Which regional conditions facilitate university spinouts retention and attraction?

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ABSTRACT

We investigate the economic and institutional factors that help regions to retain university spinouts (USOs) founded within their borders, and to attract USOs from other regions. Using UK data, we find that regions with high USO retention rates have lower urbanisation and localisation economies. This indicates that locally-founded USOs take advantage of cheaper inputs, in addition to proximity to their home university. Regions with high USO attraction rates have higher localisation economies and innovation resources, suggesting that USOs move there to benefit from dynamic innovation systems. This study offers some general implications for industrial policy to level up regional disparities.

Key words: university spinouts (USOs), firm migration, localisation economies, urbanisation economies, entrepreneurial ecosystem, regional development

JEL Classification Code: O14, O18, O25, E66

1. INTRODUCTION

Innovative start-ups are important contributors to regional economic growth and development, since they play a crucial role in innovation activities contributing to productivity growth (Decker et al. 2014) and advancing the technological frontier (Faggian and McCann, 2009). They are also an important source of employment (Carree and Thurik, 2003; Neumark et al., 2006), and bring new knowledge into local networks (Almeida and Kogut, 1999), increasing their locality's attractiveness to prospective investors and qualified personnel seeking employment (Fritsch and Schindele, 2011; Shah and Pahnke, 2014). The creation of innovative start-ups has been flagged as a way to revive the economy of lagging-behind regions (Stephens and Partridge, 2011), breathing new life into areas that have suffered from de-industrialisation and potentially playing a role in reducing regional inequality Iammarino et al., 2019).

According to a definition widely used in the academic literature and in policy practice, university spin-out companies (USOs) are innovative start-ups "created by scientists based on intellectual property (IP) generated in the university" (Wennberg et al., 2011, p.1128); the IP may reside with the academics or with the university, and the university may or may not decide to take an equity share in the company. Compared to other start-ups, USOs are particularly concentrated in high-tech and knowledge intensive sectors (Druilhe and Garnsey, 2004; Lawton Smith and Ho, 2006) and specialise in the provision of new, technologically advanced products and services (Baines and Lawton Smith, 2019). USOs play key roles in knowledge transfer processes and in local entrepreneurial university ecosystems (Miller et al. 2018; Fuster et al. 2019). USOs tend to survive for longer than other start-up companies (Shane, 2004; Oskarsson and Schlapfer, 2008), perhaps because of academic entrepreneurs' higher opportunity costs, or the competitive advantages of receiving tacit knowledge and incubation services from the university (Zhang, 2009), or because the university resources may support them even when they are not commercially viable (Jelfs, 2016). USOs are, to some extent, similar to corporate spinouts, since the latter are also created with the objective to transfer technology from a parent company. However, compared to corporate spinouts, USOs tend to seek external resources more (Festel, 2013). Interestingly, in peripheral regions corporate spinouts have been found to have a survival advantage over other start-ups (Habersetzer, 2016); to our knowledge, no attempts have been made to investigate whether USOs have the same advantage, though it is quite plausible given that they have greater survival rates than other start ups.

The creation of USOs has long captured policymakers' attention as a way to foster economic development, at regional level. Particularly in lagging-behind regions,

exploiting knowledge resources from a local university as a launchpad for new enterprises seems an effective strategy (Pugh, 2017). In countries such as the UK (Rosli and Rossi, 2015), Norway (Gulbrandsen and Rasmussen, 2012), Spain (Molas-Gallart and Castro-Martinez, 2007) Australia (Jensen et al., 2009), the rate of USO creation is one of the benchmarks used to assess university performance (Rosli and Rossi, 2015). The creation of a regional infrastructure for USOs, including incubators, technology transfer offices, and the provision of seed funding has also been supported (in countries like Germany, Denmark and Sweden; Sellenthin, 2006). The academic entrepreneurship literature has extensively examined the environmental and organisational factors that facilitate USO creation (Link and Scott, 2017; Corsi and Principe, 2016; Lawton Smith and Ho, 2006; Elgen et al., 2004).

Policymakers have paid less attention to ensuring that USOs, once created, stay in their region of origin, or that other USOs are attracted to the region. But given that innovative start-ups, including USOs, are particularly mobile (Pellenbarg et al., 2002; Brouwer et al., 2004; Godfrey et al., 2020), a region's ability to attract and retain existing USOs is as important as its ability to create USOs. For example, retaining a greater share of the USOs originating within the region could support the regeneration of peripheral regions by creating more highly skilled jobs and attracting investment (Bramwell and Wolfe, 2008; Hewitt-Dundas and Roper, 2011). Policies to retain USOs within regions would fit with industrial policy approaches aimed at supporting the development of lagging behind regions, such as the 'levelling up' agenda in the UK (UK2070 Commission, 2020) which is designed to ameliorate regional disparities in economic performance caused by regional productivity gaps (UPP, 2020). The aim of this study is therefore to answer the following, so far neglected, research question, with implications for regional development and the reduction of regional disparities:

what are the economic and institutional factors that help regions to attract and retain USOs?

This study addresses a two-fold gap in the literature. First, the literature on firm migration has focused both on 'push' factors inducing movement away from a region, and 'pull' factors attracting firms to a region (van Dijk and Pellenbarg, 2000; McCann, 2001), but it has not focused on USOs, nor on innovative start-ups more generally. This presents a research gap, since, as Weterings and Knoben (2013) noted, the attractiveness of different regional characteristics might differ between different types of firm. Second, the literature on the factors that induce migration of innovative start-ups, including USOs, focuses primarily on firm or individual characteristics. For instance, Niedomysl et al. (2019) have used Swedish individual data to explore how the personal characteristics of business owners influence their probability to migrate, while Benneworth and Charles (2005) have discussed the characteristics of USOs that drive them to migrate. This study investigates the *regional* characteristics associated with greater or smaller retention and attraction of USOs, an issue that is particularly relevant for regional and industrial policy.

The paper is organised as follows. In the next section, we build on and integrate contributions from academic entrepreneurship, regional economics and firm migration literature to identify the main factors that increase a region's ability to retain USOs, and those that increase a region's ability to attract migrating USOs. We then present our data and methodology. In the following section, we analyse the correlates of regions' USO retention and attraction rates, and model the influence of regional factors on USO's decisions to remain in their region of origin, and those that influence USOs' decision to move to a specific region. Finally, implications for

regional and industrial policy and for USO management, and limitations of the analysis and directions for further research, are discussed.

2. LITERATURE REVIEW

Although USOs tend to locate close to their parent universities (Heblich and Slavtchev, 2014), a sizeable share of USOs have migrated outside their home region (Elgen et al. 2004; Benneworth and Charles, 2005). Recent evidence suggests that they tend to move particularly away from large cities (Godfrey et al., 2020), a pattern that has been observed for start-ups in general (Wajcman, 2017; Hillier, 2018). Studies in the entrepreneurship and firm migration literature have analysed the influence of regional factors on firms' location decisions. The entrepreneurship literature has shown that regional factors play a role in entrepreneurs' decision to establish a firm in the entrepreneurs' location of origin or elsewhere: some regions offer better conditions for incubating new firms and for supporting firms' innovative capabilities (Frenkel et al., 2001), which make them particularly attractive to resource-constrained start-ups. The literature on firm migration has demonstrated that, since regional economic features strongly influence the innovative and entrepreneurial activities of local firms (Sternberg and Arndt, 2001) and ultimately their profitability (Van Dijk and Pellenbarg, 2000), firms consider regional economic characteristics in their location decisions (Conroy et al., 2016). In particular, while the decision to move away from one's current location mainly depends on firm-related factors (such as the need to accommodate and foster firm growth), regional factors play an important role in the choice of whither to move (Audretsch et al., 2005): they are more important the further the move (Weterings and Knoben, 2013).

We focus on two sets of regional features that have been linked with greater attractiveness of regions to migrating firms: regional agglomeration economies, and a region's overall entrepreneurial ecosystem. We discuss how these features might affect regions' ability to retain and attract USOs.

Regional agglomeration economies

Agglomeration economies are spatial economies of scale deriving from being located in the same area as many other firms. They include both localisation and urbanisation economies.

Localisation economies – also known as Marshallian externalities (Glaeser et al., 1992; Frenken et al., 2007) – are the benefits that firms experience from being located near to many other firms performing similar or related activities. The agglomeration of firms in the same sector often breeds large pools of highly specialised workers and suppliers into which firms can tap (Arauzo-Carod and Viladecans-Marsal, 2009; Holl, 2004) and encourages formal and informal knowledge transfer between firms (Capello and Faggian, 2005; Nguyen et al., 2013). Knowledge can easily diffuse between firms within a region, through labour mobility, spin-offs and personal networks (Almeida and Kogut, 1999). In turn, knowledge spillovers act as a key mechanism to foster innovation, deemed particularly important for knowledge-intensive firms that build their competitive advantage on continuous innovation. Concurrently, localisation diseconomies may arise when firms compete for resources such as qualified labour and other inputs (Stuart and Sorenson, 2003), leading to shortages and higher prices.

Urbanisation economies – also known as Jacobs externalities – are 'external economies available to all local firms stemming from a variety of sectors' (Frenken et al., 2007, 687). Urban areas host many firms in a wide range of industries, and have

high population density, which together confer a variety of benefits to firms located therein. One benefit is a large supply of generic labour and other inputs, which can be accessed with low transport and transaction costs (Dahl and Sorenson, 2010). Another benefit is the possibility to derive knowledge spillovers from other firms not necessarily in the same sector. Another important benefit of urbanisation is the presence of a large market of potential consumers (Daunfeldt et al., 2013), leading to greater potential profits (Bodenmann and Axhausen, 2012; Brouwer et al., 2004). For USOs in high tech, knowledge-intensive sectors, the demand may primarily come from other firms. Hence, regions with particularly high levels of economic activity relative to their population size should attract more firms and have a higher ability to retain firms. Richer and more urbanised regions will also have higher levels of local demand and usually have better amenities. These are useful to attract and retain new qualified staff, who value the importance of their employer's location (Kronenberg, 2013), often trading off with lower wages, an advantage for small firms with scarce financial resources.

At the same time, richer regions are also affected by competition effects (Arikan and Schilling, 2011) leading to congestion and rising prices due to over-demand (Broersma and Van Dijk, 2008). When firms agglomerate, there will be competition for land, which increases real estate costs and drives firms away from the region (Flyer and Shaver, 2003; Arauzo-Carod and Viladecans-Marsal 2009). Therefore, highly urbanised regions may suffer from urbanisation diseconomies due to higher prices for office space and generic services, reducing their attractiveness to cash-constrained firms like USOs.

Some studies find that the positive effects of urbanisation economies are particularly strong for service firms (Schmenner, 1986). The negative effects especially apply to

manufacturing firms, on average larger in size than service firms (Kronenberg, 2013). In the case of USOs, usually small in size regardless of sector, these effects may not be so evident.

Regional entrepreneurial ecosystems

Proponents of the 'entrepreneurial ecosystems' approach (Stam, 2015; Brown and Mawson, 2019) argue that some environments are able to facilitate entrepreneurship thanks to particular local conditions. Entrepreneurial ecosystems have been defined as 'a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory' (Stam and Spigel, 2016, p.1). These local factors and their systemic interactions should play a role both in retaining USOs in a region and in attracting USOs from elsewhere.

Stam (2015) identified several 'pillars' of an entrepreneurial ecosystem, including: human capital and the local education and training system; accessible markets; support for entrepreneurial firms (covering financing and mentoring); and the government and regulatory framework. Others have also mentioned the presence of universities and research institutes, R&D facilities, and technology policy (Sternberg and Arndt, 2001; Beugelsdijk, 2007; Wang and Lin, 2013). Focusing on those pillars that are likely to be particularly important in retaining and attracting USOs, we consider factors that relate to two main dimensions: the availability of resources for innovation, and the presence of dedicated support for entrepreneurship.

Innovation resources include human capital. This is often linked to the quality of the local education and training system, including the presence of major universities (Stam, 2015). The ability to easily access highly qualified, capable and motivated individuals endowed with management and technical talent, and entrepreneurial experience, has been identified as an important factor in firm's location choices (Van

Dijk and Pellenbarg, 2000). The presence of highly qualified staff facilitates the emergence of innovations (Sternberg and Arndt, 2001), particularly important for innovative firms like USOs (Lawton Smith and Bagchi-Sen, 2010; Huggins et al., 2017). As outlined by Calcagnini et al. (2016), USOs' locational choice is in fact sensitive to the presence of human capital.

Highly innovative, R&D-intensive firms and public research institutions including universities (Fritsch and Aamoucke, 2013; Pinto et al., 2015) also constitute key innovation resources. Highly innovative firms generate benefits for other firms, including USOs. First, they can generate demand for the USOs' high tech products and knowledge-intensive services. Second, they can provide opportunities for networking and R&D collaborations (Cabrer-Borras and Serrano-Domingo, 2007). Third, their presence is often linked to dense local networks of investors, advisors, mentors, which form start-up communities (Feld, 2012). In turn, these communities create more opportunities for investors and more demand for knowledge-intensive services (localised increasing returns to scale; Gordon and McCann, 2000). Universities and other research institutes as 'anchor institutions' play multiple and complex roles in innovation-led regional development (Feldman, 2003). Universities' anchor role appears particularly important in peripheral regions (Benneworth and Neith, 2019) where they fulfil many of the ecosystem functions and thereby contribute to innovation-led economic development (see Reichert, 2019). Calcagnini et al. (2016) confirm that USOs in regions with high innovation intensity, academic institutions and large markets, have higher business opportunities. At the same time, firms with strong knowledge bases and high levels of innovation are more likely to stop rivals entering their market area (Alcácer, 2006), though USOs are unlikely to compete directly with large R&D-intensive firms. Evidence regarding how the spatial

concentration of highly innovative firms affects potential entrants is inconclusive (Beaudry and Schiffauerova, 2009).

Dedicated support for entrepreneurship, another pillar of entrepreneurial ecosystems (Stam, 2015), has been found to increase a region's attractiveness for start-up firms, and is expected to be important for USOs. This comes in many forms, including local financial capital (Davidsson, 1995), local research facilities (Sternberg and Arndt, 2001), science parks and incubators, and local support for high-tech companies (Hu et al., 2008) such as professional services (Feld, 2012).

As the innovative performance of USOs is often dependent on the availability of financial resources (Rodríguez-Gulías et al., 2016), ease of access to these resources locally might be a factor in USOs' locational choices. A clear empirical link has been established between the increased rate of creation and in-migration of high-growth start-ups and access to formal and informal financial intermediaries, including seed-corn and venture capital (Gries and Naudé, 2009).

Regional infrastructures, such as science parks and incubators, are often provided by universities (Phan et al. 2005), which further emphasises their anchor role. Such infrastructures provide USOs with affordable premises, networking opportunities, as well as technical and business services at reasonable prices (Link and Scott, 2017), and their support can be of crucial importance for USOs' effective operation (Soetanto and Jack, 2016).

Since USOs are usually founded by academics rather than experienced entrepreneurs, the availability of entrepreneurship education and business advice might be important for retention and attraction of USOs. Entrepreneurship training promotes the creation of graduate ventures (Marzocchi et al., 2019) and shapes the entrepreneurial competencies for start-ups (Erikson and Gjellan, 2003). Education and training have

been found to increase a region's level of entrepreneurial activity (Babson College, 2001), and firms' in-migration (De Faoite et al. 2003).

3. DATA AND METHODOLOGY

Database construction

This study focuses on USOs in the UK[1]. The database was constructed from information drawn in 2012 from UK universities' public websites. The construction of the database involved several steps. First, the names of 136 public universities were obtained from Universities UK[2], and cross-checked with those provided by the Higher Education Funding Council (HEFCE), the Scottish Funding Council (SFC), Higher Education Funding for Wales, and Higher Education Division, Department for the Economy (Northern Ireland). Second, the list of USOs was constructed by searching through the websites of universities' business and innovation centres, such as Oxford University Innovation (University of Oxford) and UCL Advances (UCL) and departmental websites. Some universities that did not provide a list of USOs on their websites were contacted to ensure no omissions. Then, the list of manually retrieved USOs was merged and reconciled with the comprehensive list of all UK spinout

[1] We adopt the definition provided by the now defunct Higher Education Funding Council for England (HEFCE) for the Higher Education Business-Interaction (HEBCI) survey, in considering USOs established by academic or university staff, in any sector, irrespective of whether the IP is owned by the academic entrepreneur or by the university, and whether the latter has invested equity in the USO or not (https://www.hesa.ac.uk/data-and-analysis/business-community/ip-and-startups, last accessed in July 2018). Another type of start-up company linked to university are graduate start-ups founded by current or former students. While extending the population to graduate start-ups would have broadened the number of companies available for the analysis, these companies are elusive and hard-to-trace, and information about them is not available from the public websites of most UK universities. Additionally, USOs and graduate start-ups differ in several aspects including their ability to rely on university resources (human capital, facilities, equity investment) which is usually greater for the former. Hence, graduate start-ups need a separate analysis.

[2] http://www.universitiesuk.ac.uk, last accessed in July 2018.

companies provided by Spinouts UK[3]. From the 1356 USOs in the database[4], 931 were found to be active, 87 of which had been merged or acquired.

We collected information about the USO's foundation year, their current address, the founders' contacts and the number of products and services offered. The number of employees and the SIC code were retrieved from Companies' House; information about the infrastructures in support of knowledge transfer offered by each university was retrieved from the HEBCI survey 2010/11.[5] Information about regional economic variables at NUTS2 level was retrieved from ONS (regional gross value added[6], regional average house prices[7]) and Eurostat (rate of unemployment, percentage of graduate population, shares of employment in manufacturing, in knowledge-intensive services and in high-technology manufacturing[8]).

Sample selection and spatial level of analysis

The analysis only considered USOs founded between 2005 and 2012, because we wanted to capture USOs in their early years, rather than established companies originating as USOs. Furthermore, since our data only allowed us to infer whether a USO moved from its region of origin at some point between its foundation and 2012, but not the date when it moved, we needed to consider a short period of time to make sure that the regional characteristics we measured at the start of the period were still relevant at the time of the move. The period of 7 years was an acceptable compromise

[3] www.spinoutsuk.co.uk, last accessed on July 2018

[4] According to HEBCI 2010/11 (https://www.hesa.ac.uk/data-and-analysis/publications/hebci-2010-11 last accessed in July 2018), the number of three year-old or older spinout companies was approximately 1,000. Therefore we were able to retrieve a larger number of USOs than those reported by universities to HEFCE.

[5] https://www.hesa.ac.uk/data-and-analysis/publications/hebci-2010-11, last accessed in July 2018.

[6] https://www.ons.gov.uk/economy/grossvalueaddedgva/bulletins/regionalgrossvalueaddedincomeapproach/2014-07-07, last accessed in September 2019.

[7] https://www.ons.gov.uk/economy/inflationandpriceindices/bulletins/housepriceindex/jan2017#house-price-index-by-english-region, last accessed in September 2019.

[8] https://ec.europa.eu/eurostat/web/regions/data/database, last accessed in September 2019.

between the need to restrict the focus on USOs that moved relatively recently (so that retention and attraction rates could be meaningfully correlated with regional economic variables) while allowing sufficient time for USOs to move.[9] We restricted the sample to USOs that were still active at the end of the period, excluding USOs that were in liquidation, in administration, dormant/non-trading, as well as five for which there were some values missing.[10] The sample was thereby reduced to 408 firms. Hence, our analysis refers to USOs founded by academic or other university staff members, which are active up to seven years from their foundation date, and focuses on their mobility within this early period since their foundation.

We chose NUTS2 regions as our spatial unit of analysis, for three main reasons. First, the literature suggests that, for short distance moves, firm level factors are more important than regional factors, with the opposite holding for long distance moves (Weterings and Knoben, 2013): we wanted to focus on regions sufficiently large for regional factors to matter. NUTS2 regions fulfil this criterion as, for most firms within their boundaries, moving out of the region means being unable to maintain daily commuting with the university of origin. Second, compared with travel to work areas (TTWA), more economic data are disaggregated at NUTS2 level. Third, the boundaries of NUTS2 often coincide with local government responsibilities, unlike for TTWAs.

Empirical strategy and variables

[9] In particular, we followed the concept of firm's life stage coined by Taylor (1975) and Holl (2004). As a new firm is first established, entrepreneurs usually have limited information about alternative locations; in the case of USOs, they are usually based at or close to their home university due to the link with the academic founders. When they start to grow, between 5-7 years (Mohr and Garnsey, 2011) they obtain better knowledge about business prospects in alternative locations, and start making explicit locational decisions.

[10] We focus on firms that have the potential to make an economic contribution to the region they base themselves in, which need to have demonstrated a degree of commercial viability. This is unlikely to be the case for USOs that were already dormant, non-trading, in administration or liquidation within seven years of their foundation (Jelfs, 2016).

Our empirical analysis is presented in two parts. In part 1, we categorise NUTS2 regions based on their ability to retain and attract USOs, in particular we call *regional USO retention rate* the share of USOs founded in a region that remain in their region of origin, and *regional USO attraction rate* the share of USOs that have moved to the region (with respect to the overall number of USOs that have moved). We then analyse the correlates of high and low retention and attraction rates, focusing on the regional factors that the literature has indicated as potentially important determinants: agglomeration economies (localisation and urbanisation economies) and the region's entrepreneurial ecosystem (availability of resources for innovation, dedicated support for entrepreneurship).

Localisation economies are measured using: the share of regional USOs that belong to sectors with high concentration of employment in the region (*Localisation economy*); and the region's share of employment in knowledge intensive services and in high tech manufacturing (*% employment HTMKIS)*. The latter proxies for the presence of a local labour market which could provide a pool of qualified human resources specific to USOs (Hu et al., 2008) and a source of demand for USOs' products and services. Urbanisation economies are measured using: the region's *Population density* (number of inhabitants per square km) and the region's *GVA,* to proxy for the presence of a large local demand. Additionally, we consider *Average House Prices* to identify possible congestion effects.

Several variables are considered to capture regional entrepreneurial ecosystem aspects. The share of graduates (ISCED levels 5-8) in the regional population aged 25-64 (*Share of graduates*), measures the availability of generically qualified human resources (Daunfeldt et al., 2013). The region's *R&D expenditure per capita* and the number of EPO patent applications per million inhabitants (*Patents per capita*) proxy

for the presence of research-intensive firms and institutes. The number of universities in the region (*Number of universities*) and particularly the *Number of research intensive universities*[11] capture the presence of universities as anchor institutions. All regional economic variables refer to 2005.

Information about dedicated support for entrepreneurship provided by the USOs' home universities is drawn from the HE-BCI survey 2010/11: presence of local premises and incubation services (university incubator, university science park, local incubator); university provision of local finance for start-ups (seed corn funding, venture capital); university provision of training and advice for entrepreneurs (entrepreneurship training, advice for enterprises). These variables take value 2 if the support is provided by both the university and an external partner, 1 if it is provided either by the university or by an external partner, and 0 if it is not provided. These variables have then been averaged across all USOs founded in the region. See Table 1 on descriptive statistics of the observed variables used for 30 NUTS2 region analysis.

Table 1. Descriptive statistics: regional variables at NUTS2 level

Variable	N obs.	Mean	Standard Deviation	Minimum	Maximum
Retention rate	30	0.77	0.20	0.33	1.00
Attraction rate	30	0.03	0.03	0.00	0.15
Localisation economy	30	0.09	0.23	0.00	1.00
% employment HTMKIS	30	42.85	5.40	35.30	57.40
Population density	30	1618.98	2291.28	65.40	9397.43
GVA	30	335599.23	18847.63	9841	97902
Average House prices	30	155880.20	59043.31	94026.09	359778.30
R&D expenditure per capita	30	528.84	527.08	119.50	2702.10
Patents per capita	30	86.80	56.59	31.29	239.08
Share of graduates	30	29.42	5.78	21.20	43.00
N universities	30	11.73	5.75	2.00	25.00
Number of research intensive universities	30	4.20	2.73	1.00	11.00
University incubator	30	1.08	0.46	0.00	2.00
Science park	30	0.91	0.57	0.00	2.00
Local incubators	30	1.02	0.57	0.00	2.00
Seed corn funds	30	1.43	0.44	1.00	2.00
Venture Capital	30	1.13	0.30	1.00	2.00
Advice	30	1.73	0.34	1.00	2.00
Entrepreneurial training	30	1.39	0.43	0.97	2.00

[11] These were computed as number of universities in the more research-intensive KEF Clusters V and X; see Research England (2020).

In part 2, we model a USO's probabilities of staying in its home region (Model 1) and of moving to a specific region (Model 2).

In Model 1, we consider the entire set of 408 USOs and run a logit regression on the USO's probability of staying. We analyse whether the characteristics of the home region (urbanisation economies, localisation economies, availability of resources for innovation, and support for entrepreneurship) influence the probability of staying, controlling for several firm characteristics. The dependent variable *Stay_local* is equal to 1 if the firm has stayed. Robust standard errors are clustered by NUTS2 region (30 clusters).[12] To avoid multicollinearity issues, we create indicators to be used as independent variables. First, we transform all regional variables into their interquartile ranges. Then, we construct the *Localisation economies* as the sum of the interquartile ranges of *Localisation economy* and *% employment HTMKIS*, and the *Urbanisation economies* as the sum of the interquartile ranges of *GVA* and *Population density*. The variable *Innovation resources* is constructed as the sum of the interquartile ranges of *R&D expenditure per capita*, *Patents per capita*, *Number of research intensive universities* and *Share of graduates*.[13] Finally we aggregate the variables measuring the presence of support for entrepreneurship. *Local premises* is the sum of the variables *University incubator*, *Science park* and *Local incubator*. *Local finance* is the sum of the variables *Seed corn funds* and *Venture Capital*. *Local advice* is the sum of the variables *Advice* and *Entrepreneurial training*.

[12] Including the double clustering of standard errors for both NUTS2 region (30 clusters) and university of origin (70 clusters) produces very similar results.

[13] The indicators thus constructed display acceptable Cronbach's Alpha values (all greater than 0.5).

We control for a number of USO characteristics: whether the USO has been acquired by another company (*Acquired*), an important phenomenon particularly in some sectors such as the life sciences (Lawton Smith et al., 2008; Mathisen and Rasmussen, 2019), which is expected to strongly reduce a USO's probability of staying in region; the USO's age; the USO's technological intensity (*Patents per year*) and its sector (*KIBS*, *Personal_services*, *Manufacturing*, *Chem_pharma*, *ICT*). The UK has a highly centralised regulatory system; however the three devolved countries – Scotland, Wales or Northern Ireland – have greater policy autonomy particularly in relation to education, innovation and enterprise policy. This can play a role in creating attractive regional entrepreneurial ecosystem (Stam, 2015). Hence, we control for the USO having originated outside England (*Devolved region*). See Table 2 for basic descriptive statistics for Model 1 variables.

Table 2. Descriptive statistics: firm-level variables used in regression modelling probability to remain in home region

Variable	Obs	Mean	Std. Dev.	Min	Max
Stay_local	408	0.72	0.45	0.00	1.00
Localisation economies	408	3.48	1.72	2.00	8.00
Urbanisation economies	408	4.90	2.01	2.00	8.00
Innovation resources	408	8.90	3.37	4.00	15.00
Local premises	408	2.93	1.07	0.00	5.00
Local finance	408	2.63	0.88	0.00	4.00
Local advice	408	3.04	0.82	0.00	4.00
Devolved region	408	0.30	0.46	0.00	1.00
Acquired	408	0.06	0.24	0.00	1.00
Age	408	4.10	2.11	0.00	7.00
Patents per year	408	0.39	2.58	0.00	50.00
KIBS	408	0.65	0.48	0.00	1.00
Personal services	408	0.04	0.19	0.00	1.00
Manufacturing	408	0.14	0.35	0.00	1.00
Chem_pharma	408	0.04	0.19	0.00	1.00
ICT	408	0.09	0.29	0.00	1.00

In Model 2, we consider the subset of 113 USOs that have moved to another region, and model their probability of moving to a specific region. We analyse whether the characteristics of the destination region (localisation economies, urbanisation economies, innovation resources, dedicated support for entrepreneurship) influence

the USO's probability of moving to the region. In this logit model, the observations are the pairs (*i,j*) with i = 1, …, 113 being the set of USOs that have moved to a different NUTS2 region, and j = 1,…, 27 are all the NUTS2 regions which have attracted at least one USO in the period. There are 113 x 27 = 3,051 pairs. The dependent variable *Moved* takes value 1 when the pair (*i,j*) is observed (e.g. when firm *i* has moved to region *j*) and value 0 otherwise). For the independent variables, we use the same indicators *Localisation economies, Urbanisation economies, Innovation resources* as in Model 1, only here they refer to the region that is a potential destination of the USO. *Local premises*, *Local finance* and *Local advice* are similarly defined, however the variables are averaged across all universities in the destination region before being aggregated at the regional level. We also control for the destination region being devolved (*Devolved_region_dest*) - to consider their policy autonomy. Additionally, robust standard errors are clustered by NUTS2 regions (30 clusters) and by USO (113 clusters), to account for correlations within pairs that include the same USO. See Table 3 for basic descriptive statistics for the variables used in Model 2.

Table 3. Descriptive statistics: firm-region pairs-level variables used in regression modelling probability to move to a specific region

Variable	Obs	Mean	Std. Dev.	Min	Max
Moved	3051	0.04	0.19	0.00	1.00
Localisation economies	3051	3.30	1.38	2.00	8.00
Urbanisation economies	3051	4.41	1.28	2.00	7.00
Innovation resources	3051	8.56	3.53	4.00	15.00
Local premises	3051	3.27	1.76	0.00	10.00
Local finance	3051	3.36	2.06	2.00	12.00
Local advice	3051	3.25	1.43	2.00	8.00
Devolved_region_dest	3051	0.15	0.36	0.00	1.00

4. FINDINGS

Retention and attraction rates of different regions

The majority of USOs stay in their region of origin: of the 931 active or acquired companies, 70.4% stayed in their university's home region. We find similar shares of USOs staying in their home region in the 408 active or acquired USOs founded after 2005 (72.1%) and in the 523 active or acquired USOs founded before 2005 (69.0%).[14] Within the 408 USOs, different firm characteristics relate to a different propensity to remain. If we consider the shares of USOs that stayed within their NUTS2 region by sector, age, size, patent intensity, and whether they had been acquired (Table A1, Appendix A), we find that trade and 'other' USOs are those that move the least, while manufacturing and chemical-pharmaceutical are the most mobile USOs. No clear pattern is visible in relation to the USO's patent intensity and age (but all our USOs are at most 7 years old). Acquired USOs are significantly less likely to stay, perhaps moving closer to their new owners. See Table 4 for the regional USO retention and attraction rates[15]

[14] Since the literature suggests that older firms are less likely to move than younger ones, we might have expected the latter share to be higher than the former. However, since our full dataset includes companies founded a long time ago (with the oldest firm founded in 1946) it is possible that the older firms moved when they were young. Because we can only measure whether migration occurred at some points between the foundation date and 2012, this further reinforces the importance of focusing on a group of USOs founded within a relatively short period.

[15] In the period considered we have not found any USOs originating from the following ten NUTS2 regions: Cumbria (UKD1), Cheshire (UKD6), Lincolnshire (UKF3) Herefordshire, Worcestershire and Warwickshire (UKG1), Bedfordshire and Hertfordshire (UKH2), Essex (UKH3), Outer London - East and North East (UKI5), Outer London – South (UKI6), Cornwall and Isles of Scilly (UKK3), Highlands and Islands (UKM6). As we cannot compute a retention rate for those regions, they are not included in the table.

Table 4. Regional USO retention and attraction rates.

NUTS 1 region	NUTS 2 region	Retention rate NUTS2 region	Attraction rate NUTS2 region	Retention rate above (H) or below (L) national average	Attraction rate above (H) or below (L) national average
North East	Tees Valley and Durham (UKC1)	87.5%	0.9%	H	L
	Northumberland and Tyne and Wear (UKC2)	78.6%	4.4%	H	H
North West	Greater Manchester (UKD3)	66.7%	2.7%	L	L
	Lancashire (UKD4)	90.0%	1.8%	H	L
	Merseyside (UKD7)	100.0%	2.7%	H	L
Yorkshire	East Yorkshire and Northern Lincolnshire (UKE1)	66.7%	0.0%	L	L
	North Yorkshire (UKE2)	100.0%	0.9%	H	L
	South Yorkshire (UKE3)	88.9%	2.7%	H	L
	West Yorkshire (UKE4)	50.0%	6.2%	L	H
East Midlands	Derbyshire and Nottinghamshire (UKF1)	62.5%	0.9%	L	L
	Leicestershire, Rutland and Northamptonshire (UKF2)	62.5%	5.3%	L	H
West Midlands	Shropshire and Staffordshire (UKG2)	75.0%	0.0%	L	L
	West Midlands (UKG3)	66.7%	1.8%	L	L
East of England	East Anglia (UKH1)	82.9%	7.1%	H	H
London	Inner London – West (UKI3)	33.3%	2.7%	L	L
	Inner London – East (UKI4)	63.6%	9.7%	L	H
	Outer London - West and North West (UKI7)	50.0%	6.2%	L	H
South East	Berkshire, Buckinghamshire and Oxfordshire (UKJ1)	68.6%	15.0%	L	H
	Surrey, East and West Sussex (UKJ2)	80.0%	1.8%	H	L
	Hampshire and Isle of Wight (UKJ3)	40.0%	1.8%	L	L
	Kent (UKJ4)	100.0%	1.8%	H	L
South West	Gloucestershire, Wiltshire and Bristol/Bath area (UKK1)	42.9%	3.5%	L	H
	Dorset and Somerset (UKK2)	100.0%	0.0%	H	L
	Devon (UKK4)	100.0%	0.0%	H	L
Wales	West Wales and The Valleys (UKL1)	100.0%	0.0%	H	L
	East Wales (UKL2)	92.9%	2.7%	H	L
Scotland	Eastern Scotland (NUTS 2013) (UKM2)	90.4%	2.7%	H	L
	South Western Scotland (NUTS 2013) (UKM3)	83.3%	4.4%	H	H
	North Eastern Scotland (UKM5)	80.0%	0.0%	H	L
Northern Ireland	Northern Ireland (UKN0)	0.9%	0.9%	H	L

Regions with high retention rates are not necessarily those with high attraction rates, and vice versa. London and the South East, and to a lesser extent the East Midlands, have low retention and high attraction rates; the devolved countries, many regions in the North of England and in the South West, have high retention rates but low attraction rates. Some regions (West Midlands, some in the East Midlands and North of England) have low retention and low attraction rates. Finally, a few regions in the North East, East of England and Scotland have high retention and high attraction

rates.

Figure 1. Regional USO retention rates

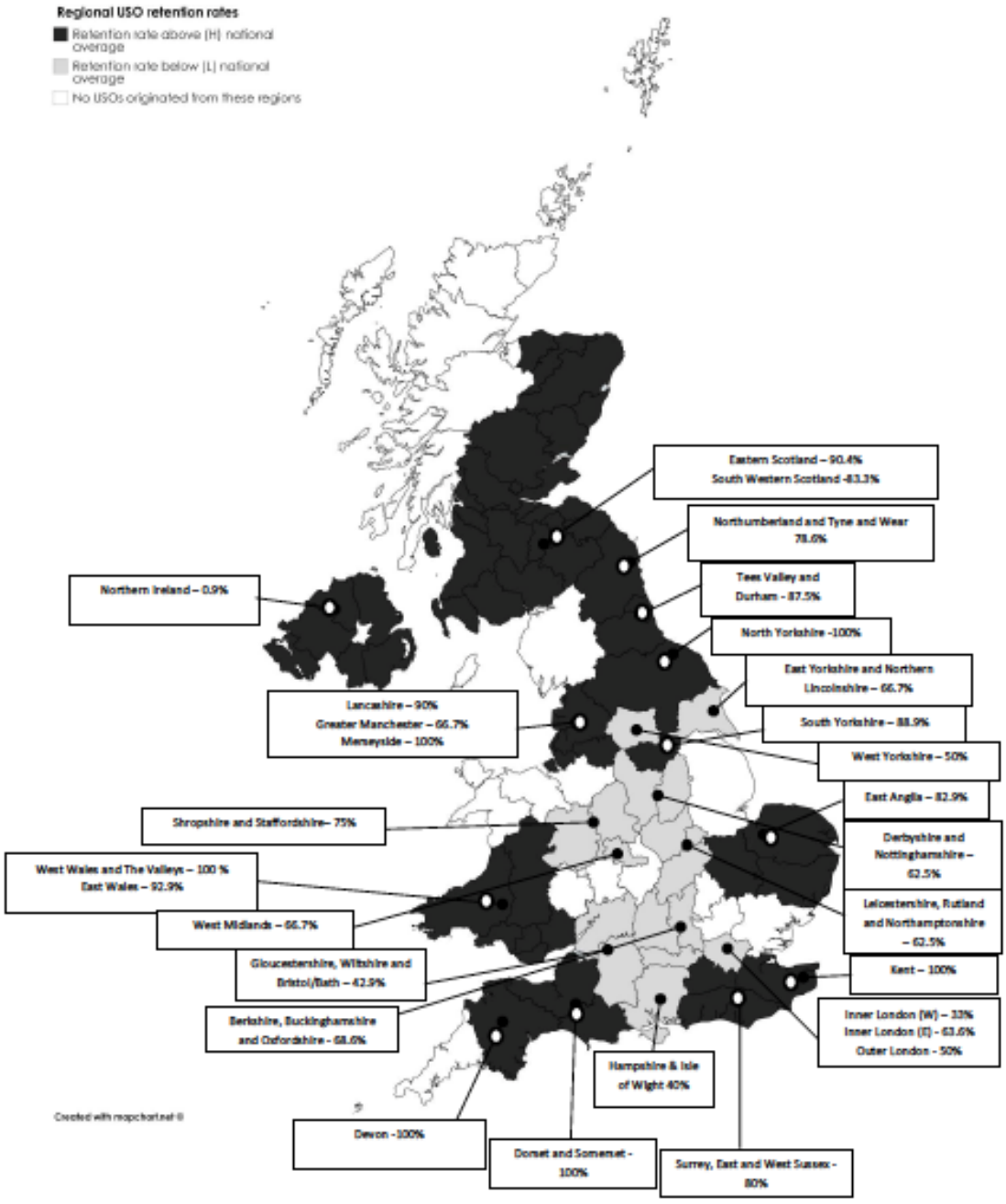
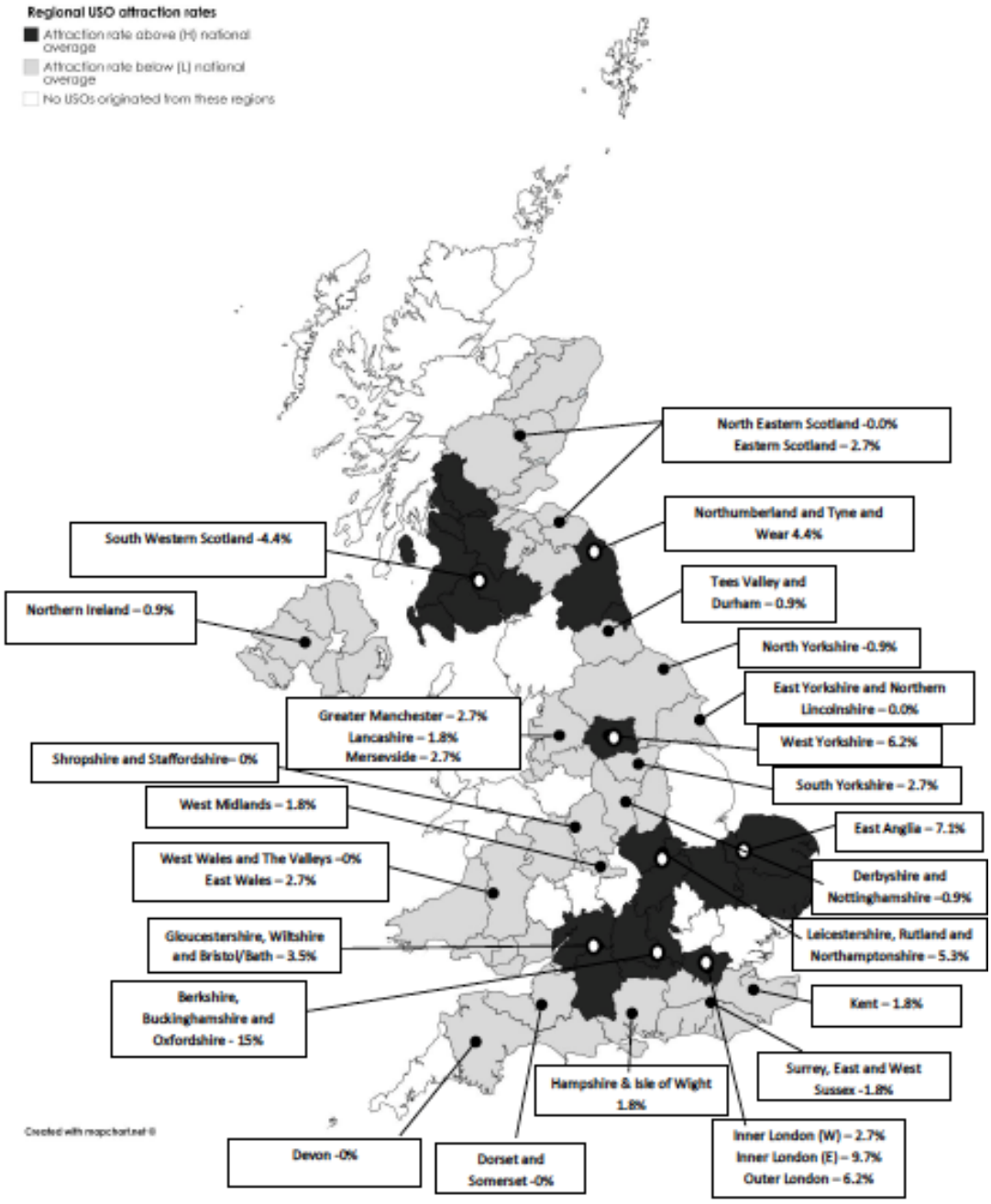


Figure 2. Regional USO attraction rates



There are no systematic differences between the USOs originating in regions with low and high retention rates (Table B2, Appendix B): hence different retention rates are not easily explained by these regions systematically creating USOs with different propensities to stay based on their inherent characteristics. Similarly, there are no systematic differences between USOs originating in regions with low and high attraction rates: the characteristics of USOs present in the region do not exert a specific attraction for USOs potentially moving from elsewhere. USOs are small and few in number compared to the overall number of firms in a region, and are unlikely in themselves to influence the region's attractiveness. Interestingly, we find that regions with a higher share of USOs with female founders are on average more attractive. This could be a proxy for the social dynamism of the region.

In Table 5, we consider whether there are differences in variables that relate to regional characteristics. First, we consider the comparison between high and low retention regions. Agglomeration economies, both urbanisation and localisation economies, are higher in low retention regions than in high retention ones: densely populated regions, with higher GVA, a concentration of firms in knowledge-intensive sectors, and a higher share of employment in high tech manufacturing and knowledge intensive services (the latter with p-value<0.2) are also more expensive for companies to settle in (as shown by the higher average house prices), and they tend to retain a smaller share of USOs.

Instead, there are no significant differences between low and high retention regions in the average values of the variables capturing the availability of resources for innovation and support for entrepreneurship, with the exception of the number of universities in the region, particularly of research-intensive universities, which are *lower* in high retention regions (perhaps because universities tend to be present in

greater numbers in highly urbanised contexts). It appears that USOs that stay in their original region are not particularly affected by local innovation resources. The USOs' relationships with their home university probably provide them with sufficient access to innovation resources (specialised personnel and graduates, labs, networks) to sustain their innovation capabilities. Some entrepreneurship support services are present to a higher extent in high retention regions.

The share of employment in high tech manufacturing and knowledge intensive services and localisation economies (the latter with p-value<0.2) is higher in high attraction regions, suggesting that USOs that move search for proximity with other firms in their same sector and a local labour market. Some innovation resources appear higher in high attraction regions (patents per capita, the share of graduate population, the number of research-intensive universities), suggesting that USOs move to more dynamic innovation systems. The differences between most of these variables are marginally non-significant (p-values between 0.1 and 0.2). Finally, the availability of science parks and advice for entrepreneurs is higher in high attraction regions (again with marginally non-significant p-values).

These patterns suggest that the features that increase retention rates are different from those that increase attraction rates. Some regions, (e.g. most of London and the South East), have low retention rates and high attraction rates, while others (e.g. the devolved countries) show the opposite pattern. USOs that stay and those that move appear to do so for different reasons. USOs that stay take advantage of the cheaper cost of inputs, irrespective of regional innovation resources (probably because they enjoy the innovation resources of the home university). Migrating USOs trade off proximity to the home university for access to innovation resources elsewhere, and for

the opportunity to be closer to other companies in the same sector (localisation economies).

Table 5. Differences between high and low retention and attraction regions: regional variables

Variable types	Variables	Average in low retention regions	Average in high retention regions	P-value of t-test	Average in low attraction regions	Average in high attraction regions	P-value of t-test
Localisation economies	Localisation economy	0.18	0.03	0.08*	0.05	0.20	0.11
	% employment HTM + KIS	44.64	41.47	0.11	41.78	45.34	0.09*
Urbanisation economies	Population density	2785.52	726.91	0.01**	1343.31	2262.20	0.33
	GVA	44866.46	24983.12	0.003***	30991.76	39683.33	0.26
	Average house prices	179464.4	137845.0	0.05*	149408.3	170981.1	0.37
Availability of resources for innovation	R&D expenditure per capita	652.44	434.32	0.27	514.76	561.68	0.83
	Patents per capita	101.61	75.47	0.22	77.52	108.45	0.17
	Share of graduates	30.87	28.31	0.24	28.50	31.56	0.19
	N universities	13.76	10.17	0.09*	11.04	13.33	0.32
	Number of research intensive universities	5. 31	3.35	0.05*	3.76	5.22	0.18
Support for entrepreneurship	University incubator	1.14	1.04	0.54	1.01	1.24	0.22
	Science park	0.82	0.97	0.47	1.00	0.69	0.18
	Local incubators	1.10	0.95	0.47	1.06	0.94	0.62
	Seed corn funds	1.36	1.48	0.47	1.42	1.45	0.86
	Venture Capital	1.06	1.18	0.27	1.14	1.11	0.85
	Advice	1.57	1.84	0.03*	1.67	1.86	0.19
	Entrepreneurial training	1.26	1.50	0.14	1.36	1.48	0.50

*** p<0.01, ** p<0.05, * p<=0.1.

Determinants of USOs' decisions to remain and move

Regression model 1 concerns a USO's probability to stay in its home region. As shown in Table 6, this probability is not affected by the quality of the innovation system or by localisation economies. The proximity of the home university is arguably sufficient for the USO's needs, so the decision to stay is not motivated by the quality of the local innovation system or the presence of localisation economies. On the other hand, the probability to stay is negatively affected by the presence of urbanisation economies. A quadratic term for urbanisation economies suggests that the effect is inverted U-shaped, with both very low and very high urbanisation economies having a negative effect on the probability to stay. In the case of highly

urbanised regions with high population density and high GVA, there are urbanisation diseconomies associated with higher prices. We also find a positive effect of local entrepreneurship training and advice. Hence, the advantages of staying are mainly the proximity to the home university and the availability of cheaper inputs.

Table 6. Firms' probability to stay in NUTS 2 region

VARIABLES	(a) Stay_local	(b) Stay_local
Localisation economies index	-0.006	0.094
	(0.088)	(0.088)
Urbanisation economies index	-0.175*	0.989*
	(0.107)	(0.606)
Urbanisation economies index^2		-0.107*
		(0.058)
Innovation resources index	-0.066	-0.079*
	(0.053)	(0.046)
Local premises index	0.069	0.093
	(0.162)	(0.149)
Local finance index	0.030	-0.004
	(0.143)	(0.112)
Local advice index	0.202*	0.237*
	(0.124)	(0.122)
Devolved region	0.954*	1.546***
	(0.589)	(0.495)
Acquired	-2.042***	-2.074***
	(0.508)	(0.517)
age	0.062	0.062
	(0.040)	(0.040)
pat_per_year	0.225**	0.216**
	(0.107)	(0.105)
KIBS	-0.546	-0.605
	(0.750)	(0.778)
Personal_services	-0.531	-0.473
	(1.092)	(1.097)
Manufacturing	-1.303*	-1.307*
	(0.763)	(0.762)
Chem_pharma	-0.832	-0.786
	(1.134)	(1.098)
ICT	0.202	0.142
	(0.923)	(0.939)
Constant	1.817	-1.342
	(1.149)	(1.695)
Observations	408	408
Wald chi2	155.45***	255.55***
Log pseudolikelihood	-202.19	-200.63
Pseudo R2	0.1635	0.1699

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<=0.1

As for the control variables, we find the expected effects. More technologically intensive USOs are more likely to stay as are those based in the devolved regions. USOs acquired by other firms are less likely to stay as are those in the manufacturing

sector, in line with patterns found at regional level. If we compute separately the coefficients for manufacturing USOs and service USOs (Table C3, Appendix C), we find that urbanisation economies have a negative impact on both types of USO, though the coefficient is less significant for manufacturing USOs. Manufacturing USOs are more likely to stay when there is greater provision of local financing and service USOs are more likely to stay when there is greater provision of local advice, however these effects are marginally non-significant (p-values are 0.16 and 0.18 respectively).

Model 2 shown in Table 7 concerns a moving USO's probability to move to a specific region. This model confirms that USOs that move are more attracted to regions that have high localisation economies, while urbanisation economies and the availability of innovation resources does not seem to have an effect. Again, the two types of agglomeration economies have different effects. This is in line with the finding by Conceicao et al. (2017) that for technology start-ups, spillovers arising from co-location with other high-tech firms are more important factors in the localisation decision than is access to general amenities presented in urban areas. For USOs, intangible knowledge sources are important as research collaborations: personal ties with home universities can weaken over time. USOs are less attracted to devolved regions. Thus those that move appear to seek knowledge spillovers from firms in their same sector. When computing separately the coefficients for manufacturing USOs and other USOs (Table D4, Appendix D), we do not find any differences in terms of agglomeration economies and innovation resources.

Table 7. Firms' probability to move to a specific NUTS 2 region

VARIABLES	moved
Localisation economies index	0.177*
	(0.105)
Urbanisation economies index	0.086
	(0.114)
Innovation resources index	0.032
	(0.052)
Local premises index	0.049
	(0.050)
Local finance index	-0.030
	(0.078)
Local advice index	0.083
	(0.084)
Devolved_region_dest	-0.543
	(0.597)
Constant	0.083
	(0.084)
Observations	3,051
Wald chi2	23.77**
Log pseudolikelihood	-471.43
Pseudo R2	0.0246

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<=0.1.

5. CONCLUSIONS

UK regions have different propensities both to retain and to attract USOs from elsewhere. A number of different factors are involved to answer our research question, 'what are the economic factors that help regions attract and retain USOs?'

Regions with high retention rates are likely to have lower urbanisation economies, suggesting that USOs tend to stay in regions where cheaper inputs are available. High urbanisation and high concentration of firms in high-tech and knowledge intensive sectors create agglomeration *dis*economies (mainly higher rental prices and higher input costs) that push some USOs away. USOs that stay in their home region do not appear to be influenced by the region's entrepreneurial ecosystem as they take advantage of the proximity to the home university to access innovation resources. Instead, regions with high attraction rates tend to have higher localisation economies and higher availability of innovation resources, suggesting that migrating USOs look for intangible resources (perhaps not sufficiently provided by their home university)

such as proximity to other firms in the same sector and a more dynamic innovation system.

These patterns are confirmed when we look at the determinants influencing USOs' decisions to remain or to move. Particularly, this analysis allows us to disentangle the different effects of the two types of agglomeration economies. Urbanisation economies, leading to congestion effects and high input prices, reduce the likelihood of a USO staying, while localisation economies and innovation resources do not have an effect (home universities compensate for the deficit). Some resources provided by the university acting as anchor institutions are important. For example, the provision of entrepreneurship training and advice increases the retention rate, particularly for service USOs. For manufacturing USOs it is the provision of local finance that is important. For migrating USOs, localisation economies increase the likelihood to move to a specific region, as USOs seek knowledge spillovers from other firms in the same sector. Innovation resources do not show an effect, although these seem to play a role when looking at region-level data.

This study offers some general implications for industrial policy particularly related to the regional disparities reduction, for instance, in the UK's "levelling up" agenda (UPP, 2020). Our findings suggest that USOs take advantage of the intangible resources provided by their home universities, indicating a key policy implication that industrial strategies and policies, which involve strengthening universities' capacity to engage with local firms, specially USOs, will pay dividends (Reichert, 2019).

If USOs decide to move to other regions, available intangible resources are in the form of proximity to other companies from the same sector or a lively regional innovation ecosystem (even though tangible resources, such as local financing, are also important specifically for manufacturing firms). A further implication is that

industrial policies aiming to increase the USO retention and attraction rates of lagging regions, with a view to reduce regional disparities, should therefore capitalise on the fact that such regions generally do not experience urbanisation diseconomies (for example, congestion, and high prices), and invest in fostering the intangible resources that help make these regions more attractive to USOs.

Particularly, local authorities are in a good position to introduce initiatives or interventions aimed at promoting innovation-enhancing localisation economies, such as industry-focused networking events to facilitate collaboration between firms and knowledge spillovers. Finance resources available within the region are significant to both retaining and attracting USOs. Hence, the provision of local finance should be actively promoted, such as a reduced business rate incentive policy for small business or start-ups. Indirect tax relief, especially, offers tax incentives to investors, thus incentivising investment in the USOs based in the region. Both direct and indirect tax incentives can help nurture young and small firms to accelerate and stay. In order to retain and attract USOs, local entrepreneurship training and advice services should not be neglected. It is possible that increased knowledge transfer activities within universities as well as coordinated actions between universities and different regional actors may have a significant effect.

While this study benefits from a unique, comprehensive dataset collecting information about the universe of UK USOs in a specific year, the analysis has some limitations. We are not able to observe the date in which USOs have moved to their current location, a cut-off period was adopted instead; more specific information about the date of the move could have allowed us to build a broader sample with regional-level information referring to the year of the move. Another limitation relates to the choice of regional unit of observations: while TTWAs are more suitable for our purposes, we

had to exclude them due to economic data unavailability. Some interesting variables at firm level could not be used in the regressions due to missing observations (such as size of the USO).

Identifying the factors that increase regional retention and attraction rates of USOs is important, and these factors are likely to change over time as remote working might make some types of firm more mobile. Further research could focus on specific types of USO (in specific sectors, or specific technology areas, or at different stages of their life cycle) in order to better understand what factors matter for locational decisions. Qualitative analysis could complement quantitative findings by shedding light on the reasons USOs choose to move or stay. The specific role exerted by the university, rather than the overall regional environment, in retaining USOs in the locality or attracting them from outside, also needs further exploration. Finally, this study is limited to USOs established by academics and other university staff members. Extending the analysis to graduate start-ups would shed light on the regional factors affecting the mobility of a different type of innovative start-ups which are likely to be inherently more mobile given their weaker linkages to the home university, but still very important from a regional development perspective.

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Appendix

Table A1. Characteristics of USOs that remain in their NUTS2 region

USO characteristics	Categories	Number USOs	% USOs that stay in NUTS2 region	P-value of (Chi2 or T) test
Sector	KIBS	264	73.5%	0.0674*
	Healthcare	15	73.3%	
	Manufacturing	58	56.9%	
	Chem pharma	15	66.7%	
	Trade	2	100.0%	
	Other	54	81.5%	
Age	0	21	76.2%	0.756
	1	39	71.8%	
	2	51	66.7%	
	3	42	76.2%	
	4	57	77.2%	
	5	71	71.8%	
	6	65	64.6%	
	7	62	75.8%	
Patent intensity	Patents	138	68.1%	0.205
	No patents	270	74.1%	
Acquisition	Acquired	24	33.3%	0.000***
	Not acquired	384	74.5%	

*** p<0.01, ** p<0.05, * p<=0.1.

Table A2. Differences between high and low retention and attraction regions: Characteristics of USOs originating from the region

Variables	Average in low retention regions	Average in high retention regions	P-value of t-test	Average in low attraction regions	Average in high attraction regions	P-value of t-test
Number of employees	9.86	11.51	0.7260	9.74	12.41	0.5767
Firm age	4.32	4.59	0.4924	4.54	4.32	0.6136
Patents per year	0.36	0.30	0.6993	0.30	0.39	0.5871
Female founder	0.16	0.09	0.3689	0.07	0.24	0.0393**
KIBS	0.71	0.61	0.3354	0.62	0.73	0.3479
Personal services	0.03	0.03	0.7013	0.03	0.03	0.8598
Manufacturing	0.11	0.22	0.2634	0.19	0.13	0.6121
Chem pharma	0.02	0.01	0.2781	0.01	0.01	0.7787
Trade	0.02	0.00	0.2093	0.01	0.00	0.6403
ICT	0.08	0.08	0.9033	0.09	0.05	0.3963

*** p<0.01, ** p<0.05, * p<=0.1.

Table A3. Coefficients of the independent variables in model 1 interacted with *Manufacturing* dummy

	Manufacturing=0	Manufacturing=1
Localisation economies index*Manufacturing	-0.006	0.114
	(0.094)	(0.240)
Urbanisation economies index*Manufacturing	-0.175	-0.175
	(0.115)	(0.166)
Innovation system index*Manufacturing	-0.079	-0.033
	(0.067)	(0.060)
Local premises index*Manufacturing	0.066	0.082
	(0.168)	(0.307)
Local finance index*Manufacturing	-0.055	0.458
	(0.147)	(0.330)
Local advice index*Manufacturing	0.183	0.316
	(0.137)	(0.336)

*** p<0.01, ** p<0.05, * p<=0.1.

Table A4. Coefficients of the independent variables in model 2 interacted with *Manufacturing* dummy

	Manufacturing=0	Manufacturing=1
Localisation economies index*Manufacturing	0.172*	0.194*
	(0.101)	(0.119)
Urbanisation economies index*Manufacturing	0.084	0.094
	(0.115)	(0.110)
Innovation system index*Manufacturing	0.029	0.041
	(0.053)	(0.050)
Local premises index*Manufacturing	0.049	0.052
	(0.053)	(0.055)
Local finance index*Manufacturing	-0.028	-0.036
	(0.079)	(0.076)
Local advice index*Manufacturing	0.079	0.096
	(0.085)	(0.085)

*** p<0.01, ** p<0.05, * p<=0.1.