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The attractiveness of university and corporate anchor tenants in the conception of a new cluster

Christos Dimos[a], Felicia M. Fai[b] and Philip R. Tomlinson[c]

ABSTRACT

Using an *ex-ante*, policymaker perspective, this study focuses upon a proposal for a new university (automotive) research institute (URI) – the University of Bath's Institute for Advanced Automotive Propulsion Systems (IAAPS) – and its role in the conception of a new industrial cluster. Analysing unique survey data, we identify the key characteristics of the firms most likely to observe future potential benefits from the presence of this proposed public anchor (1) in isolation and (2) when the proposed public anchor is established with a research-based relationship with a co-located private anchor. We find the presence of a private anchor amplifies the attractiveness of the public anchor, heightening the likelihood of a cluster emerging. We discuss implications for policy.

KEYWORDS

anchor tenants; clusters; networks; innovation; automotive; aerospace

JEL O30, R11, R53, R58

HISTORY Received 3 November 2019; in revised form 2 February 2021

INTRODUCTION

Using an *ex-ante* policymaker perspective, this study focuses upon a proposal for a new university (automotive) research institute (URI), and its role in the conception of a new cluster and whether the presence of a private anchor amplifies the attractiveness of the public anchor, heightening the likelihood of a cluster emerging. We do so by using the concept of anchor tenants (ATs) within cluster formation.

ATs – organizations heavily engaged in research and development (R&D) with the absorptive capacity to apply new knowledge and generate knowledge externalities within a particular technological field (Agrawal & Cockburn, 2003) – play a key role in the development of regional clusters. Anchors can connect actors (such as buyers and suppliers) both within and beyond a specific cluster. This network building is important for collaboration, knowledge transfer and value creation within the cluster and, crucially, enabling cluster-based firms to capture this value by exploiting new market opportunities (Bailey et al., 2018).

At least two categories of ATs with respect to R&D activity exist: (1) private anchor tenants (PvAT), for example, large original equipment manufacturers (OEMs) and/or multinational firms with R&D capabilities resident within the cluster (Agrawal & Cockburn, 2003); and (2) public anchor tenants (PuAT), for example, research universities and public research organizations (PROs) embedded within the cluster and its technological domain (Feldman, 2003; Lawton-Smith et al., 2016). The role of the AT is important within the context of nascent clusters because it can act as a magnet for attracting new investment and become central to the nurturing of cluster specialisms in new technological fields (Braunenjelm & Feldman, 2006). Studies generally divide the roles of private corporate anchors (PvATs) and public universities (PuATs), and their respective impacts on their local regions, as two separate literatures. They reveal the roles of PvATs and PuATs are different. Corporate ATs can generate opportunities for locally present firms to access the corporation's networks, that is, their global knowledge and value chains (Chaminade & Vang, 2008). Universities can contribute as a user/producer of local goods and

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services, as an employer, and through their 'third mission' (Benneworth, 2018) by transferring their know-how to local industry and supporting regional knowledge networks (Goddard et al., 2014). Whilst studies also indicate mutual benefits are gained from university–corporate interactions, there is little literature that considers whether a purposeful collaborative relationship between these two actors at the start of cluster formation, could positively influence regional industrial growth.

Our other critique of existing studies is that by examining the historical dynamics of established clusters, prescient knowledge of the importance of ATs for cluster dynamics is generated *ex-post*, which we then tend to impose onto the conception of a new cluster as the *hypothetical/proposed* benefits such a cluster may bring (Niosi & Zhegu, 2010). However, there is little *empirical* confirmation that the firms which might benefit from the presence of these ATs in a potential new cluster, actually recognize the importance of these factors *ex-ante*. This makes it difficult for policymakers to design appropriate policy initiatives in which public and private anchors are key contributors within new cluster formation. Given the growing policy interest in the role of universities (and PROs) as local anchors to stimulate regional growth and technological/industrial cluster formation (Benneworth, 2018), this policy challenge is becoming very important.

To be clear, this study is not set within an actual physical cluster, but the proposal for the birth of a new one, that is, its conception stage. Given this setting, we seek to make two main contributions. First, we outline a framework as to how a new PuAT is perceived to best establish private sector links within the ambitious context of *conceiving* a new cluster. In doing so, we explore the significance of a potential PuAT's links to a co-located PvAT, focusing in particular on their different and complementary roles and how this relationship might 'bridge' knowledge and business networks in order to propagate value creation and facilitate value capture (Bailey et al., 2018). This enables us to offer a framework of firm-level characteristics that may assist policymakers *ex-ante* in identifying firms that would find a PuAT attractive as a regional 'magnet' and hitherto stimulate a cluster's emergence and growth.

Second, and utilizing this framework, we offer an exploratory case study of the attractiveness of both a new university research facility and a corporation as ATs in the *conception* of a new cluster. We do so in the context of what was, at the time of data collection, a detailed proposal for the creation of a new University of Bath automotive research institute (URI) – the Institute for Advanced Automotive Propulsion Systems (IAAPS) – to be located at the nearby and relatively new Bristol and Bath Science Park (BBSP)[1] – a potential PuAT. Drawing upon a unique survey of firms in the UK automotive, and (technologically adjacent) aerospace sectors, we identify the range of benefits the URI is perceived to offer private firms characterized by different structural characteristics and managerial attitudes towards innovation, hence the *attractiveness* of the proposed URI facility in terms of the specific physical assets and resources on offer, and the networking opportunities it aspires to create, to a variety of firms from across the UK. We also explore the amplifying effects on the URI's attractiveness if it were to form a research-based relationship with a co-located global OEM (acting as a PvAT) in an emerging cluster. The policy implications of these results are then also considered.

The remainder of this paper is as follows. Next we offer a theoretical overview of the role of PuAts and PvATs in the emergence and development of regional clusters and set out a framework for identifying the types of firms that are likely to find an AT attractive. We then introduce our specific URI (IAAPS) case study, the description of our methodological approach and empirical results. Following this, we consider the wider policy implications of our findings for more generic cluster development and finally conclude.

THEORETICAL ISSUES AND HYPOTHESES

ATs as magnets in cluster formation

In the genesis of high-technology clusters, ATs can play a key role as magnets for new investments by firms and other institutional actors external to the cluster (Braunenjelm & Feldman, 2006; Wolfe & Gertler, 2004). The presence of large PvATs may facilitate agglomeration economies, notably by developing skilled labour pools and procuring locally sourced inputs. The PvAT's research programme can also generate a new pool of entrepreneurs and spin-offs, who may become involved in the anchor's innovation projects (Feldman, 2003). For instance, Baglieri et al. (2012) document the significant role played by STMicroelectronics in providing highly qualified employment and R&D investment, while also fostering high-tech spin-off ventures and attracting international firms/suppliers and public funds in the emergence and development of both the Grenoble and Catania nanotech clusters. PvATs are also typically engaged in global value chains – they seek to become leaders in new 'technological domains' (Mudambi et al., 2017) by creating value through innovation and capturing this value in global markets (Wright, 2014). Other firms may be attracted to their location to benefit from positive externalities and possibly the opportunity to become part of the PvAT's supply chain.

PuATs can also play a crucial role in establishing and supporting local networks, making the region attractive for entrepreneurs, and in some cases, enticing PvATs to the cluster (Smedlund, 2006). Research universities may provide facilities, expertise and technical support to cluster-based firms, while offering socially inclusive spaces that attract/retain highly skilled researchers and students in the region (Gertler & Vinodari, 2005). These add to the cluster's stock of tacit knowledge, skillsets and thickness of local labour markets. For Etzkowitz and Klofsten (2005), the 'entrepreneurial' research university is part of the triple helix, supporting government and industry in cluster development and 'found at the root of virtually any high-tech region' (p. 246). As such, they can act as PuATs in developing human capital and research resources, as the seedbed for interdisciplinary scientific cross-fertilisation, and for facilitating social interaction and networking capacity for (local) actors to tap into shared knowledge bases (Lendel, 2010). The enhancement of regional assets enhances the cluster dynamic and strengthens its attractiveness for external actors further.

Establishing business links with new regional public anchors

While anchors play an important role in cluster emergence, policymakers and public agencies can act as key facilitators. In the policy context of a proposal for significant public investment in a new regional PuAT, it is especially important to demonstrate *ex-ante*, the potential for fruitful collaboration between the PuAT and the private sector. This requires a framework for identifying the types of firms attracted to and most likely form collaborative links with, the proposed PuAT. The existing literature on university/PRO–industry linkages offers some guidance.

Laursen and Salter (2004) distinguish between (1) *structural factors* relating to the characteristics of the firm and its environment; and (2) *managerial strategy* towards open innovation strategy. We adapt their approach identifying structural factors within three categories: basic firm characteristics (firm size, age, financial position), technological capability (R&D intensity/innovativeness) and external environment (industry and regional context) whilst we define managerial choice in terms of a firm's openness (i.e., development of knowledge sharing in external networks).

Structural factors

Basic firm characteristics

It is argued larger firms have more internal resources, capacity and capabilities to manage and exploit knowledge flows from linkages with a PuAT (Cohen & Levinthal, 1990). On the other hand, younger firms (start-ups/scale ups) – especially those operating in advanced technological sectors – may be likely to engage with a PuAT to compensate for their own lack of resources. Some may be spun out from universities/PROs, and are comfortable with such interaction, whereas others may be encouraged to engage through government support (Cohen et al., 2002). We also consider a firm's financial position and its ability to access external capital. When firms are financially constrained, they are unable to access the resources that enable them to engage and collaborate with a PuAT (Gorodnichenko & Schnitzer, 2013; Howell, 2016). Hence, we specify:

Hypothesis H1a: The attractiveness of the URI (as a PuAT) is greater for larger firms vis-à-vis smaller firms.

Hypothesis H1b: The attractiveness of the URI (as a PuAT) is greater for younger firms vis-à-vis older firms

Hypothesis H1c: The attractiveness of the URI (as a PuAT) is lower for financially constrained firms vis-à-vis non-financially constrained firms.

Technological capability

A firm's investment in R&D generates absorptive capacity which it can then utilize to absorb and exploit knowledge flow from external sources (Cohen & Levinthal, 1990). R&D-intensive firms are therefore more likely to engage with a PuAT. Indeed, a PuAT is an attractive partner since its public funding base facilitates 'blue sky' and basic research that may underpin radical innovation. PuATs play a key role as knowledge generators and conduits for knowledge diffusion, which the private sector can exploit (Andreoni, 2016). Firms with higher levels of R&D intensity are more likely to absorb and apply this external knowledge for their own commercial purposes. Hence, for highly innovative and R&D-focused firms, URIs are highly attractive for research collaborations (Cowan & Zinovyeva, 2013): the universities' specialized physical resources (e.g., laboratories and equipment) and expert knowledge can attract such firms to locate close by. We therefore specify:

Hypothesis H2a: The attractiveness of the URI (as a PuAT) is greater for highly R&D-intensive firms (than less R&D-intensive firms).

Hypothesis H2b: The attractiveness of the URI (as a PuAT) is greater for highly innovative firms (than less innovative firms).

External environment (industry and regional context)

Where a PuAT has a specific industry focus (as in our case), firms in the same industry are the ones most likely to utilize its facilities and build links. Additionally, geographically proximate firms to the PuAT will have easier access to the facility, its technologies and the opportunity to benefit from tacit knowledge spillovers (Eom & Lee, 2010), and are more likely to find the PuAT attractive than more remote firms. It follows firms which are both in the same industry and proximate to the PuAT will hold positive perceptions. Hence, we specify:

Hypothesis H3a: The attractiveness of the URI (as a PuAT) is greater for firms in the same industry as the URI.

Hypothesis H3b: The attractiveness of the URI (as a PuAT) is greater for firms located in the same region as the URI.

Hypothesis H3c: The attractiveness of the URI (as a PuAT) is greater for firms in the same industry and located in the same region as the URI.

Managerial strategy, open innovation and networks

Using a composite measure of 'openness' (capturing firm involvement in trade fairs, conferences and meetings from the UK Innovation Survey), Laursen and Salter (2004) argue firms tend to utilize university created knowledge when they are already engaged in a range of 'open innovation' activities. This reflects managerial strategy and is indicative of firms being more open to searching, being widely networked and accessing external knowledge sources.

For a policymaker, especially in the context of our study, it may be useful to consider distinctions between the *types* of networks firms are currently involved in, and are likely to seek out, with a PuAT and/or the proposed co-located PvAT. Giuliani's (2007) distinction between *knowledge* and *business* networks is particularly instructive. Knowledge networks involve actors deliberately sharing knowledge to deliver innovative solutions to complex *technical and technological* problems and, as such, are highly selective. Anchors with strong technical knowledge bases may be identified as technology leaders and sought out by firms for advice/technical expertise. Both PuATs and PvATs can become central actors in knowledge networks although the knowledge networks themselves are likely to be differentiated in terms of the technological knowledge's proximity to the science base versus commercial application. In contrast, a business network is a group of firms and entrepreneurs that connect to explore, create and pursue business opportunities (Österle et al., 2001). They *create* and *capture* value through innovations geared towards creating and exploiting market opportunities (Wright, 2014).

Firms with positive experiences of network collaboration are more likely to join new networks to broaden their pool of collaborators, reconfigure their existing networks and expand their knowledge base. In doing so, these firms reduce their risk of becoming locked into their existing networks, which over time may become stale and over-embedded (Huggins & Thompson, 2014). We speculate firms already deeply embedded in networks (business or technical knowledge based) may be more attracted to ATs due to the potential knowledge networks which might emerge around them. A firm interested in technical knowledge, as evidenced by its deep embeddedness in current knowledge networks, may find both the PuAT and PvAT attractive relative to a firm which is not interested/deeply embedded in knowledge networks. Similarly, a firm which is deeply embedded in business networks may also be attracted to new technical knowledge as it may enable it to grasp new business opportunities in the future.[2] Hence, we specify:

Hypothesis H4a: The attractiveness of the URI (as a PuAT) is greater for firms highly embedded in existing knowledge networks (vis-à-vis those loosely/not embedded in existing knowledge networks).

Hypothesis H4b: The attractiveness of the URI (as a PuAT) is greater within firms highly embedded in existing business networks (vis-à-vis those loosely/not embedded in existing business networks).

The role of anchors as bridges

ATs acting as magnets can bring scale and density to a cluster. However, the positive externalities physical proximity creates is a suboptimal outcome. Policymakers want clusters to form networks to co-create and diffuse knowledge to stimulate regional innovation – relational embeddedness between organizations is important (Capello & Faggian, 2005). Whilst the potential for networks to form around ATs exists, it may not be realized without purposeful efforts to build connections within and between technical knowledge and business networks (Clarysse et al., 2014).

ATs can play a critical role here and facilitate this purposeful activity by acting as a bridge for actors across each type of network. Figure 1 (panel A) illustrates several clusters (the focal cluster for our purposes is the larger one to the left). In the focal cluster, multiple firms exist; some may have direct linkages to other firms (not illustrated, but see the note to Figure 1) both within the focal cluster and beyond it. Figure 1 (panel B) illustrates the same cluster, but now with a university acting as PuAT within it. As discussed above, a PuAT can play a key role in the initial formation of a *knowledge* network by being a magnet, creating multiple direct bilateral knowledge linkages with local actors in a hub and spoke formation (Youtie & Shapira, 2008). For instance, PuATs such as the German *Fraunhofer* institutes and the Japanese *Kohetsushi* centres have long acted as bridges by enabling regionally based small and medium-sized firms to access new technologies, knowledge and allowing them to participate in joint applied-research projects (Andreoni, 2016). Moreover, through its connections with other universities beyond the cluster, a PuAT may even act as a bridge for local firms to be able to access expertise from global academic research networks (Bramwell & Wolfe, 2008).

While the attraction of the PuAT and PvAT's knowledge networks can entice technical and specialist firms to an emerging cluster, we propose it is the possibility of the PuAT acting as a bridge for possible access to the PvAT's wider *business* networks (and the commercial opportunities therein) that provides an additional degree of attractiveness of the PuAT to firms.

Large PvATs are also in a prime position to act as a bridge, but this time between cluster-based *knowledge* networks and broader *business* networks (Figure 1, panel C). This is because PvATs are especially attuned to developing products and services for commercial exploitation within big global markets (such as global value chains). Where obstacles or gaps arise within the PvAT's business network, these can be fed back into the knowledge network stimulating new research and innovation opportunities. Without the 'bridge' to business networks provided by the presence of the PvAT, the knowledge embedded within knowledge networks emerging around the PuAT in regional clusters may have more limited value. It is in this role as 'bridge' that the PvAT further propagates the cluster dynamic, strengthens its magnetic appeal to external actors and ensures the development of the cluster (Clarysse et al., 2014).

In clusters where both PvATs and PuATs reside, the connection between knowledge and business networks is

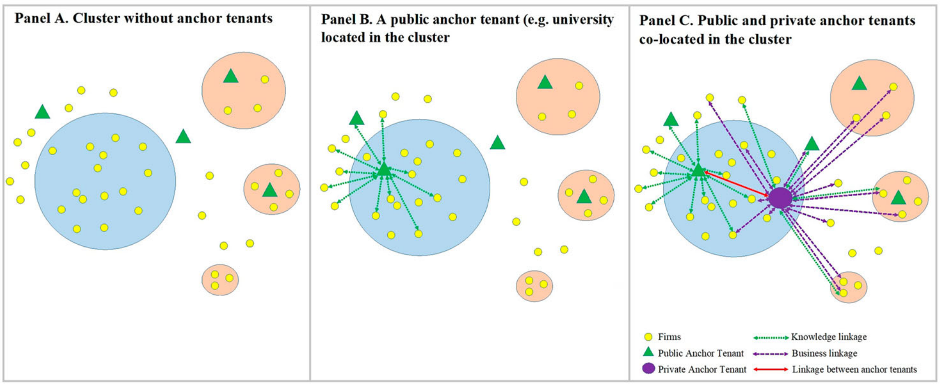

Figure 1. Cluster linkages and anchor tenants (ATs).
Note: We assume that some inter-firm linkages exist both between firms within the specific cluster(s) and between firms within and beyond the specific cluster, but for the purposes of clarity, we have illustrated only those linkages that pertain to the roles of the central actors in our analysis – private (PvAts) and public anchor tenants (PuATs).
Source: Authors.

especially strong when both anchors collaborate together closely. This may arise, for example, when a PvAT utilizes technological platforms developed by a local university that will assist the transfer of the more technical knowledge from publicly funded research into commercialized output. The United States, for instance, has long encouraged such collaboration, with regionally based university centres and public R&D agencies working closely with leading private sector actors to commercialize scientific discoveries (Block, 2008).[3] Such activities strengthen both the magnetism and potential dynamism of a cluster, allowing it to develop a regional system of innovation in which (local) university research is more likely to be absorbed by local firms, thereby stimulating local industrial R&D, and enhancing the attractiveness of the cluster for inward investment by non-local firms. Hence, we specify:

Hypothesis H5: The potential for research collaboration between the URI (as the PuAT) and an OEM (as the PvAT) co-located within the cluster enhances the attractiveness of the URI as a PuAT.

CASE BACKGROUND

The theoretical issues in the previous section highlight the potential roles of PvATs and PuATs within a cluster. In the conception of a new cluster, where public funding decisions on new research facilities are being made, policymakers are interested in the role of both PvATs and PuATs in spurring cluster growth. This was especially important within the context of our case study, where significant funding has been awarded to establish a new public anchor.

In July 2017, the University of Bath announced it had been awarded funding jointly from the UK Research Investment Fund (UKRPIF) and the West of England Local Enterprise Partnership to establish a £70 million Institute for IAAPS to be based at the existing (yet relatively new) local BBSP.[4] IAAPS aim is to be a Global Centre of Excellence delivering transformational R&D for future generations of low carbon vehicles. In this regard, it is to be one of the six spokes in the UK's Advanced Propulsion Centre network and is unique in being conceived as the only facility to allow 'precise systems level examinations of the whole powertrain, facilitating whole vehicle assessments under real-world driving conditions'.

IAAPS will work closely with global OEMs in the automotive industry, SMEs and other universities to deliver low carbon technologies and advanced combustion engines, alongside electric, hybrid and alternative fuel systems.[5] These technologies may also be of interest to the aerospace sector, which is experiencing similar technological challenges (as the automotive sector) and for which the region has a global reputation, potentially through developing links with a nearby aerospace OEM and through local aerospace supplier firms diversifying their skills and interests into advanced propulsion systems based on alternatives to fossil fuels. The University of Bath has world leading research capabilities in advanced mechanical engineering, delivered 15 Innovate UK- and APC-funded projects and received research income in excess of £11 million between 2011 and 2015. It has long, extensive experience of working with global automotive OEMs, including Ford and Jaguar Land Rover. In short, the scientific expertise already resides in the university (and hence region) and there is an existing (albeit currently predominantly geographically distant) client base.

In preparing the bid, it was important for the university to demonstrate the wider benefits of the public investment in the facility, particularly with regard to SMEs in the UK automotive and related industries and, for the interests of its local enterprise partnership (LEP), the potential to develop a new regional cluster. As a PuAT, if IAAPS is to thrive, it is important it fosters productive relationships and technological synergies with SMEs in this process to facilitate knowledge transfer, innovation and value creation/capture. Of particular interest then were the types and characteristics of firms that might be attracted to the future cluster and form links with the new IAAPS facility. Understanding the attractiveness (captured through firms' perception of benefits) of IAAPS from the viewpoint of possible users was not only important to justify the allocation of public funds, but also it aids IAAPS's management team to coordinate and tailor its facilities and activities to attract the calibre of firms most likely to generate a dynamic cluster.

METHODOLOGY

Survey and sampling frame

The data for this study were drawn from a survey of 1100 firms operating in the UK automotive and aerospace industries, and which are listed on the membership directories of the main industry trade associations: The Society of Motor Manufactures and Traders (SMMT), the Aerospace, Defence, Security, Space Group (ADS) and the West of England Aerospace Forum (WEAF). The directories provided contacts and background information on member firms operating at the four-digit standard industrial classification (SIC) in both sectors. The rationale for this sectoral sampling frame is that whilst IAAPS will primarily focus upon propulsion systems for the automotive industry, there are likely to be strong synergies with technologically proximate sectors, especially aerospace in which the south-west of England has a well-established global reputation.

The survey was addressed to the managing director of each of the 1100 firms and administered during the summer of 2016. Information explaining the concept of the proposed URI, its remit and facilities on offer were provided through a two-page leaflet and online video. The questionnaires sought information on each firm's research and innovation capabilities, their interest in IAAPS and its proposed facilities, along with background information. It also asked several questions relating to firms' perceptions of the likely benefits and their utilization of IAAPS and whether or not the possible co-location of a global OEM would affect their attitude and attraction to it. Survey questions were largely based upon previous academic studies and utilized a seven-point Likert scale.[6] In total, 116 usable responses (10.5% response rate) were received, with 57 (a 14.0% response rate) from automotive firms and 59 (8.9%) responses from aerospace firms.

Model and variable construction

From the survey, we used *perceptions* of IAAPS's proposed benefits as proxies for the attractiveness of the facility to firms. In line with self-perception theory (Bem, 1965), we interpret firms will perceive IAAPS's future benefits accruing to them in ways that align with their own characteristics and past activities, thus rendering their responses qualitatively reliable. We explore partial correlations between firms' existing (1) R&D intensity and innovative capacity, (2) involvement in business and/or knowledge networks and (3) the perceived attractiveness of IAAPS both as a standalone entity and when it is co-located with a PvAT (e.g., OEM). More formally:

$$\begin{aligned} Benefits_i = {} & \gamma_0 + \gamma_1 RDintensity + \gamma_2 Innov_i i \\ & + \gamma_3 BusinessNetwork_i \\ & + \gamma_4 KnowledgeNetwork_i + \gamma_5 Size_i + \gamma_6 Age_i \\ & + \gamma_7 Industry_i + \gamma_8 Region_i \\ & + \gamma_9 (Industry_i * Region_i) \\ & + \gamma_{10} Financial\ Constraints_i + u_i \end{aligned} \quad (1)$$

To capture the attractiveness of (1) IAAPS, as a standalone PuAT, and (2) IAAPS, when it is co-located with an OEM (as a PvAT), we asked respondents to indicate the extent to which their firms would expect to utilize IAAPS's facilities, on separate seven-point Likert scale items. We interpret firms that expect to utilize the facilities to a greater extent, perceive they will derive greater benefit from IAAPS than firms expecting to use them to a lesser extent. We also interpret the greater the perceived benefits of working with and utilizing IAAPS, the more attractive the facility is to private firms.

We used questionnaire items to create constructs by combining them into single factors through exploratory factor analysis (EFA), employing an oblique (direct oblimin) rotation of the extracted factor matrix. We extracted four factors that constitute our attractiveness constructs, each capturing a different type of attractiveness.[7] Two of these identify the attractiveness of IAAPS as a standalone facility, while two constructs identify the attractiveness of having an industry-specific OEM co-located with the URI. In particular, the first construct (*URI facility-specific physical benefits*) captures the extent to which firms expect to utilize and derive benefit from IAAPS's proposed facilities and laboratories while the second (*URI facility-specific knowledge benefits*) captures the extent to which firms perceive IAAPS as a means to enhance their own stock of knowledge, through its scientific and technical advice, support and training, information sharing and/or wider industry networks. The third construct (*Region-wide benefits stemming from URI–OEM co-location*) captures the attractiveness of the potential regional synergies arising between IAAPS (as the PuAT), and an unnamed, but industry-specific, OEM (as the PvAT) and private firms. Finally, the fourth construct (*Firm-based benefits stemming from URI–OEM co-location*) captures how the presence of a direct relationship between IAAPS and an OEM would generate benefits for the firms that may render them more willing to establish a relationship with the URI. These constructs, which jointly explain 62.41% of the variance of the correlation matrix, act as our dependent variables. Full details of the items utilized and the construction of the dependent variables (and the EFA), the independent variables and descriptive statistics are provided in Tables A1–A3 in Appendix A in the supplemental data online.

ESTIMATION AND RESULTS

Equation (1) was estimated by ordinary least squares (OLS), and the results are reported in Table 1.[8] Overall, the Ramsey tests indicate the models are well specified, while the low variance inflation factors (VIFs) suggest multi-collinearity is not a problem. The adjusted R^2 values are also reasonable for exploratory cross-sectional studies of this type (Greene, 2003, p. 37). We should also note the intention of the models is *not to infer causality*, but to identify, statistically, the types of firms (and their characteristics) for whom IAAPS is most attractive.

Public anchor's attractiveness and firm characteristics

With regards the results, we first consider structural factors (H1–H3). First, both firm size and age are insignificant across all perceived benefit categories (H1a and H1b not supported). However, financially constrained firms (Table 1, panel A, row 10, columns 6 and 8; H1c supported) have less favourable perceptions of the potential benefits of IAAPS, although this is only (negatively) significant with regard to a potential link up between the URI and an OEM in the cluster where the associated benefits are greater (see the section 'Amplifying the benefits of an OEM link up' below). Financially constrained firms may lack the capacity and resources to participate in such projects and benefit from regional synergies arising from such a link up, and if they are to do so, they will require additional support (Mateut, 2018).

Second, the results indicate highly innovative firms tend to report between 0.468 and 1.246 points higher in the Likert scale across the four attractiveness constructs compared with less innovative firms, *ceteris paribus* (Table 1, panel A, row 1). That is, more innovative firms are significantly more positive about each of the attractiveness measures relating to IAAPS vis-à-vis less innovative firms (H2b supported). IAAPS is being established as a public research facility and wants to attract highly innovative firms capable of utilizing its powertrain research, climatic vehicle performance and vehicle testing facilities, and associated laboratories. Innovative firms also view IAAPS positively as a means to acquire technical and specialist knowledge, and access to new knowledge pools around propulsion systems (Cowan & Zinovyeva, 2013). Highly innovative firms are also significantly more positive about a potential link-up between IAAPS and an OEM (H5 supported), which may allow them to access the latter's value networks and also gain from the wider potential regional synergies arising (as a result of the connection) within the cluster.

H2a is only partially supported. Firms with high R&D intensity (relative to those with low R&D intensity) are only significantly more positive on the attractiveness of IAAPS's specific facilities. However, the negative coefficients (Table 1, panel A, row 2) also indicate high R&D intensity firms are less convinced by other types of potential benefits, albeit these are only significant in the context of the enhanced regional benefits derived from both types of ATs working together. We interpret this result to signify low R&D-intensive firms perceive they have more to gain from regional synergies arising from a relationship between IAAPS and an OEM than do high-intensity R&D firms. It is possible that low R&D-intensive firms are less endowed with technological skills, and so have most to gain from any growth in the quality of the regional labour pool, professional/ancillary services and new investors.

Third, regionally based automotive firms are more likely to benefit from knowledge exchange with the URI (H3c supported). This may be due to a better alignment of IAAPS's facilities and activities to their own research orientation and expertise. However, aerospace firms based in the south-west perceive fewer facility benefits than firms from the same industry based in the rest of the UK. This may be due to existing facilities in the locale that already place local aerospace firms at an advantageous position compared with their wider UK counterparts. In separate estimations of models 1–8 (Table 1), excluding the Industry*Region interaction term, we found no evidence for a general regional or industry impact on the URI's attractiveness (H3a and H3b, not supported).[9] Finally, there are no significant differences in the attractiveness of IAAPS with regards to firms' involvement in knowledge networks, their size or age.

Turning to managerial and strategic factors, firms already highly engaged in business networks hold significantly more positive perceptions of both IAAPS's specific facilities and the potential knowledge benefits it can convey, which may provide them with an opportunity to better align their value creation and capture activities. These firms are also significantly positive about IAAPS's potential link-up with an OEM (Table 1, panel A, row 3), which may allow them to extend their own business networks and commercial opportunities, especially in global markets (H4b supported). For firms highly engaged in knowledge networks, the estimated coefficients are again positive, but insignificant (H4a, not supported).

Pairwise comparisons

To further explore how the benefits of IAAPS relate to the different types of firms, we augment equation (1) with two-way interaction terms (see equation 2). We consider the two most relevant structural variables (*Innovativeness* and *R&D intensity*) – as indicated by their statistical significance in Table 1 (panel A) – and the two variables relating to the firms' managerial and

Table 1. Ordinary least squares (OLS) estimation results.

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	(A)								(B)							
	URI				URI–OEM (co-location)				URI				URI–OEM (co-location)			
Variables	Facility benefits		Knowledge benefits		Region-wide benefits		Firm-based benefits		Facility benefits		Knowledge benefits		Region-wide benefits		Firm-based benefits	
Model equation	(1a)	(1b)	(1a)	(1b)	(1a)	(1b)	(1a)	(1b)	(2a)	(2b)	(2a)	(2b)	(2a)	(2b)	(2a)	(2b)
Innovativeness	0.468*	0.589**	0.664**	0.793**	0.996***	1.246***	0.824**	1.010***	0.486*	0.612**	0.627**	0.746**	1.040***	1.209***	0.859**	0.961***
	(0.271)	(0.291)	(0.310)	(0.354)	(0.299)	(0.302)	(0.329)	(0.352)	(0.267)	(0.299)	(0.315)	(0.367)	(0.270)	(0.281)	(0.334)	(0.364)
R&D intensity	0.472**	0.456*	−0.0790	−0.131	−0.637**	−0.797**	0.00776	−0.0626	0.855***	0.926***	0.395	0.429	−0.255	−0.265	0.389	0.462
	(0.228)	(0.250)	(0.316)	(0.348)	(0.320)	(0.349)	(0.416)	(0.477)	(0.228)	(0.252)	(0.287)	(0.317)	(0.266)	(0.283)	(0.337)	(0.367)
Business networks	0.540*	0.639**	0.685**	0.799**	0.213	0.316	1.059***	1.257***	0.789***	0.830***	0.759***	0.807***	0.138	0.136	0.955***	0.989***
	(0.290)	(0.294)	(0.304)	(0.329)	(0.353)	(0.354)	(0.392)	(0.401)	(0.267)	(0.288)	(0.248)	(0.273)	(0.260)	(0.287)	(0.331)	(0.365)
Knowledge networks	0.343	0.245	0.351	0.272	0.162	0.0112	−0.144	−0.360	0.843***	0.888***	0.674**	0.719**	0.104	0.104	0.426	0.445
	(0.271)	(0.284)	(0.382)	(0.409)	(0.440)	(0.450)	(0.493)	(0.500)	(0.260)	(0.272)	(0.304)	(0.327)	(0.310)	(0.328)	(0.385)	(0.407)
Firm size (micro/SMEs)	−0.191	−0.318	0.252	0.189	0.229	0.198	0.170	0.0676	−0.154	−0.261	0.243	0.160	0.193	0.124	0.231	0.108
	(0.207)	(0.216)	(0.388)	(0.440)	(0.357)	(0.392)	(0.429)	(0.472)	(0.226)	(0.249)	(0.409)	(0.459)	(0.353)	(0.393)	(0.437)	(0.480)
Age (young firms)	0.276	0.444	0.224	0.380	0.426	0.661	0.276	0.614	0.180	0.333	0.213	0.381	0.321	0.501	0.361	0.691
	(0.252)	(0.279)	(0.334)	(0.387)	(0.373)	(0.404)	(0.431)	(0.483)	(0.231)	(0.257)	(0.344)	(0.418)	(0.381)	(0.428)	(0.445)	(0.511)
Industry (automotive)	−0.165	−0.122	−0.410	−0.386	0.257	0.408	0.0877	0.136	−0.175	−0.157	−0.402	−0.391	0.221	0.328	0.0800	0.0558
	(0.233)	(0.260)	(0.362)	(0.416)	(0.337)	(0.367)	(0.398)	(0.430)	(0.265)	(0.293)	(0.381)	(0.425)	(0.369)	(0.393)	(0.397)	(0.418)
Region (anonymised)	−0.447*	−0.552**	−0.539	−0.606	0.508	0.580	0.174	0.160	−0.481*	−0.574**	−0.534	−0.599	0.519	0.623*	0.183	0.153
	(0.256)	(0.268)	(0.369)	(0.393)	(0.370)	(0.381)	(0.488)	(0.497)	(0.272)	(0.286)	(0.375)	(0.400)	(0.362)	(0.360)	(0.495)	(0.511)
Industry*region	0.407	0.352	1.407**	1.359*	−0.447	−0.720	−0.0815	−0.288	0.615	0.591	1.412**	1.371*	−0.363	−0.575	−0.116	−0.203
	(0.371)	(0.379)	(0.625)	(0.684)	(0.594)	(0.636)	(0.759)	(0.816)	(0.423)	(0.450)	(0.654)	(0.716)	(0.654)	(0.693)	(0.781)	(0.840)
Financial constraints		−0.374		−0.412		−0.616**		−0.955***		−0.404*		−0.407		−0.622**		−0.917**
		(0.234)		(0.348)		(0.288)		(0.363)		(0.224)		(0.369)		(0.311)		(0.390)
Constant	1.924***	2.099***	3.231***	3.355***	2.806***	2.909***	3.401***	3.663***	2.041***	2.210***	3.269***	3.403***	2.928***	3.081***	3.261***	3.568***
	(0.240)	(0.274)	(0.411)	(0.447)	(0.375)	(0.417)	(0.443)	(0.485)	(0.252)	(0.283)	(0.462)	(0.489)	(0.415)	(0.455)	(0.473)	(0.511)
Ramsey test	$F(3, 103) = 7.81$ ($p = 0.0001$)	$F(3, 90) = 3.32$ ($p = 0.0233$)	$F(3, 103) = 1.70$ ($p = 0.1707$)	$F(3, 90) = 1.14$ ($p = 0.3357$)	$F(3, 103) = 1.03$ ($p = 0.3831$)	$F(3, 90) = 0.15$ ($p = 0.9291$)	$F(3, 103) = 0.96$ ($p = 0.4152$)	$F(3, 90) = 1.24$ ($p = 0.3010$)	$F(3, 97) = 7.13$ ($p = 0.0002$)	$F(3, 84) = 4.19$ ($p = 0.0082$)	$F(3, 97) = 1.34$ ($p = 0.2654$)	$F(3, 84) = 0.66$ ($p = 0.5793$)	$F(3, 97) = 1.37$ ($p = 0.2552$)	$F(3, 84) = 0.21$ ($p = 0.8888$)	$F(3, 97) = 0.57$ ($p = 0.6360$)	$F(3, 84) = 1.32$ ($p = 0.2726$)
Mean VIF	1.52	1.51	1.52	1.51	1.52	1.51	1.52	1.51	2.74	2.72	2.74	2.72	2.74	2.72	2.74	2.72
R^2	0.250	0.292	0.142	0.167	0.167	0.234	0.123	0.188	0.302	0.337	0.157	0.182	0.204	0.271	0.146	0.205

(*Continued*)

Table 1. Continued.

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	(A)								(B)							
	URI				URI–OEM (co-location)				URI				URI–OEM (co-location)			
Variables	Facility benefits		Knowledge benefits		Region-wide benefits		Firm-based benefits		Facility benefits		Knowledge benefits		Region-wide benefits		Firm-based benefits	
Model equation	(1a)	(1b)	(1a)	(1b)	(1a)	(1b)	(1a)	(1b)	(2a)	(2b)	(2a)	(2b)	(2a)	(2b)	(2a)	(2b)
Joint significance (*F*-test)	$F(9, 106) = 2.19$ ($p = 0.0282$)	$F(10, 93) = 2.90$ ($p = 0.0033$)	$F(9, 106) = 2.35$ ($p = 0.0187$)	$F(10, 93) = 2.04$ ($p = 0.0376$)	$F(9, 106) = 2.37$ ($p = 0.0176$)	$F(10, 93) = 3.98$ ($p = 0.0002$)	$F(9, 106) = 2.09$ ($p = 0.0365$)	$F(10, 93) = 2.72$ ($p = 0.0057$)	$F(15, 100) = 1.68$ ($p = 0.0670$)	$F(16, 87) = 2.35$ ($p = 0.0060$)	$F(15, 100) = 1.83$ ($p = 0.0409$)	$F(16, 87) = 1.57$ ($p = 0.0939$)	$F(15, 100) = 2.16$ ($p = 0.0127$)	$F(16, 87) = 2.75$ ($p = 0.0014$)	$F(15, 100) = 1.71$ ($p = 0.0601$)	$F(16, 87) = 2.00$ ($p = 0.0213$)
Observations	116	104	116	104	116	104	116	104	116	104	116	104	116	104	116	104

Note: OEM, original equipment manufacturer; URI, university (automotive) research institute (URI); VIF, variance inflation factor.
Robust standard errors are shown in parentheses: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$.

open innovation strategy (*Business* and *Knowledge networks*).[10]

$$
\begin{aligned}
Benefits_i = {} & \beta'_0 + \beta'_1 Innov_i + \beta'_2 RDintensity_i \\
& + \beta'_3 BusinessNet_i + \beta'_4 KnowledgeNet_i \\
& + \beta'_5 Size_i + \beta'_6 Age_i + \beta'_7 Industry_i \\
& + \beta'_8 Region_i + \beta'_9 (Industry_i{*}Region_i) \\
& + \beta'_{10}(Innov_i{*}RDintensity_i) \\
& + \beta'_{11}(Innov_i{*}BusinessNet_i) \\
& + \beta'_{12}(Innov_i{*}KnowledgeNet_i) \\
& + \beta'_{13}(RDintensity_i{*}BusinessNet_i) \\
& + \beta'_{14}(RDintensity_i{*}KnowledgeNet_i) \\
& + \beta'_{15}(BusinessNet_i{*}KnowledgeNet_i) + \varepsilon'_i
\end{aligned} \qquad (2)
$$

The interpretation of the coefficients on $Innov_i$, $RDintensity_i$, $BusinessNet_i$, $KnowledgeNet_i$ and their respective interaction terms is somewhat more complex, and not directly meaningful. Hence, we compute predictive margins and the corresponding 'marginal effects' for these variables (the latter reported in Table 1, panel B) and employ multiple pairwise comparisons across the combinations of types of firms (as defined by these four variables) which yields more tangible results (Long & Freese, 2006). To militate against Type I errors, we also use the Bonferroni correction and retrieve the Bonferroni-adjusted *p*-values. These multiple pairwise comparisons are our main interest and a (qualitative) summary of the key results are presented in Table A4 (panels A–F) in Appendix A in the supplemental data online.

Overall, our two-way interaction results illustrate the potential URI holds most appeal for research-intensive innovative firms already highly engaged in their own business and knowledge networks. The key details are:

- Highly innovative firms operating with high levels of R&D intensity (indicated by 1,1, in Table A4 in Appendix A in the supplemental data online) are significantly more positive about the benefits of the proposed IAAPS facility and the potential link up with an OEM (vis-à-vis low innovative/low R&D-intensive firms – indicated by 0,0). Although less R&D-intensive firms perceive more regional benefits than highly R&D-intensive firms (Table 1, panel A), firms which are simultaneously highly R&D intensive and highly innovative may be in a better position to exploit the wider synergies and commercial opportunities from the OEM's involvement in the region (see Table A4, panel A, in Appendix A in the supplemental data online).
- Highly innovative firms that are strongly engaged in *business* networks (1,1) have a more positive perception of the knowledge benefits from IAAPS, and of benefits arising from its co-location with an OEM in the same science park (vis-à-vis low innovative firms with weak engagement in business networks – 0,0) (see Table A4, panel B, online).

- Innovative firms that are also well engaged with knowledge networks (1,1) are significantly more positive about IAAPS's facilities, are more inclined to become involved with the URI and exploit the regional synergies offered by the collocation of IAAPS and an OEM (relative to firms which have low innovation and knowledge network engagement – 0,0) (see Table A4, panel C, online).
- Finally, those firms highly involved in both existing business and knowledge networks (1,1) expect to appropriate more facility and knowledge benefits from IAAPS (vis-à-vis firms not highly involved in either type of networks (0,0)) (see Table A4, panel F, online). Although knowledge networks on their own may provide limited access to benefits from IAAPS (Table 1, panel A), firms that are also embedded in business networks may exploit dynamics from both types of networks and better capture value from the public investment within the cluster.

The amplifying benefits of an OEM link up to the URI

Our analysis also sought to ascertain whether there were any amplifying effects on the attractiveness of the proposed IAAPS facility when an OEM becomes a local partner (i.e., purposive co-location) (H5). To do this, we derived the difference between the following two constructs:

> *URI (only) benefits: this captures how attractive IAAPS is to the firm overall (in terms of both its proposed facilities and potential knowledge base, combined) (Cronbach's alpha = 0.90).*
>
> *URI–OEM co-location benefits: this captures how attractive IAAPS becomes when a global OEM co-locates to work with the URI (i.e., in terms of region-wide and firm-based benefits, combined) (Cronbach's alpha = 0.94).*

The difference between these two constructs is positive (1.06 points) and statistically significant at the 1% level, suggesting the attractiveness of the URI is clearly amplified when an OEM is co-located in the region (H5 supported). This is indicative of a potential 'halo effect' that the OEM may have not only on the URI specifically but also on the region itself more broadly. This may act as a critical 'enabler' of an emerging technological cluster in the region.

WIDER DISCUSSION AND POLICY CONSIDERATIONS

On the roles of, and relationship between, PuATs and PvATs

As a PuAT, IAAPS potentially offers a range of physical facilities and knowledge enhancing benefits. In general, these benefits appear to be more highly valued by private firms that are already R&D intensive, highly innovative and well embedded in existing business networks (Clarysse et al., 2014). These types of firms are most likely to be in the upper tier (e.g., Tier 1) in both the automotive and aerospace supply chains (Tomlinson & Fai, 2016). From IAAPS's perspective, such firms should be identified as targets with whom early productive relationships may be established given this group of firms is most likely to have the absorptive capacity to benefit from knowledge transfer and technological advances the URI seeks to generate. Fostering such relationships will be critical in stimulating the nascent cluster. An important adjunct for IAAPS business managers would be to establish an on-site knowledge transfer team specifically tasked with nurturing and building a technology-focused (SME) network and facilitating their engagement in the URI's related projects. In due course, such support may be extended to firms identified as having the technical *potential* to work with the URI, but whose current financial constraints mean they are less likely/precluded from participating in the project in its earliest phase.

It is also evident that the attractiveness of the PuAT is amplified if a PvAT, such as a global OEM, is attracted by the former to co-locate in the same region. The involvement of a PvAT (Iansiti & Levien, 2004) within an emerging cluster provides a 'halo effect' to the PuAT tenant by signalling there are potential commercial benefits to emerge from this research facility in future. This in turn may attract more firms to the region contributing to the dynamic growth of the cluster. Local firms may look to the OEM as a beacon of the direction of travel for the future commercialization of technologies generated by IAAPS. Moreover, where the technological specialization of the cluster is in a novel area/related to emerging technology – such as low carbon propulsion – the business network of the PvAT may be fairly open, or in flux, and may provide a window of opportunity for prudent firms with the right capabilities to join the OEM's value chain.

There are, of course, common concerns regarding the close involvement of an OEM. For instance, their larger resources can crowd out locally based SMEs by attracting the best talent from the local labour pool. Moreover, the technological orientation of the PvAT will play a key role in shaping the emerging cluster. It may, for instance, orientate the cluster's research focus to its own benefit and hence dominate the cluster's technological trajectory, which – in adverse scenarios – can lead to technological 'lock-in', potentially inhibiting long-run growth (Bailey, 2003). To counteract this, the URI will need to help fully embed the R&D activity of the OEM into the wider cluster-based innovation system, and in doing so, support knowledge circulation within the cluster between the private anchor and other clustered members (Guimon et al., 2018).

The latter possibility is more likely if the OEM subsidiary pursues a *competence creating mandate*, where it actively seeks to leverage local knowledge sources and resources to develop and enhance novel capabilities for itself in new and related scientific fields/opportunities (Cantwell & Mudambi, 2005). For the OEM, this will involve gearing the subsidiary's R&D operations towards scientific and technological exploration to unearth new opportunities rather than just exploiting its own existing technological capabilities for the UK market.[11] Success will require the OEM becoming highly embedded in the region's networks, and embracing a more open system of innovation and knowledge sharing with local firms and the URI (Cantwell & Piscitello, 2005).

In our specific case, the regional context is especially favourable for a resident OEM to adopt a *competence creating mandate*. The West of England hosts two world-leading universities, a strong science and engineering base, and a highly skilled workforce, while the link up with IAAPS offers new scientific and technological opportunities (Cantwell & Mudambi, 2011; Cantwell & Piscitello, 2005). There are also opportunities in the cross-fertilisation of knowledge and new synergies between the automotive and aerospace sectors in the development of low carbon technologies. This type of technological diversification (between related fields) can stimulate the cluster dynamic and hitherto enhance its own resilience and sustainability (Foray, 2015; McCann & Ortega-Argilés, 2015).

A UK exemplar in this context is the Sheffield Advanced Manufacturing Research Centre (AMRC), which began through a University of Sheffield technological link-up with Boeing. In 2003, the AMRC became the key AT on the Advanced Manufacturing Park at Catcliffe, South Yorkshire, and also at the nearby Sheffield Business Park, at Broughton with the purpose-built Factory 2050 dedicated to facilitate collaborative research into 'reconfigurable digitally assisted assembly, component manufacturing and machining technologies'.[12] These facilities sit at the heart of South Yorkshire's 'Innovation District', and the cluster has attracted significant private sector investment with new private anchors, including McLaren, Rolls Royce, Tata Steel and Toshiba. While research is primarily industry led (with a commercial focus), the AMRC has subsequently expanded its research operations across a wider range of advanced manufacturing applications (including composite and additive manufacturing, metrology, medical and nuclear).[13] This technological diversification has meant the cluster has become more resilient, and indeed has become a critical node/asset within global high value manufacturing production networks (Bailey et al., 2020; Williams et al., 2016).

Caveats and wider policy issues

This study has focused upon the role of PuATs and PvATs. The IAAPS project is fully in line with current thinking that universities can, and should, contribute more to their local economies (Benneworth, 2018). One of the main ways often advocated following the successes of Stanford in Silicon Valley and the University of Cambridge in Silicon Fen is via the growth of university spin-outs and the development of SMEs. Whilst there are ambitions in this direction for IAAPS, there is also some scepticism, in the UK at least, as to the ability of university PuATs to spawn a sufficient number of high-growth firms to promote cluster formation (Brown, 2016), and more widely, their contribution to regional innovation (Power & Malmberg, 2008). We agree with Feldman and Francis (2004) that successful cluster formation is the sum of many parts rather than a result of (one-off) large-scale projects. Whilst development of nascent clusters is highly uncertain, Bresnahan et al. (2001) have identified several common characteristics in a cluster's emerging stage. We compare IAAPS with these in order to identify key weaknesses that would threaten the emergence of this potential cluster.

First, in Bresnahan et al. (2001), new clusters all took advantage of new unexploited technological and market opportunities. The technologies IAAPS will generate will certainly enable innovations in unexploited, and in some cases, possibly as yet unknown, technological and market spaces. Second, Bresnahan et al. found that in many cases established firms were either blind to, unwilling or unable to move from their existing technological and market bases toward these areas of new opportunity. There is no evidence of this arising in our study – indeed, generally the established firms in our dataset appear to have a certain degree of openness in their mind-set, which perceives the new opportunities and trajectories IAAPS could lead them to, as complementary to, or extensions of, their existing technologies and markets.[14] Third, Bresnahan et al. found all the technologies in the new clusters were complementary to existing technologies rather than direct challengers. As such, they were in demand by established large firms who were seeking to move into new technological directions. Therefore, there was scale in the demand for the new technologies emerging in these successful new clusters as the potential adopters were the existing incumbents. In studies of industrial clusters, the role played by the traditional 'demand forces' is often underplayed relative to the effects of agglomeration and externalities effects associated with knowledge sharing. In our case context it would be strategically prudent to establish where demand for IAAPS's technological output is likely to be greatest and to build strong links to those key players. Hence, fostering links between IAAPS's and those automotive OEMs with the greatest interest in low carbon automotive propulsion systems at an early stage is likely to be important for the nascent cluster. In part, this could be achieved by building upon the University of Bath's existing partners base in this domain.

Bresnahan et al.'s final common feature in the birth of (now successful) clusters was the availability of a highly skilled labour pool, often emerging from local universities, but also from larger firms which can supplement university education with more practical training and skills. If the IAAPS project is to succeed, a cadre of skilled graduates – in technical and managerial skills – will be required to bring knowledge and skills to existing cluster firms (and future anchor OEMs), while raising the possibility of entrepreneurial spin-offs during the cluster's growth phase. In the latter regard, the role of entrepreneurs is often underplayed in cluster policy, and yet they often emerge locally and play a critical role in cluster formation, innovation and its commercialization (Feldman et al., 2005). In the context of IAAPS, it is possible skilled engineering labour and new firms in complementary technological areas can spin out of the wider region's existing technological bases such as aerospace and information and communication technology (ICT). Nevertheless, a key adjunct in the cluster's emergence will be entrepreneurial mentoring programmes delivered through educational establishments, including local universities, colleges and local public–private agencies that are specifically geared towards new business creation, spin-offs and bringing innovative ideas to market.

CONCLUSIONS

This paper has explored the potential for a new university research facility to act as a PuAT and its perceived attractiveness in the conception of a new cluster. Its attractiveness appears as concentric circles emerging from the facility. The facility itself can be perceived as an attractive PuAT in an emerging cluster, which is enhanced if it can offer user firms not only the benefit of access to its facilities, laboratories and equipment, but also knowledge-enhancing benefits that go beyond scientific and technical advice and include nurturing localized *knowledge* networks as a second, outer ring. Moreover, the perceived 'value' of the university public anchor is likely to be enhanced further still if it can link up with a global OEM – potentially gaining commercial validation for its research. With the addition of an OEM, the attractiveness of the PuAT spills over into potential regional growth effects. For many firms, the corporate partner creates a halo effect for the PuAT (and the region) whilst the OEM itself, acts as a magnet for other firms to potentially access leading-edge knowledge in more applied settings than scholarly research programmes, and a means to access international/global business networks. Both PuATs and PvATs can also play a critical role in bridging specialized *knowledge* networks and commercial *business* networks that enhances value creation and capture within the cluster.

These benefits of the PuAT are generally greatest for firms that are R&D intensive, highly innovative and are already engaged in networks. Identifying such firm-level characteristics, and the types of relationships with the PuAT that are likely to be most desired by such firms, gives university executives and technology transfer advocates, tasked with delivering greater local impact and regional growth, important insights as to the key targets for their outreach and engagement activity in the conception stage of a cluster life cycle. We suggest this can contribute to making the research facility more attractive and increase the chances of a local cluster forming. More generally, our study highlights the attraction of securing a collaborative link up between PuATs and PvATs in the conception and emerging stages of clusters.

While the insights from this study provide important indicators for policy design and implementation – both for the specific URI case and more generically in relation to the role of ATs in the genesis of clusters – we note some limitations of the study and possible avenues for future research. First, our study is limited to a single UK case, and given the relatively small sample, caution should be exercised in drawing wider conclusions. Whilst examples such as the AMRC in Sheffield would appear to lend further support to our findings within an *ex-post* rationale, future work should seek other cases of nascent clusters, to provide a more generic identification of the attractive characteristics of ATs in new cluster formation. Second, our analysis is at a specific point in time and based on managerial perceptions of the likely benefits of a conceptual facility and cluster. Clearly, once the IAAPS facility is physically established, it would be useful to conduct a follow-up study to explore whether its attractiveness and potential to stimulate cluster formation are actually being realized. This type of evaluation would be particularly helpful for policymakers and will assist in our understanding of the dynamic role of ATs in the genesis of clusters.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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NOTES

1. In 2017, IAAPS received £39 million of public funding to build a Global Centre of Excellence in its research field. It is scheduled to open in 2021.
2. For example, automotive companies with globally dispersed value chains based on petrochemical technologies are attracted to universities and other research centres investigating the potential of electric and hydrogen fuel.
3. Examples include federal laboratories such as the Lawrence Berkeley in California, the MIT Radiation Laboratory in Boston and the National Institutes of Health, alongside numerous smaller regional research institutes in defence and other sectors (Block, 2008).
4. For details on IAAPS, see https://iaaps.co.uk/; and for the BBSP, see https://www.bbsp.co.uk/.
5. IAAPS has actively been in discussions with a leading OEM (which has existing R&D facilities in the UK) to form a technological link-up around the new facility and low carbon propulsion.

6. We took advice from University of Bath senior staff involved in the IAAPS project on the framing of particular questions.
7. We also employed Harman's single factor test, and because no single factor was extracted and no factor accounted for the majority of the covariance of the items, we may conclude that there is no undue influence of common method bias on the results (Podsakoff & Organ, 1986).
8. We include the 'financial constraints' variable in a separate model because values for this variable exist for a subsample of 104 observations.
9. These estimates are available from the authors upon request.
10. It is reasonable to restrict our exploratory analysis here to these four variables, and hence six two-way interaction terms/pairwise correlations (see Table A4 in Appendix A in the supplemental data online) on both conceptual and econometric grounds. Conceptually we are primarily interested in exploring the two-way interaction between the most relevant structural factors and those relating to managerial and open innovation strategy (Laursen & Salter, 2004). Empirically, if we were to include all nine independent variables (rather than four), then the specification would have to include 36 interaction terms, and this would severely limit our degrees of freedom.
11. A subsidiary's *competence creating mandate* is distinct from the more traditional *competence exploiting mandate*, in which the subsidiary seeks to adapt/deepen the parent firm's existing competences to local markets (e.g., through assembly operations/market servicing) (Cantwell & Mudambi, 2005, 2011).
12. See https://www.amrc.co.uk/facilities/factory-2050.
13. For further details, see http://www.welcometosheffield.co.uk/business/developments/innovation-district.
14. It may be global environmental pressures about emissions and the scarcity of fossil fuels, and local regulatory compliance and standards already indicate the necessity for all companies (in both the automotive and aerospace sectors) to find ways to develop propulsion systems which are cleaner and more efficient. To have a closed or blinkered mindset as a firm under such conditions is likely to be highly detrimental to its long-term survival.

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