they would not consider and areas that they were unsure about or did not know. Using these maps and surveys we selected ten students per school to interview, using their maps as the basis for semi-structured interviews focusing on the geographies through which their knowledge of higher education was constructed and prescribed. The maps themselves also provide a valuable resource for understanding the flows of students to particular universities as we examine below.

Regional Circuits of Higher Education: Exploring the Geography of University Recruitment and Intake Patterns – We begin our analysis by looking simply at flows of students between different LA districts/areas, these LA areas form the nodes in the network.¹ What we see visualise here are the migratory movements of students between different areas effectively allowing us to explore shared catchments of different university towns and cities. Using students' home postcode and their postcode while at university, we aggregated these individual addresses to the LA in which each of these postcodes are situated. What we see in Figure 2 is an authority to authority graph, with directed, weighted edges showing the movement of students from their home LA to their university town or city. The Q value calculated in Gephi is 0.422. On the graph (Figure 2), the thicker the line, the more students move from home to university. Each node (i.e. each LA area) is positioned geographically using the longitude and latitude of the centroid of each area, this was calculated

in R and then plotted in Gephi. To make the graph more legible we have filtered edges so that only movements of students of 50 students or more are shown on the map. This allows us to concentrate on the large movements of students and removes the 'noise' of many LA to LA movements for university which involve small numbers of students.

The communities detected here by the modularity analysis, confirm the findings reported elsewhere (Raffe & Croxford 2013) that the Scottish and Northern Irish systems of higher education tend to recruit largely from within their own nations. Taking Scotland first, only Northumberland, the northern-most county in England situated on the Scottish border sends 50 or more students to a single Scottish LA area. None of the Scottish LA areas send 50 or more students to a single other LA in the UK, suggesting that where students do migrate out of Scotland for higher education, they do so to a range of different university towns or cities in relatively small numbers. We will return to the Northern Ireland case below, using qualitative data to complement our understanding.

In contrast to both Scotland and Northern Ireland, the community detection analysis suggests Wales is more closely linked into regional patterns of university recruitment within England. Movements between LA areas suggest that the larger regional boundary of student migration to and from Wales splits it into North and South Wales, with South Wales tied into a region of higher education migration with parts of the South-West of England (coloured orange) and North Wales tied into a separate region with parts of the North of England (coloured lime green). This reflects the cultural and geographic divides within Wales with poor transport links and the legacy of an extractive political economy centred on moving goods and materials into England, embedding and creating North-South cultural and linguistic divisions. It is also interesting to note the comparative integration of Welsh students into Anglo-Welsh regional circuits of higher education. Relative to Scotland or Northern Ireland there appears to be a less distinct and autonomous pattern of higher education recruitment, though further work is needed here. The community detection analysis suggests that patterns of student migration

reflect distinct cultural and geographical spatial divides which are subtly different from the official government office regions (Figure 1).

The other inter-area flows of students within England also suggest a broad Midlands region of student movement centred on Birmingham, as well as a Northern English region which crosses the official regions of Yorkshire and the Humber, North West England and the North-East. A final set of regional circuits of higher education is suggested that centres on London but includes East Anglia and large parts of Southern England South of the Thames river. The regional boundaries suggested by the modularity analysis reflect the fact student recruitment is largely localised, with 55.8 per cent of first-time UK undergraduate students attending university less than 91km from their home (Authors). These migrations do not necessarily reflect official regional boundaries but instead create different *de facto* regional circuits of higher education with broader geographical boundaries. Geographies of student mobility and spatial transition enact and re-create regional boundaries, with the repeated movement of students through space to particular localities. The regional boundaries that we suggest here are exploratory and iterative but they show the strength of applying network analysis spatially to reveal the relational construction of place. Using the case of Northern Ireland, we now draw on qualitative interview and mapping material to show how students' affective ties to particular locales embed the transition to higher education into longer regional histories of migration and cultural affinity. As we will see, circuits of higher education play a role in the reproduction of regional boundaries and cultural affinity over generations.

The area to area movements of students between Northern Ireland and Liverpool (Figure 2) suggest the moment of spatial transition to university is a moment at which historical patterns of migration are enacted. As noted above, there is a distinct Northern Irish community of inter-area flows of students detected by the modularity analysis. However, also visible on the map are a large number of areas in Northern Ireland which send 50 or more students 'across the water' to Liverpool.

When viewed in the context of interviews with students from a Roman Catholic selective secondary school and a non-selective Protestant secondary school, we can see how these flows reflect and enact cultural ties that cross the Irish Sea.²

loads of people from Ballygelvin go over there so it would be good [...]. It's, because it's like a different country but it's all within a community that you would be used to'. (Sally. Ballygelvin RC Grammar School)

Then there's [pause] Liverpool, I wouldn't really wanna go to because, like my brother goes to Liverpool and he loves it, but he [pause] has always been like, a 'Ballygelvin boy' kind of thing. Like [...] there's so many of his friends that are over there now. So he's now like going into a house with all Ballygelvin ones.[...] that wouldn't be for me really.

What's a Ballygelvin boy? How would you describe a Ballygelvin boy?

[...] I don't know he loves like, the atmosphere of Ballygelvin and like I love it too but it's just not what I, I don't want to be like that for another like, four years or so. [...] I think it's just 'cause I kinda wanna like, get away and experience a new culture. And I don't think Liverpool would really do that, because so, like, so maybe people from Ballygelvin go there. (Sophie. Ballygelvin RC Grammar School)

And you said you'd always thought of going to Liverpool, what's made you think of that?

I've always been a Liverpool fan, so I go over like 3 or 4 times a year anyway, and I've always kind of fallen in love with the city basically. So I've always thought if I was to leave home, because it's basically a home from home for me. I've got quite a few, like, close family friends over there, and obviously there's a few of my friends who went last year who are over there now, like even I think I've been over 7 times this year alone, just visiting people and watching football and stuff like that. (Michael. Carrickwalter Academy)

What lies beneath the flows of students from Northern Ireland to Liverpool that we see in Figure 2 are these dense cultural ties which connect families from both sides of the religious/sectarian divide to Liverpool. All three students discuss ties between family and friends, sport and a sense of a recognisable culture within which they feel at home.

Belchem's (2006: xxxiv) analysis of Liverpool identity explores the role of the Irish pub and the Catholic parish church as key sites 'where a distinctive (and exclusive) sense of "ethnic" Irishness was constructed, implanted and upheld'. For newer generations higher education seems to be a key site to explore continuing connections connecting Liverpool to Irish/Northern Irish cities. The strength of these historic traditions of migration, family ties and sporting affiliations make Liverpool a straight-forward destination for students in Northern Ireland. Similarly, maintaining local Northern Irish identity, specific to particular towns and cities, seems more possible in Liverpool. Moving for university re-creates and embeds these circuits of culture which connect cities on either side of the Irish Sea. These circuits connecting Northern Ireland and Liverpool are visualised by the students themselves in Figure 3) with areas in green showing places they would like to study. Returning to Massey (2005), we can see how place is created at the confluence of flows and networks of movements of people that compound and form the cultural and social sediment that creates spatial identities. The moment of moving to university is one when new and historical boundaries of culture are created and renewed.

Spatial Hierarchies of Schools and Universities: Elite Formation and Distinctive Circuits of Higher Education – Beyond the relational construction of place, we applied the same community detection techniques to the same data but with schools/colleges and universities as nodes of a bipartite network (Figure 4). Our analysis here was undertaken using the R package bipartite, with the analysis giving an overall modularity of $Q = 0.451$. Each node represents the geographical location of either a school/college or a university. In Figure 4, we can see that changing the structure of the network to observe school to university movements produces a similar, geographical community structure. The division between North and South Wales remains with both regions tied into broader regional flows of students in the North of England and the South-West of England. The Midlands again forms its own community of circuits of higher

education, though it includes more schools and colleges in the East of England and further South just outside of London. London again forms its own cluster including schools in the counties that surround the capital. Scotland and Northern Ireland are again distinctly separate, although this time the algorithm suggests a single community. While the flows of students from Scotland to Northern Ireland in 2014–2015 were minimal, students from Northern Ireland studying in Scotland made up the largest intake from any other UK region (6.7% of first year undergraduates studying in Scotland in 2014–2015, see: Donnelly & Gamsu 2018). Nonetheless this finding suggests the limits and the iterative nature of these methods; other analyses using these techniques to explore geographical data had similar problems of misrecognition and combining of spatially non-contiguous areas (Comber *et al.* 2012b).

Despite these methodological caveats, the most striking difference between Figure 4 and Figure 2 is the presence of a distinctive community of elite schools and universities, primarily concentrated in England and spread throughout the English regions. This cluster of schools and universities is worthy of further attention because of its potential implications for understanding social reproduction and the geography of class formation among the English-British middle class and elite. The list of universities included here (Table 1) suggests there is a distinctive geography of recruitment and movement of students from elite state and private schools to a highly select group of universities primarily located in England (Gamsu 2018). Though these are institutions are mostly highly ranked in various league tables, the sub-grouping highlighted here suggests that conventional rankings, may not reveal the more subtle distinctions made between universities by students at elite schools. There are again caveats to this classification as the inclusion of Teeside University and the University of Suffolk and local schools and colleges are examples of misrecognition. These latter two universities have largely localised, working-class intakes and their geographical locations may lead to them having relatively distinct recruitment patterns separate from their broader regions. While noting these caveats, these findings nonetheless

Table 1. *Universities in elite community (coloured red in Figure 4).*

The University of Bath
The University of Birmingham
The University of Bristol
The University of Cambridge
University of Durham
The University of Exeter
Imperial College of Science, Technology and Medicine
King's College London
London School of Economics and Political Science
The Royal Veterinary College
St George's Hospital Medical School
University College London
Loughborough University
University of Nottingham
The University of Oxford
The University of Warwick
The University of St Andrews
Courtauld Institute of Art
University Campus Suffolk
Teesside University

allow us to understand in greater depth how regional geography combines with distinct spatial patterns of class formation in the school to university transition.

The socio-spatial hierarchies between the elite community and the regional communities that are suggested here are subtle. Within the regional communities, the universities are largely newer, less academically selective institutions, but these groups also include large, older, 'research-intensive' universities in post-industrial cities like the University of Manchester or the University of Sheffield. These results do not simply suggest a binary between working-class regional circuits of education with less prestigious, locally recruiting universities and an 'a-spatial' middle-class/elite set of circuits of higher education including the 'Russell Group' of universities in the UK (a self-selected association of research-intensive, academically selective universities). Rather what is suggested here is that certain universities including the Universities of Manchester, Sheffield and Liverpool as well as the Welsh, Northern Irish and most Scottish Russell Group universities, are not the favoured universities for students in the most academically and socially selective state and private schools

in England and Wales. These schools have larger flows of students to a more distinctive subset of English (and one Scottish) universities. While these historic universities are conventionally seen as middle-class universities by dint of their inclusion in the 'Russell Group', they do not appear to be favoured by students in the elite schools that are also included in the community. Drawing on our qualitative data we can see how these subtle distinctions are woven into a distinctive archipelagic cultural geography of elite locations and universities.

Viewed in the context of existing research and qualitative data this elite cluster suggests a distinctive pattern of recruitment from high-attaining state and private schools to a particular sub-set of high prestige universities. Within the recent literature on elite formation, Wakeling and Savage (2015) highlight how members of the elite are more likely to be concentrated in Oxbridge and the historic London universities, the so-called 'Golden Triangle'. Within this elite, higher incomes are associated with having attended a Golden Triangle with universities such as Warwick, Bristol and Nottingham trailing ahead of the other institutions (Wakeling & Savage 2015). Rather than producing a classification of universities from a broader set of social, economic and educational data (Boliver 2015), the approach taken here allows an examination of the geography of class formation and the implicit hierarchies that are present as students apply to university. These hierarchies may be different from those detected by Boliver (2015) as students consider a different range of factors; issues that are key to universities such as research funding are perhaps less central to students' decisions. These findings fit qualitative research undertaken elsewhere that showed how elite state schools focus on a distinct sub-set of universities within the 'Russell Group' (Gamsu 2018). These high-profile state schools, often selective grammar schools with competitive entry exam at 11 or located in affluent areas, form a distinct institutional constellation with elite private fee-paying schools. For reasons of space, we do not reproduce the full list of schools here, but what is suggested is a community of elite schools which target a subset of elite universities creating a distinctive set of circuits of education. These schools and universities are primarily English,

with Welsh private schools and the University of St Andrews (attended by heir to the throne, Prince William) being the exceptions. Two of the private fee-paying schools detected by this analysis were also included in our study and the interviews and maps below provide further qualitative evidence which complements the hierarchical spatial structure suggested by the community analysis.

At St. Alexander's Boys School, a 500 year old fee-paying school in London, boys repeatedly focused on the elite cluster of universities highlighted in Table 1. Universities located in post-industrial cities like Newcastle, Birmingham, Manchester, Glasgow, Swansea or Cardiff were frequently dismissed as places they would not want to go for university. However, this exclusion of northern English universities, did not apply to Durham University:

What is it about Durham?

It's a really good university that a lot of people um, from like St Alexander's and other schools that I know will be going there. [...]

And what's nice about Durham then? What is it about Durham that sort of attracts you?

Um, I've heard that it's quite, quite almost middle class, very middle class town like in the middle of the North. And that's like the way that I've been brought up so it would be nice to live in a similar way at university to how I've been grown up and similar environment, so there's no culture shock when you get there, which I just think would be quite nice-

Yeah. Do you think it's quite different from other parts of the north?

Um, well yeah, I think so. Well because there are just so many people, who [are] not from the north go up there for university. [...] it has a different culture, so I think you'd probably get that with most university towns, they're not quite the same. To the area around them, because there are so many students not directly from that area. (Samuel. St Alexander's Boys School, London)

Like you've put all the north in orange, are they different or?

Yeah (sigh), I just... I know there are good a lot of good unis in that section, of England, but I just, haven't really thought about it, I mean, I'd be fine going there, I wouldn't mind, I just.

Yeah, and Durham, do you see that as being part of the north or?

Ummm, well I've heard it's very much like west London, as you get a lot of, (laughs) a lot of, highly educated people going there. But, even-like my sister goes to university in Manchester, and she really enjoys it but, it's just- It just doesn't really... It doesn't give, it doesn't excite me but it doesn't, like, push me away. [...]

When you said before people say Durham's like west London, who was saying that?

Well, uh, people from West London. (sigh) Well, just um my sister, like she knows a lot of people who go to these unis, she goes to unis herself. And she just said that you don't like, you don't get a great mix of people there, you just get like, a lot of just, you feel like just, like you're hanging around. Like, we're in quite a- bubble. Where I am, [names other elite schools in London] down the road they're all, fairly- private schools. And somewhere like Bristol you get a bit more diversity. (Stephen. St Alexander's Boys School, London)

Durham is seen by these two boys as an island of elite, middle-class culture situated in the North of England. This is an accurate description as Durham, with its university and historic cathedral, is surrounded by the former mining communities of County Durham. These towns and villages are still heavily affected by the economic devastation left by pit closures begun under Margaret Thatcher. In contrast, Durham University provides a collegiate model of education which is the most similar to Oxbridge within the UK. The architecture and culture of collegiate academic study has long been central to the formation of the British elite (Joyce 2013). Stephen and Samuel's description of the continuation of the 'bubble' of West London at Durham with students from similar schools also attending the university, supports the idea of distinctive communities of schools and universities forming a distinctive set of elite circuits of education.

The discussion of provincial cities as locations for study deserves greater attention. Samuel's exclusion of the University of Manchester aligns with the findings of the community detection. While this is not sufficient to exclude the University of Manchester from the educational geography of elite formation in the UK, this dismissal

of post-industrial cities of the North was not an isolated case. An engineering teacher at the school described how students would not apply to Sheffield or Loughborough for engineering despite the strong reputation of these universities in these subjects. Stephen's description of Bristol as a place with 'more diversity' needs to be considered with caution. Bristol is certainly a more multicultural city than Durham, but the University of Bristol is second only to Oxbridge in recruiting large numbers of students from London's historic private schools (Gamsu 2017, p. 147). There is a distinctive sub-grouping of institutions which are 'deemed acceptable' (Teacher, St Alexander's) by students at this and other elite schools and this institutional hierarchy both creates and is tied into a distinctive geography of elite places.

What the communities analysis suggests is a distinctive sub-field of elite universities and high-performing state and private schools locked into feeder school type relationships. The community analysis alone is an iterative and exploratory method but viewed in conjunction with the qualitative data presented here it suggests a distinctive geography of school to university movements. On the one hand schools and colleges that largely send students to universities within the region reinforce the findings suggested in the first part of this paper about regional circuits of higher education. On the other, as we have seen here, there are a sub-set of largely English elite schools and universities, in which students are not making decisions about where to study in relation to distance or cultural affinities of place and space. Instead these students move between particular elite locales, underlining the deep social and spatial cleavages that segment and separate students in these educational institutions.

Conclusion: Social Network Analysis, Regional Boundaries and Elite Formation in the Transition Between School and University – Through the use of exploratory SNA alongside qualitative data from a multi-sited study of the geography of the transition from school to higher education, we provide a new lens through which to understand the geography of higher education. The SNA methods

allow us to examine how recruitment by universities functions along regional lines, with these regional circuits of higher education suggesting that student movements form regional boundaries. It thus becomes possible to see how the moment of transition to university is a moment in which old and new spatial, social and cultural divisions are created and enacted. In Massey's (2005) terms, place is formed through the accumulation of meetings and the mesh of repeated flows of people; attending university is a moment of place and boundary formation. As we saw in the case of students moving from Northern Ireland to Liverpool, these regional circuits of education often reflect historic movements of people with student movements embedded in much longer historical traditions of spatial migration. What the first part of this paper sought to emphasise is how the geography of the student transition is not separate from cultural and economic regional division, rather the geography of student mobility to attend university *creates* regional boundaries and divisions.

These spatial divisions are not abstracted from hierarchies of class and power. While the social network analysis method of community detection does not allow us to measure the effects of class, race or gender on the 'community structure' of the network, the communities detected in the school to university graph (Figure 4) suggest specific spatial hierarchies of schools and universities. Using network analysis allows us to extend our understanding of the geographies of elite formation at the moment of transition into higher education. This analysis suggests a distinctive spatial pattern of school to university movement between a cluster of elite state and private schools and elite universities. Alongside the regional/national circuits of higher education within England, Scotland and Northern Ireland there is a distinctive set of socio-spatial trajectories connecting elite Welsh and English private and elite state schools to certain, largely English elite universities. The absence of Scottish private schools and all the ancient Scottish universities (except St Andrews), also has interesting implications for understanding the role of spatial mobility for university study, middle class and elite formation and nationalism. These mobility patterns and institutional hierarchies

reinforce other evidence suggesting the relative autonomy of the educational infrastructure of the Scottish middle class and governing elite (Keating & Cairney 2006). We show how hierarchies of universities are embedded in a distinct archipelago of elite geographies connecting particular institutions and locales concentrated in England. Understanding how universities function as nodes on circuits of power which run from elite schools to universities and on into commanding positions within British society is a key contribution we make here.

Methodologically this paper has sought to use community detection methods as a means of exploring the geographical structure of the transition to university. We noted above the iterative and exploratory nature of these methods and the caveats relating to the varying algorithms available. For this reason, we have presented our SNA alongside qualitative data which complements and corroborates some of the quantitative patterns presented in the network analysis. Nonetheless, given the relative youth of modularity and community detection methods, we expect these methods will continue to be improved and refined in the future. Our paper has shown the potential for these methods to be used to uncover spatial divisions and hierarchies within educational data. Joining these novel methods with a rich theoretical understanding of space, education, power and class provides a rich lens through which to examine the geographies of education. What we see is how power and divisions are formed through education as people move from school to university. Spatial mobility from home and school to university is a movement which creates and enacts places and boundaries as students move through uneven geographies of economic, cultural and social power. As we noted in the introduction, there is currently a lack of comparative analysis on *how* regional inequalities and divisions, patterns of spatial mobility for university and class formation through higher education intersect. Thus we cannot assess the extent to which these findings are unique to the English and UK contexts. A comparative turn within the

geography of education would allow some of these questions to be answered and would allow us to understand the intersection of space, power, place and education in greater depth.

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Notes

¹ In the 2011 census, these local authority districts had a median population of 122,092.

² Please note that all student and school names of students quoted here and below are pseudonyms. In the case of Northern Ireland, the towns where the research took place are also anonymised to protect the identity of the schools and students that participated in the research.

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