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Modelling the number of client firms needed to support a new Science Park and the spacing between new Parks and existing Parks with similar themes.

Charles Mondal, Adilkhan Kussainov and Robert B. Mellor*
Computing & Maths, Kingston University, KT1 2EE, London
* corresponding author on r.mellor@kingston.ac.uk. orcid.org/0000-0003-0925-7016

Abstract:

UK Science & Technology Parks (STPs) specialised in pharmaceutical areas were compared with universities scoring highly in pharmaceutical research and with firms returning the corresponding Standard Industry Classification (SIC) codes at Companies House. There was no correlation between the average distance between STPs and highly scoring universities and no evidence that high-ranking universities can attract specialised firms. The ability of STPs to attract specialised firms was investigated and on-campus STPs (within 2 km of the university) were not significantly more successful or less successful than other STPs. To support a specialised STP, an average of 19.15 firms with a similar speciality was found within a 7.89 km radius. In the UK, STPs that are members of the Science Park Association (UKSPA) exist on average 12 km apart but STPs specialised in pharmaceuticals were much further apart, average 32.65 km and this difference is highly significant.

Keywords: Science and Technology Parks, regional development, knowledge spillovers, university enterprise.

Biographical data

Charles Mondal is a Doctoral Researcher in the Faculty of Science, Engineering and Computing at the Kingston University, London. His research interests include aspects of the tech entrepreneurship ecosystem.

Adilkhan Kussainov is a freelance researcher associated with the Big Data Analytics Group at Kingston University.

Robert B. Mellor is author of over 100 scientific publications in reputable journals, including, e.g., *Nature* and *PNAS*. In addition to his scientific publications, he has written 11 books, including four on innovation and entrepreneurship and several have appeared in foreign translations. With qualifications from, e.g., Copenhagen and Göttingen, he is expert advisor to several national governments and to the European Union. He is now co-leads the Big Data Analytics Group in Computing and Maths at the Kingston University, London, UK.

Introduction:

Science and Technology Parks (STPs) are curated locations where New Technology Based Firms (NTBFs) and other SMEs can conglomerate and promote a culture of innovation (for review, see Lecluyse et al, 2019). They are often used by regional planners as a strategy to stimulate economic growth (Lindelöf and Löfsten 2003) around new, innovative products, and have been postulated to exhibit various positive effects, including ameliorating the effects of recession (Taylor 2009). Traditionally, they are assumed to be associated with a nearby university as knowledge source (see Lecluyse et al, 2019).

The recent vaccine efforts around SARS-CoV-2 virus (Covid 19) technology transfer with prominent actors including Oxford University and also the NTBF BioNTech prompted us to investigate into how universities, innovative firms and STPs active in the pharmaceutical sector, can associate together and function to bring new products to the market. This behaviour is the heart of the so-called "Triple Helix" model (Etzkowitz and Ledersdorff 1995). However, a host of metrics pertaining to setting up new STPs appear to be missing from the "Triple Helix" model (Etzkowitz and Ledersdorff, 2000). These include:

1. The population density of New Technology Based Firms (NTBFs) and other SMEs involved in researching specific topics in the locale around the STPs, that enable the STP to acquire critical mass and to function,
2. The number of specialized firms (which could be acquiring specialised knowledge or graduates) around universities,
3. The degree of separation between STPs, because these may essentially be competing, and
4. Degree of co-location between STPs and universities as knowledge sources, which is also relevant to the topic of enterprise development in universities.

These metrics are all important for successful technology transfer and the start-up and development of an STP into a thriving tech entrepreneurship ecosystem. In government supported STPs generally, the central co-ordinating bodies (often referred called the “Cluster Initiative” or “CI”) make decisions about which firms can inhabit that STP. Wegner and Mozzato (2019) speculate that CI decision-making is improved where experienced managers from larger firms can be involved. Using structural equation models (SEM), Monte-Carlo modelling and panel data from a large IT-oriented STP, Al-Kfairy et al (2020) and Al-Kfairy and Mellor (2020) narrowed this figure down to two such larger firms (more may be present in an STP, however involving >2 increases the transaction costs). This finding was supported by Mondal and Mellor (2021), who used SEM and panel data for STPs with zero or 2 larger firms in residence, showing that growth as e.g., number of on-cluster employees, was far healthier in the STP with the presence of 2 large companies. Nonetheless, Wadhwa (2013), Kelly and Firestone (2016) and Pugh et al. (2018) report that overall, only about 20% of start-up STPs are successful, despite often having promising technology (e.g., Roberts et al, 1980). Clearly this needs to be understood in order to avoid negative e.g., “backwash” effects (see e.g., Mellor, 2021). A further shadow on the "Triple Helix" model has been cast by Perkmann et al (2013), who used a large-scale statistical analysis exposing that universities experience great difficulty in attracting research contracts from established businesses, independently of whether these were located within STPs or not. Winters and Stam (2007) go further and point out that university-industry collaborations can be relatively void of new innovations. It may be that a part of the answer is the very high asset specificity needed for fruitful co-operations between industry and universities, as noted by various authors [Hobbs et al. (2017),

Johnston and Huggins (2018), Johnston (2019), Ng et al. (2019), Lecluyse et al. (2019), Johnston (2020)].

We have adopted a focussed and data-driven approach to address issues in technology transfer, problems like Covid 19, research impact metrics, as well as the implementation of start-up STPs generally in regional development and in government policymaking. In this report we use:

A. firms active in the UK pharmaceutical industry,
B. university departments scoring highly in pharmacy, and
C. STPs specialised in the pharma/biomed area,

as experimental factors in a virtual model to determine success parameters for small and medium STPs.

In this work, Albahari et al, (2018) is taken as point of departure because "*firms in less technologically developed regions benefit more from location in an STP*" (Albahari et al, 2018, p143) and thus we have taken a relatively abstracted model and used that to reach general conclusions for an imaginary and sparsely populated landscape. In this model we endeavour to estimate how many specialized firms are required in the locale to support the creation of a new and similarly specialized STP. This approach also yields estimates as to how close a new and specialized STP can be to established STPs with a similar specialization, compared to STPs with different specializations.

Methodology and data sources:

UK firms active in pharma and biomed sectors were identified by taking all UK firm data from Gov.uk (2021), cleaning it (e.g., removing dissolved entities, etc.) and selecting those self-identifying with SIC codes 21100 and 21200. There were 1197 firms self-identifying as being in SIC code 21100 (Manufacture of Basic Pharmaceutical Products) and 520 firms self-identifying as being in SIC code 21200 (Manufacture of Pharmaceutical Preparations).

UK STPs active in pharma and biomed were identified from the website of the UK Science Parks Association ("UKSPA"). From the "over 100 Innovation Locations" (UKSPA, undated) and 27 could be identified as specialising in pharma and biomed (table 1).

UK universities active in pharma and biomed were identified from the REF 2014 (UK Research Excellence Framework, www.ref.ac.uk/2014), tables as being active in Unit of Assessment (UoA) 3 (Allied Health Professions and Pharmacy) and from the 95 listed, the 26 highest impacting (as judged by the aggregated number of internationally recognized publications being over 100) were used (table 2).

Statistical analyses were performed in Stata (www.stata.com). Data manipulations were done in Excel and in ArcGIS-pro (www.esri.com/en-us/arcgis/products/arcgis-pro/overview). Using ArcGIS-pro a circle of radius 7.89 km was drawn around each object (STP or university), and the number of companies from the Companies House data were counted. That circle radius was set because Kussainov et al (2020), using IT-oriented STPs and biomed-oriented STPs previously showed that on-cluster firms migrating to off-cluster locations, moved to an annular zone between 4 and 7 km away

from the STP. Thus the 7.89 radius encompasses such distances with a slight margin of error, as well as that the area, 200 square km, facilitates population density measurements.

Table 1: Shows the STPs used in this work. Companies include both on-cluster and off-cluster. Note there may be many more companies associated with any STP, but these other firms have different SIC codes. An asterisk (*) shows that the associated Universities did not return in UoA3 in the 2014 REF.

STP specialised in pharmaceutical/biomedical research: Name	Postcode	Number of companies with SIC codes 21100 and 21200 within 7.98 km of the postcode.
Imperial College Incubator *	W12 0BZ	241
Birmingham Research Park	B15 2SQ	34
Manchester Science Partnerships	M15 6SE	31
Cambridge Biomedical Campus *	CB2 0AA	27
Cambridge Science Park *	CB4 0FZ	27
Liverpool Science Park	L3 5TF	24
Cardiff Medicentre	CF14 4UJ	19
BioCity Group Ltd	NG1 1GF	16
Sussex Innovation Centre	BN1 9SB	11
Wellcome Genome Campus	CB10 1SA	10
Oxford Science Park *	OX4 4GA	9
University of Glasgow - Clinical Innovation Zone	G12 8QQ	6
Chesterford Research Park	CB10 1XL	7
Oxford BioEscalator *	OX3 7FZ	7
University of Wolverhampton Science Park	WV10 9RU	6
West of Scotland Science Park	G20 0SP	6
Charnwood Campus	LE11 5RB	6
Milton Park	OX14 4RY	6
Edinburgh Technopole	EH26 0BB	5
RoCRE	AL5 2JQ	5
Stevenage Bioscience Catalyst	SG1 2FX	5
Unit DX	BS2 0XJ	2
Hethel Innovation	NR14 8FB	2
Lincoln Science and Innovation Park	LN6 7FL	2
Porton Science Park	SP4 0BF	1
The OpTIC Technology Centre	LL17 0JD	1
Wilton Centre	TS10 4RF	1

Table 1 shows that a total of 517 firms were detected (average 19.15 per STP) with a standard deviation (SD) of 45.41. The only outlier being Imperial College Incubator, presumably because its 7.89 radius covers a large swathe of London and hence encompasses very many firms.

Table 2: Shows the first selection of 26 universities used in this work. The cut-off point is when the number of REF submissions falls below 100.

Top-ranked universities in UoA 3	Postcode	Number of companies with SIC codes 21100 and 21200 within 7.98 km of the postcode.
University of Sheffield	S10 2TN	5

Swansea University	SA2 8PP	6
University of Southampton	SO17 1BJ	4
University of Manchester	M13 9PL	29
University of Bath	BA2 7AY	3
University of Nottingham	NG7 2RD	12
Cardiff University	CF10 3AT	19
University College London (UCL)	WC1E 6BT	323
Aston University	B4 7ET	39
University of Stirling	FK9 4LA	1
University of East Anglia	NR4 7TJ	0
University of Strathclyde	G1 1XQ	6
University of Surrey	GU2 7XH	3
Queen's University Belfast	BT7 1NN	11
Queen Mary University of London	E1 4NS	285
King's College London	WC2R 2LS	323
University of Bristol	BS8 1TH	4
Keele University	ST5 5BG	1
Newcastle University	NE1 7RU	6
Lancaster University	LA1 4YW	0
University of Nottingham	NG7 2RD	12
University of Brighton	BN2 4AT	12
University of Sussex	BN1 9RH	11
University of Leeds	LS2 9JT	12
Bangor University	LL57 2DG	0
University of Bradford	BD7 1DP	11

Table 2 shows that 1138 firms were detected (average 43.77, SD = 98.78). The outliers Queen Mary University of London, University College London (UCL) and King's College London all have high numbers, presumably because their 7.89 km radius covers a large swathe of London. However, Aston University and University of Manchester are less prominent outliers too.

Results and discussion:

Table 2 shows that the predominant universities as shown by REF 2014 ranking showed no particular correlation with the numbers of firms surrounding them. The obvious feature that was revealed, however, is that location is the largest factor, with London universities; Kings, UCL and Queen Mary, dominating the table, accounting for 931 out of 1138 (over 81 %). This figure is actually a larger figure, because UoA3 universities not in the top 26, but still in London, included City University London (EC1V 0HB), which had 209, the University of Greenwich (SE10 9LS) had 89, and the University of Westminster (W1B 2HW) had 189 firms in their respective surrounding areas.

The old established industrial centres also scored well; the highly ranked Aston University (Birmingham) scored well, which can be combined with the (unranked) University of Birmingham (B15 2TT), which had 33. The University of Manchester scores highly when combined with the unranked Manchester Metropolitan University (M15 6BH) with 26, as did South Wales (Cardiff and Swansea,

together 25) and the Leeds/Bradford area (23 combined) equal with Sussex/Brighton (23 combined). Numbers under these are presumed to represent the background.

Table 1 shows, in agreement with Table 2, that the vast majority of activity occurs in London-based STPs, with STPs in Birmingham and Manchester also showing strongly. South Wales and Sussex/Brighton STP activity also correlate with the corresponding university profiles. In table 1, Imperial, Oxford and Cambridge STPs have a powerful showing, albeit that the corresponding universities did not submit in UoA3 (REF, 2014), which obviously skews the results in these 3 cases, but because these 3 STPs are not starting up small and mid-sized STPs, then the overall conclusions as pertaining to new start-up STPs, will not be affected.

In order to investigate university – STP spatial relationships, any university within 7.89 km was identified and, in many cases, there were multiple universities within this radius. The distance to the nearest university was also determined. In accordance with our "anonymized" model, the size and perceived success of the entities was not taken into account. The results are shown in **Table 3**, where asterisk (*) shows that the associated Universities do not return in UoA3 in the 2014 REF.

STP specialised in pharmaceutical/biomedical research: Name	**Number of pharma top 26 UoA3 universities within 7.98 km**	**Distance in km to the nearest UoA3 top 26 university**	**Distance in km to the nearest university (any uni)**
Imperial College Incubator	3	6.37	2.9
Birmingham Research Park	2	0.56	0.56
Manchester Science Partnerships	2	0.58	0.58
Cambridge Biomedical Campus	0 *	49.96	3.66
Cambridge Science Park	0 *	55.05	3.73
Liverpool Science Park	0	49.22	0.13
Cardiff Medicentre	1	1.92	1.92
BioCity Group Ltd	2	1.15	1.15
Sussex Innovation Centre	2	0.3	0.3
Wellcome Genome Campus	0	46.45	14.79
Oxford Science Park	1	4.24	4.24
University of Glasgow - Clinical Innovation Zone	3	On-campus	
Chesterford Research Park	0	47.13	18.39
Oxford BioEscalator	1	0.54	0.54
University of Wolverhampton Science Park	0	20.66	1.62
West of Scotland Science Park	3	3.67	3.67
Charnwood Campus	0	17.78	2.06
Milton Park	0	15.6	15.33
Edinburgh Technopole	0	54.74	7.19
RoCRE	0	8.48	8.48
Stevenage Bioscience Catalyst	0	14.4	14.4
Unit DX	1	2.46	2.46
Hethel Innovation	0	8.61	8.61
Lincoln Science and Innovation Park	1	0.43	0.43
Porton Science Park	0	32.25	28.99
The OpTIC Technology Centre	0	43.76	38.71

Wilton Centre	0	55.22	8.69

Table 3 shows that 20.06 km (SD 21.39) was the average distance between STPs specialising in pharma and universities ranked highly in pharma, but that many other universities that are less specialised were much closer, namely average 7.17 km (SD 9.43). The only outliers were Porton Science Park and The OpTIC Technology Centre, both of which are located very far from Higher Education Institutes, specialised or otherwise. This lack of correlation between STPs and Universities tends to lend a degree of support to the findings of other authors [Hobbs et al. (2017), Johnston and Huggins (2018), Johnston (2019), Ng et al. (2019), Lecluyse et al. (2019), Johnston (2020)].

Rodríguez-Pose and Comptour (2012, p280) say "*Physical proximity is often regarded as the key aspect making some regions genuine loci of innovation. The basic reasoning is that innovation travels with difficulty and suffers from strong distance decay effects*". Using the concepts of distance decay (Pun-Cheng, 2017), Helmers (2019, p31) also found "*knowledge spillovers decay rapidly with geographic distance*". Thus, in order to see if "on campus" STPs closer to knowledge sources were more successful, STPs with less than 2 km distance (in accordance with the results of previous measurements, see Buzard et al, 2017) to a UoA3 university were taken and the number of firms taken from table 1. The 127 firms found result in an average of 15.875 firms per on-campus STP.

Table 4: Number of firms per on-campus STP as compared with "parent" university.

STP defined as "On-campus" because the postcode <2 km from the university	**Number of companies around the STP**	**Number of companies around the UoA3 university**
Cardiff Medicentre	19	19 (Cardiff)
BioCity Group Ltd	16	12 (Nottingham)
Manchester Science Partnerships	31	29 (Manchester)
Birmingham Research Park	34	39 (Aston)
Oxford BioEscalator	7	Oxford: Not returned in UoA3
Lincoln Science and Innovation Park	3	Lincoln: Not returned in UoA3
Sussex Innovation Centre	11	11 (Sussex)
University of Glasgow - Clinical Innovation Zone	6	6 (Strathclyde)

Table 4 shows that on-campus STPs (average 15.88) were not significantly more successful or less successful than other STPs (average 19.15) in attracting NTBFs and SMEs, perhaps underlining that close physical associations with a university is not a major success factor. As previously, the major factor appears to be a metropolitan location, as seen for example in the cases of Manchester and Birmingham.

Table 5: Distance between specialised and non-specialised STPs

STP specialised in pharmaceutical/biomedical research: Name	**Distance (km) to the nearest pharma specialised STP**	**Distance (km) to the nearest STP (all of UKSPA).**
Imperial College Incubator	33.95	0.470
Birmingham Research Park	21.40	4.35
Manchester Science Partnerships	49.30	5.68

Cambridge Biomedical Campus	6.53	6.89
Cambridge Science Park	6.53	0.46
Liverpool Science Park	37.42	0.26
Cardiff Medicentre	42.98	1.45
BioCity Group Ltd	19.62	3.09
Sussex Innovation Centre	73.14	55.91
Wellcome Genome Campus	4.32	5.0
Oxford Science Park	4.08	4.42
University of Glasgow - Clinical Innovation Zone	3.67	14.94
Chesterford Research Park	4.32	6.67
Oxford BioEscalator	4.10	1.23
University of Wolverhampton Science Park	21.58	20.76
West of Scotland Science Park	3.67	18.60
Charnwood Campus	19.62	3.03
Milton Park	11.83	4.36
Edinburgh Technopole	67.75	0.73
RoCRE	13.5	10.83
Stevenage Bioscience Catalyst	13.50	9.77
Unit DX	42.98	0.71
Hethel Innovation	82.78	8.03
Lincoln Science and Innovation Park	49.71	45.11
Porton Science Park	61.39	28.81
The OpTIC Technology Centre	37.42	37.42
Wilton Centre	144.56	24.95

Table 5 shows that only the Wilton Centre was an outlier in being unusually isolated from other STPs. Table 5 also shows that STPs can be relatively close to each other (12.00 km, SD 14.72) if the STPs do not share the same speciality. STP sharing specialisation in pharmaceuticals was much further apart, average 32.65 km (SD 32.58). To see if the difference in these separations is statistically significant, the data were analysed in Stata, and the results are shown in table 6.

Table 6. Statistical analysis of the results from table 5.

Regression Statistics	
Multiple R	0.3911 41678
R Square	0.1529 91812
Adjusted R Square	0.1191 11485
Standard Error	13.817 50761
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	862.14 44039	862.14 44039	4.5156 5328	0.0436 48843

Residual	25	4773.087915	190.9235166	
Total	26	5635.232319		

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	6.226129632	3.800958184	1.638042128	0.113939661	-1.602090284	14.05434955	-1.602090284	14.05434955
Distance to the nearest pharma-specialized STP (from table 1)	0.176741904	0.083172406	2.125006654	0.043648843	0.005445139	0.348038669	0.005445139	0.348038669

These results (Table 6) show that there is a significant difference between the distance from one pharma-specialised STP to the next, and the distances between pharma-specialised STPs and other STPs (p-value = 0.0436).

Conclusion:

The mapping of UK firms resulted in 1138 out of 1717 firms (~67%) specialised in pharmaceutics being found in what may be “catchment areas” of either pharma oriented STPs or UoA3 universities, although, again, there may be an imbalance between firms self-identifying with SIC codes 21100 (Manufacture of Basic Pharmaceutical Products) and SIC code 21200 (Manufacture of Pharmaceutical Preparations), with universities that self-return in UoA3 (Allied Health Professions and Pharmacy). Table 1 shows that around a specialised STP, an average of 19.15 firms with a similar speciality are observed in the locality, possibly indicating that this is the number required for knowledge spill overs (Mellor 2015) to start to occur. There are STPs where more firms can be counted, and this may be because they have a metropolitan location, where there are simply more firms present. Indeed, this may be a weakness in the methodology; counting the number of firms works well in rural settings (Kussainov et al, 2020) but may introduce artifacts in metropolitan settings where 200 square km can represent the area of a medium sized city. This artifact would still be apparent if time distances were used instead of Euclidian distances. Indeed, in this work actual (Euclidean) distances are used instead of time distances, because of the small locales being considered; even at max 7.89 km, the "time distance" may be up to 15 minutes, which is not considered onerous, and is also negligible in terms of "cost distance".

Conversely, two large non-metropolitan locations (Oxford and Cambridge) have several well established and hugely successful STPs. These “rock stars” of the STP world form a self-sufficient ecosystem of spinouts, mergers and serial entrepreneurship (Mellor, 2019). That the associated universities have chosen not to return in UoA3 is simply a matter of their own internal policy decisions. Either way, the situation in these mature and large STPs have a limited meaning for STPs that are new and starting up, which is the focus of the work here.

As with firms around universities, the findings are similar to those for firms around STPs; an average of 43.77 per university. When the metropolitan effect is discounted, then there is little evidence that high-ranking universities can attract specialised NTBFs. To investigate this further, on-campus (within 2 km of the university) STPs were selected and analysed, and the results show they are not significantly different from other STPs (table 4) underlining again that a close geographical association between an STP and a university is not a major success factor. This again supports the results presented by previous authors, that found that co-operation between businesses and universities demand very narrow asset specificity (Johnston, 2019; Johnston 2020), which is often not fulfilled. Johnson et al (2021) found that higher levels of licensing income and patents for UK universities are associated with higher levels of research income in priority technologies, whereas Will and Mellor (2019) surveyed EU countries using large panel data sets, finding no correlation between university research funding and entrepreneurial outcomes, although the work of Will and Mellor (2019) did not focus specifically on priority technologies. Thus, the work presented here and elsewhere (e.g., Perkmann et al, 2013; Winters and Stam, 2007) tends to conclude that, generally speaking, there are no compelling reasons why NTBFs, as inhabitants of STPs or not, would need to co-locate around universities; as D'Este et al (2013, p357) put it "... *when firms located in dense clusters engage in collaborative research with universities, they do so essentially independently of the university's location*..." and an example of collaboration could be with cutting-edge priority technology, but in times dominated by e.g. MS Teams and Zoom, the university does not have to be nearby. This obviously has knock-on effects for regional development.

STPs are amongst the favourite choices in the policymakers arsenal when it comes to regional economic development (for a recent review, see Amoroso et al, 2019) and the importance of technology and business clusters (STPs etc) in strategies of regional development is well acknowledged, unfortunately it is also becoming clear that the majority of these initiatives fail to grow; both globally and in the UK, only about ~20% of STPs are successful (Wadhwa, 2013; Kelly and Firestone, 2016; Pugh et al. 2018). Part of the problem may be that basic metrics like how close together clusters can be to each other are unknown, as is how they compete with each other in their ecology. Indeed, many regions - fearing downturn - want to stimulate innovation by founding even more STPs etc, but this may simply lead to an overcrowded landscape, disappointing failures and even more resources wasted.

In the UK, STPs that are part of the UKSPA exist in an idealized landscape on average 12 km apart (SD 14.72 km), as shown in table 5. STPs specialised in pharmaceuticals were much further apart, average 32.65 km (SD 32.58 km), and this difference is highly statistically significant (table 6). This result appears to support the finding of Albahari (2019) that differing specializations can be a key to understanding the effects of STPs in a landscape. This result represents, to our knowledge, the first time that geospatial measurements have yielded concrete results in the area of STP spacing and regional development. Nevertheless, in real life more complications may exist e.g., that a new STP may be over 33 km from an established STP, but the NTBFs may prefer to inhabit the older STP when it is more prestigious. Or *vice versa*; older STPs may be full to capacity, allowing new overflow STPs to be located closer.

In conclusion, we are beginning to postulate a preliminary model of STP founding and development and to see how successful clusters can be created from new, in order to compete and inhabit a real landscape. The results presented here underline that metropolitan areas are clearly well inhabited,

but their universities are not major factors for firms and STPs to co-locate to them. Indeed, D'Este et al (2013) speculate that travel nodes may be a larger attraction. Non- or differently- specialised STPs can exist at around 12 km distance to each other in the UK. However, to capitalise on the larger economic returns derived from high-tech specialisation, a larger distance of >32-33 km appears to be required. Having >20 firms with the same speciality as the STP within 7.89 km could also be advantageous. After being established, Al-Kfairy et al (2019) and Al-Kfairy and Mellor (2020), using a transaction cost perspective, show that STPs start very simply and grow. To avoid "lock-in" with old technology, STPs need a regular influx of innovative firms with new ideas (see Cadorin, 2020; Mellor, 2015) and STPs can best manage the trade-off between being parsimoniously innovative or potentially overwhelmed by "bad-fit" innovations, by attracting help with decision making. Successful STPs appear to achieve this by being a hotbed of innovation and using this in attracting larger firms (Al-Kfairy et al 2020; Mondal and Mellor, 2021) within a 20-year time frame. These larger firms are needed to reenforce good decision making. Two larger firms in an STP improves the quality of decision making dramatically, although involving more than two increases the transaction costs while adding only marginally to the quality of decisions. This ambidextrous situation (Will et al, 2019) was found to be superior under all circumstances (Al-Kfairy et al 2020). Failure to follow this trajectory may well result in market failure or involuntary business re-orientation to lower technology levels (Mondal and Mellor, 2021). On-cluster firms grow to around seventeen years old and to size around 130 employees (Al-Kfairy et al, 2019), then either level out as growth stops, or the firm in question leaves the STP (Al-Kfairy and Mellor, 2020), which could be for several reasons, including the demand for larger physical space, etc. However, local aspects remain: Kussainov et al (2020) found that off-cluster firms were predominant in the 4-7 km zone around four STPs, and these results may indicate that initially on-cluster firms, with time and expansion, and with the help of new communications and other technologies, are able to move away from the STP centre to locales that are more attractive for their individual wants. Nonetheless, they still remain within relatively easy informational and travelling distance of the local STP and thus are still within easy (max 15 minutes) "local buzz" distance (Kussainov et al, 2020) to the STP.

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