Department for Transport

Realising and accelerating the agglomeration benefits of transport investments: Literature review and policy recommendations

Final report

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ARUP

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1   Introduction

1.1   Background

Ove Arup & Partners have been appointed by the Department for Transport (DfT) to research how policy levers can be used to support benefits arising from static and dynamic agglomeration resulting from improved connectivity delivered by new or improved transport infrastructure. This has been motivated by the imminent opening of Crossrail for which the 2007 business case estimated £7.3bn in agglomeration benefits (in 2007 prices). This was a significant share of the wider economic benefits included in the cost benefit analysis[1]. Although these agglomeration benefits are assumed to occur naturally as a result of increased economic density, there is evidence to suggest that these productivity benefits may take a decade or more to fully appear in the economy[2]. This paper investigates polices that both strengthen and accelerate these effects.

The DfT would first like to understand the theoretical micro-foundations of agglomeration, how agglomeration benefits are manifested over time, and the factors that support agglomeration economies. They have asked us to recommend policies that will support the realisation and acceleration of agglomeration benefits resulting from transport upgrades that improve connectivity. These recommendations should be supported by relevant case studies. The conclusions of the report may be used to inform the department's approaches to benefits management of current programmes.

The report has four sections. Section 2.1 provides a brief explanation of the theory of agglomeration with a focus on the dynamics that are commonly understood to lead to agglomeration benefits. These are sharing, matching and knowledge-spillover. In section 2.2 we identify three levers that can be used strengthen agglomeration effects; increasing effective economic density; increasing actual economic density; and increasing the frequency and intensity of interactions. In section 3 we explore the last of these levers more deeply and identify three policy areas that aim to enhance agglomeration effects through this channel. In section 4 we recommend policies that aim to strengthen agglomeration effects, again through the frequency and intensity of interactions. We include case studies to support our arguments.

The motivation behind this report was the opening of a new railway line in an urban or semi-urban setting and many of the policy recommendations were made with this context in mind. However, the theory underpinning these recommendations can be applied to a wide variety of transport upgrades.

1.2   Approach

We first developed a 'long-list' of literature focused both on theory and policy. This covered policy areas including commercial and residential planning, transport, micro-mobility, parking, road use, emission zones, knowledge and innovation clusters, and building design (See Annex 1).This was largely through the exploration of academic

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[1] Volterra (2007) The Economic Benefits of Crossrail
[2] Tveter, Laird (2018) Agglomeration – how long until we see the benefits?

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databases but also conversations with internal Arup experts. We sifted the long list by their relevance to the research question, discussed our initial findings with our client at the DfT and together decided the areas on which to focus. Through this process it was decided we would focus on policies that aimed to enhance agglomeration effects through increasing the frequency and intensity of interactions rather than those that increase actual or effective economic density. We carried out a deeper exploration of the chosen topics identifying potential policy recommendations in the process. We presented these policies to DfT in a workshop who provided further direction. Finally, we synthesised the literature review and policy recommendations into this report.

2   Theory

2.1   Agglomeration

An agglomeration economy and associated effects occur when individuals and firms derive productivity benefits from locating in close proximity to one another[3]. These effects rely on externalities whereby individuals and firms capture positive externalities emitted by other individuals and firms that are in the local vicinity. Marshall (1830) identified three **sources** of agglomeration effects**;** those arising from labour market interactions, from linkages between intermediate- and final-goods suppliers, and from knowledge spillovers.

Duranton and Puga (2003) classified the **mechanisms** driving agglomeration effects into sharing, matching and learning mechanisms (knowledge spillover)[4]. These mechanisms rely on the positive externalities continuously emitted and captured by businesses and workers. It is the value of these captured externalities which explain the higher productivity and wage premium we see in cities and the gravitation pull which helps form them in the first place. This report will focus on policies that enhance and accelerate these mechanisms.

Sharing

By moving to a location within an agglomeration economy, businesses and workers can make use of the facilities, infrastructure, suppliers, and labour markets that are already located there[5]. These are positive externalities emitted by the incumbent economy. Further to this, the relocating agent can benefit from the specialisation that is possible due to co-location with similar firms.

Matching

Within urban agglomerations better matching is likely to take place between employee and employer, supplier and buyer and between business partners because there is more quantity and variety from which to choose. An employee looking for a new job will benefit from the increased likelihood of a suitable job being available, the reduced costs of retraining due to the likelihood of finding a

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[3] DfT. (2016) TAG Unit A2.4: Appraisal of Productivity Impacts
[4] Duranton and Puga. (2003) Micro-foundation of Urban Agglomeration Economies,
[5] Puga. (2010) The Magnitude and causes of agglomeration economies,

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similar job to the one they have already, and the increased likelihood of finding a job that is a perfect match. The individual is benefiting from the presence of other similar workers and the externalities arising from this. Similar arguments can be made in markets other than the labour market.

Learning (Knowledge Spillover)

Urban agglomerations facilitate the diffusion of knowledge and the acquisition of skills[6]. New workers benefit from being in the proximity of experienced workers and start-ups benefit from locating near more established rivals. The high labour churn within cities helps ensure knowledge is spread from firm to firm.

The capturing of local externalities imply firms can produce more output with the same inputs in larger, denser, urban environments and there is significant empirical evidence that this is in fact the case[7]. There is a large econometric literature dedicated to estimating the relationship between effective density (agglomeration) and productivity with the estimated coefficients used to calculate the agglomeration benefits of infrastructure projects. The DfT's Transport Appraisal Guidance provides widely used elasticities of productivity with respect to effective density[8].

2.2   How to increase agglomeration effects

Various factors determine levels of agglomeration in an economy. To increase the strength of agglomeration effects policies should target these factors by increasing actual economic density, increasing effective economic density, or increasing the quantity and intensity of interactions between economic agents. The policies recommended in this report focus on those that aim to increase the frequency and intensity of interactions.

It should be noted that the elasticities of productivity used by the DfT estimate the marginal impact of an increase in effective economic density on productivity. It is these estimates that were used to calculate the agglomeration effects of Crossrail. In theory, the various policy solutions presented in this report are only speeding up the realisation of wider economic impacts explained in the TAG guidance[8] – the literature is yet unclear how transformational impacts are connected to level 2 and level 3 agglomeration benefits. On a more practical level, these policy solutions are effectively ways to unblock constraints on economic growth and thus the full estimated level 2 and level 3 agglomeration benefits can be achieved.

Increase effective economic density

Productivity gains associated with agglomeration economies result from the high effective economic density of the area[9]. The 'closer' economic agents are to one another the more opportunity there is to capture agglomeration externalities.

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[6] Audretsch, D. Feldman, M.(1996) R&D Spillovers and the Geography of Innovation and Production

[7] Puga. (2010) The Magnitude and causes of agglomeration economies

[8] DfT: Transport analysis guidance (TAG)

[9] Laird. Venables. (2017) Transport Investment and economic performance: A framework for project appraisal,

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Effective economic density is derived from actual economic density - the concentration of economic activity in an area - and the connectivity between zones within the area. Transport infrastructure improvements increase effective economic density by reducing journey times on both the local and national level. Other policies that could reduce journey times include introducing congestion charging zones, enhancing the bus lane network, and widening the use of micro-mobility options.

Increase actual economic density

Effective economic density can also be increased by increasing the underlying actual economic density. This can be done by encouraging the development of dense commercial and residential property, relaxing planning regulations, encouraging longer working days or discouraging working from home (the extent to which remote working is impacting agglomeration is an ongoing debate).

Increasing the frequency and intensity of interactions

A further way to increase agglomeration effects is by strengthening the agglomeration dynamics of sharing, matching and knowledge spillover directly, dynamics that rely on interactions between economic agents. Policies that aim to increase the frequency and intensity of these interactions will enhance agglomeration benefits and are the focus of this report

Policies that would enhance the **frequency** of interactions could include: creating shared working spaces; encouraging multi business occupation of commercial property; organising meet the buyer events and strengthening the network of start-ups, SMEs, businesses, investors, and industry experts within a tech cluster. This will be explored further in section 3.3.

Empirical evidence shows that agglomeration effects are strongest when the agents involved are knowledge-workers and knowledge intensive businesses. Policies that aim to attract knowledge-intensive businesses and the knowledge-workers employed by them will enhance agglomeration effects by increasing the **intensity** of interactions with regards to agglomeration externalities. The use of "intensity" attempts to reflect the greater emitting and capturing of externalities taking place. This is the topic of sections 3.1 and 3.2.

It is important to note the potential negative consequences of policies that aim to attract the knowledge economy and knowledge-workers to a particular area. There is some evidence which suggests that growth in high-tech jobs leads to growth in low-wage service jobs and a reduction in low-skilled wages[10].

3   Policy areas

Policy recommendations that increase the frequency and intensity of interactions within an agglomeration economy can be further categorised into three policy areas; those that aim to change the characteristics of businesses within the local

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[10] Lee, Clarke. (2019) High- technology multipliers, employment and wages in Britain.

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economy; those that aim to change the types of workers who live in the area; and policies that increase the frequency of interactions between agents.

3.1 Foster economic hubs of knowledge and innovation

Stations with the potential for knowledge-sector growth should be identified and policies implemented that seek to attract relevant businesses. This will increase the flow of agglomeration benefits because knowledge spillover is strongest within the knowledge economy.

The productivity premium in urban environments which defines agglomeration is largest when the workers have stronger cognitive and people skills[11]. This is for two reasons. Firstly, human capital spillover is greater when the workforce is more educated[12]. This is presumably because workers have more knowledge to share and because they work in sectors in which the capturing of knowledge spillover is more beneficial. Second, there are stronger matching effects when the labour force is highly educated[13]. This is partly explained by the more intense labour churn of highly-skilled workers[14].

Policies and strategies long-list identified in literature

- Identify and build on existing Knowledge & innovation clusters
- Provide facilities for tech start-ups where there is a market failure
- Capture early private sector input and commitment
- Introduce R&D tax incentives
- Create accelerator and incubator programmes for tech start-ups
- Attract University campuses to the area
- Attract knowledge-intensive anchor tenants to the area
- Attract knowledge-workers to residential areas

3.2 Attract knowledge-workers to residential areas

Stations with the most potential to attract highly educated knowledge-workers should be identified and policies implemented to encourage these workers to move to the area.

Knowledge-workers facilitate strong agglomeration effects, not only within the workplace but also less formally in their residential areas; there is evidence that informal social interaction is effective for spreading knowledge[15]. By encouraging

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[11] Bacolod, M. Blum, B. Strange, W. (2009) Skills in the City
[12] Rosenthal, Strange (2008) The attenuation of human capital spillovers
[13] Leknes. Rattso. Stokke. (2020) Assortive Labour matching, city size, and education of workers,
[14] Leknes.(2017) Evidence of heterogeneous responses along the skill and experience gradients
[15] Diemer, A. Regan, T. (2020) The Geography of Social Connectedness and Knowledge Flows in the United States: New Evidence from Patent Citations

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the development of residential areas that house a high density of knowledge-workers these informal social interactions will become more prevalent. A further argument for these policies is to provide a supply of knowledge-workers to support the development of knowledge and innovation hubs.

It should be noted that attracting knowledge-workers and business from within the knowledge economy may have displacement effects both at a local, city and national level. The potential for 'deagglomeration' is well understood in theory; however, we are not aware of high-quality empirical studies which have found clear evidence for their existence.

Policies and strategies long-list identified in literature

- Invest in residential amenities to attract knowledge-workers
- Attract pioneer business
- Create attractive public spaces
- Build arts, festivals and cultural centres
- Encourage a vibrant nightlife
- Build a reputation for diversity and tolerance
- Improve transport links
- Build suitable housing

3.3 Facilitate an environment that maximises the frequency of interactions

The agglomeration externalities sharing, matching and knowledge spillover, all rely on the proximity of economic agents and the interactions that result from this. Policies that encourage these interactions will strengthen agglomeration effects.

The environment in which these agents interact will likely influence the frequency of interactions. For example, by ensuring multiple companies from the same sector share a commercial building knowledge spillover is made more likely[16]. In fact, agglomeration externalities have been shown to attenuate rapidly with distance so ensuring firms are located in close proximity is crucial.

A further example of how environment can lead to greater agglomeration effects can be found in the recent phenomenon of shared working spaces, particularly in areas with high knowledge and innovation sector shares. The opening of the Google Campus within the Tech City Cluster in east London coincided with a significant increase in tech start-ups (see case study). This seven storey building was a shared working space which was inhabited by a significant number of tech companies. It is likely this led to significant knowledge spillover.

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[16] Rosenthal. Strange. (2017) Building Specialization, Anchor Tenants and Agglomeration Economies

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> **Polices and strategies long list identified in literature**
> - Encourage multi-occupancy in commercial buildings
> - Attract anchor tenants
> - Create shared working spaces
> - Develop shared public spaces in commercial districts
> - Build the local business network

4   Policy recommendations

To achieve the policy aims above we recommend seven policy initiatives. The initiatives aim to increase agglomeration effects through at least one of the three policy area channels in the previous section.

> **Policy areas**
> - Foster economic hubs of knowledge and innovation
> - Attract knowledge-workers to residential areas
> - Facilitate an environment that maximises the frequency of interactions

4.1   Policy 1: Manage the creation of knowledge-intensive economic clusters by creating a Cluster Management Vehicle (CMV)

Take advantage of the step change in connectivity and economic density to embed knowledge intensive economic clusters close to new stations. This process will be managed by a Cluster Management Vehicle (CMV).

The enhancement of transport connectivity associated with the opening of a train line provide access to wider labour pools, supply chains and markets. This provides an opportunity to attract new businesses and potentially build a knowledge-intensive economic cluster (KIEC) in the area. A Cluster Management Vehicle (CMV) should be created to manage this process. Typical policy measures used to build or strengthen clusters include direct and indirect financial support, start-up support, provision of working spaces, aid for administration, facilitation of networks and cooperation, as well as promotional activities[17].

Economic clusters describe the tendency for businesses within the same sector to locate in close proximity. Agglomeration dynamics are a major cause of these clusters and the productivity gains associated with them have motivated local authorities to attempt to facilitate their growth. There is much debate over the effectiveness of cluster policy with plenty of examples of both success and

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[17] Brenner. Schlump. (2011) Policy Measures and Effects in the Different Phases of the Cluster Life-Cycle

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failure[18]. Despite this, there are consistent themes that can be drawn from empirical evidence that inform effective policy[19].

Policy detail

Create a Cluster Management Vehicle (CMV). The CMV would be made up of experts from high-tech industry, venture capital, local academic institutions, local business associations, and local authorities and LEPs. The CMV would identify potential stations around which context specific KIEC's could be developed. A Cluster Strategy would be developed containing a suite of evidence-based policies relevant to the KIEC.

The Cluster Management Vehicle should be a catalyst and intermediatory rather than the lead. The CMV would act as a catalyst for the development of the KIEC by sharing their vision and bringing together stakeholders including domestic and international investors, academic institutions, local authorities, commercial property owners and developers, local business and media outlets. This network will facilitate cross-collaboration, a coherent joined up vision and a collective confidence that will lead to commitments and action, both financial and legislative.

Build on existing economic strengths. Evidence suggests that building of new innovation clusters from scratch is difficult and less successful than building on existing clusters and sectors already present in the area[20]. Many seemingly random cluster developments are in reality built on historical local skills and industry knowledge. As such the chosen sector specialism should recognise and build upon local and regional strengths and tap into historical and cultural narratives.

Seek early private sector involvement and commitment. The early and active involvement of the private sector ensures the development of a cluster strategy in which investors are confident. This significantly increases the likelihood of investment, the key ingredient for successful cluster success.

Utilise targeted public sector funding to leverage private sector investment. Public sector investment is an effective way of building stakeholder confidence and crowding in investment. Other signals can be used to demonstrate long-term public sector support such as cluster promotion and branding, attracting high profile support from businesses and individuals, and the formation of the CMV itself.

The CMV should also function as a support service for SMEs and start-ups. Technical and business support services that help SMEs to develop new technologies, commercialise their products, will help support the development of the KIEC.

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[18] Avnimelech. (2013). Targeting the biotechnology clusters in North Carolina and Israel: lessons from succesful and unsuccessful policy making

[19] Uyarra. Ramologan. (2012) The effects of Cluster Policy on Innovation

[20] Uyarra. Ramologan. (2012) The effects of Cluster Policy on Innovation

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Things to avoid

- *Creating new clusters from scratch.* It is thought that what appear to be new clusters are often formed out of the remnants of existing industries in the area and a skills and knowledge base that already exists. Without this economic history cluster formation is thought likely to fail

- *The CMV as navigator.* The CMV should ensure that local businesses and other stakeholder provide the direction for the KIEC.

Case Study 1: East London Tech City - Silicon Roundabout

From the late 1990s this cluster of high-tech industry emerged without targeted action around Old Street Roundabout, earning the nickname 'Silicon Roundabout'. The cluster initially developed organically, with minimal direct policy intervention[21]. Artists, designers, fashion, and furniture makers first settled here due to the old buildings and cheap rents[22]. This led to the migration of dot-com firms, creative digital agencies, branding, marketing research corporations and web designers. This in turn stimulated demand for ICT services such as software and applications development[23]

In 2010 David Cameron, the incoming coalition government Prime Minister, stated a desire to build the area into 'one of the world's great technology centres' (Cameron 2010), and rebranded the area "Tech City". The Tech City Investment Organisation (TCIO) was established to lead the cluster's development and policies were implemented covering finance, workspace, connectivity, business development, immigration, public-private competitions and research collaborations[24]. Instead of significant public expenditure, policies focussed on promotion, attracting domestic and international investment, and facilitating collaboration between start-ups, SMEs, investors, academics and the public sector. By the end of 2011, the cluster contained over 200 firms and in 2012 Google opened their largest office outside of Silicon Valley in the heart of the cluster (see below)[25].

Perhaps the most important policy intervention was the Seed Enterprise Investment Scheme, introduced in 2012 by the coalition government. This scheme introduced tax breaks for investments that backed risky projects. It was widely taken up and led to an explosion in tech start-ups in the Tech City area. There were 330 start-ups in London by 2015 and over half of these in Tech City[26]. Tech start-ups in London raised $5.2 billion of venture capital funding from 2010 to

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[21] Urban Regeneration: From the Arts `Feel Good' Factor to the Cultural Economy: A Case Study of Hoxton, London, A Pratt, 2009

[22] The renaissance of the city as a cluster of innovation, Jerome S. Engel1 , Jasmina Berbegal-Mirabent2 * and Josep M. Piqué3, 2018

[23] Location, location, location: Exploring the complex relationship between creative industries and place, Comunian, Chapain, & Clifton, 2010

[24] Here be Startups: Exploring London's 'Tech City' Digital Cluster, Max Nathan, 2015

[25] The renaissance of the city as a cluster of innovation, Jerome S. Engel1 , Jasmina Berbegal-Mirabent2 * and Josep M. Piqué3, 2018

[26] The real London tech StartUps. The Business, DueDil/TechHub. 2011

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2018 with Tech City an essential component in the London tech ecosystem[27]. Additional policies implemented during this time included legislative help for firm relocations and property investment[28].

Another interesting characteristic of East London Tech City was the introduction of a large, shared working space in the heart of the cluster. The Google Campus, opened in 2012, provided a central hub that had previously been missing[29]. The building was a seven story coworking space which also held events and housed a café which provided a free workspace. The space was used by a variety of accelerators and start-up programmes with free mentoring often provided. There is anecdotal evidence that this space played a significant role in supporting the development * of the UK's start-up ecosystem[30].

4.2 Policy 2: Innovation accelerators and incubators

Create innovation accelerators and incubators to support the growth of tech start-ups within the KIEC.

Technology incubators and accelerator programs aim to support and grow tech start-ups by proving a range of services including working space, mentoring services, networking opportunities, and, in the case of accelerators, private or public sector seed investment. They are differentiated by the source of financial support; incubators generally provide free or subsidised office space whereas accelerators invest directly in the business. The Catapult Network is an example of these kinds of schemes in the UK albeit with a focus on bridging the gap between academia and business[31]

The introduction of these programs has been shown to have positive economic effects on the local area in addition to the direct effects on participants[32]. Incubators have been shown to increase local employment after the direct effects of the program have been accounted for. There is also evidence of the creation of high-quality jobs and productivity increases, again net of direct impacts[33]. Further to this, the growth was shown not to be accompanied by displacement effects.

Accelerator programs also have an impact beyond the business directly involved. The launch of an accelerator is associated with a significant increase in the number and value of investments made into high-tech companies not involved with the program[34].

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[27] The renaissance of the city as a cluster of innovation, Jerome S. Engel1 , Jasmina Berbegal-Mirabent2 * and Josep M. Piqué3, 2018

[28] The new boomtown? Creative city to Tech City in east London, Foord, 2013

[29] Wired magazine, 2012

[30]30 CNBC, 2021

[31] The Catapult Network website

[32] BEIS. (2019) Impacts of commercial and property development, 2019

[33] BEIS. (2019) The impact of business accelerators and incubators in the UK, BEIS, 2019

[34] Hochberg. Fehder. (2015) Accelerators and the regional supply of venture capitalism

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Creating accelerator or incubator programms within the cluster that match the sector specialism will facilitate the creation and growth of start-ups, an important element in a knowledge-intensive ecosystem. Further to this, it will attract highly knowledgeable workers leading to stronger agglomeration effects.

Case Study 2: Digital Catapult London

Digital Catapult London (DCL) aims to connect academics, researchers, scaleups, start-ups and corporates within the digital sector, connect businesses to potential new markets in the UK and overseas, and support them with the commercialisation of their work. It builds and operates physical and digital facilities not currently available elsewhere in the UK and provides these facilities to innovative tech start-ups and SMEs. Situated in the Kings Cross Knowledge Quarter, it also provides a hub for innovation and commercialisation.

The facilities that DCL provide include a 5G testbed, a research and innovation studio for virtual production, a Future Networks Lab that supports the adoption of IoT and 5G technologies, and a volumetric video and 3D capture studio for the production of immersive content. They also provide business support, specialist knowledge, and expertise, and act as a bridge between academic institutions and businesses where this support may not be available due to market failure, commercial risk, or inhibitory costs.

The UK Catapult Network is funded mainly through central government but are encouraged to seek commercial income through research projects. DCL and three other regional centres share £17.5 million of annual income, £11.9m of this is from central government and the rest raised via commercial enterprise and collaborative R&D. The Catapult network has so far supported over 8000 small and medium sized enterprises, has established over 2,000 academic collaborations and almost 15,000 industry collaborations.

Policy detail

The CMV will support the development of an incubator or accelerator program that will sit within the KIEC and match its area of specialism. A Program Management Team (PMT) will be carefully put together as evidence suggests the characteristics of this team is crucial to success. Experts with a venture capital background and industry expertise will be sought as they have been shown to have a more positive impact on program and start-up success than consultants or business developers[35]. The presence of venture capitalists within a program has been shown to lead to employment growth and a more skilled workforce, whilst an industry expert improves the quality of innovation.

Empirical evidence suggests there are a few key services that most benefit start-ups. The PMT will focus on providing these services. Firstly, help with the formation of the team. This is important due to the difficulty inexperienced entrepreneurs have identifying and locating the skills they need to make a success of the project. Providing access to peers also has a significant effect, again probably due to the

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[35] BEIS. (2019) The impact of business accelerators and incubators in the UK

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inexperience of the businesses involved. Finally, direct funding and access to investors both have large positive impacts on the success of participant businesses.

4.3   Policy 3: Anchor tenants

Attract firms with influence in the KIEC sector specialism to part-occupy commercial properties in the area. These firms will act as a magnet for the target industry.

There is ample evidence that the presence, within a multi-occupancy building, of a business with significant sector-wide influence skews the building's composition towards the 'anchor' tenant's industry[36]. Although this effect also exists at a local area level the effect is significantly stronger within the building than across adjacent buildings. As such providing incentives for an influential sector leader to occupy a share of a commerical property should act as a catalyst for other firms and significantly increase sector presence in the area.

The anchor tenant acts as a magnet by generating agglomeration externalities that other firms are attracted by, such as knmowledge spillover and improved matching. It is thought that employees working for different firms but in the same building are more likely to experience spontaneous interactions because, for example, they meet more often in shared spaces and events. Evidence suggests these productivity spillovers decline discretely once workers step outside the building. However, as these effects can also work across buildings the use of anchor tenants should not be stricly restricted to within building strategies.

By targeting sectors within the knowledge economy this policy aims to support the creation of the KIEC. Further to this the policy will directly lead to increased agglomeration effects by increasing the frequency of interactions between agents.

Policy detail

The CMV should identify anchor tennants that are best placed to act as a magnet for the sector specialism of the KIEC. By working with commercial property owners, office space can be identified that provides an ideal environment for knowledge-spillover. The anchor firm should be incentivised to re-locate using business rate subsidies provided by the local authority and by appealing to the economic opportunities provided by the new transport provision. Further to this, building owners are incentivised to attract anchor tennants as knowledge spillover within their building leads to productivity increases and thus rent rises. Working with landlords to attract target tenants is another potential strategy.

4.4   Policy 4: Public sector relocation

Relocate public sector jobs to the specialism clusters

The relocation of public sector jobs has been shown to crowd in private sector employment, largely in sectors related to the public sector and predominently in

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[36] Rosenthal. Strange. (2017) Building Specialization, Anchor Tenants and Agglomeration Economies

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the services sector[37,38]. Examples of this include the dispersal of public sector jobs following the Lyon review in 2004 and the relocation of BBC jobs to Media city in Salford.

By re-locating appropriate public sector jobs so that they match the KIEC specialism, this policy can act as a catalyst for clustering and increase the share of knowledge-economy employment.

Policy detail

The CMV should work with the public sector to identify teams and departments linked to the cluster specialism that could benefit from being located in a knowledge-intensive sector. Suitable premises would be found by working with commercial property owners and rent subsidies provided if necessary.

Case study 3: Lyon Review Public Sector Dispersals

The 2004 Lyon review led to the dispersal of around 25,000 civil service jobs out of London and the South-East towards other UK destinations[39]. The aim of the policy was to stimulate economic activity in less prosperous areas of the country and address regional imbalances. The aim was also to save departments money given the lower costs of operating outside of London and south-east. Estimates made at the time suggested £2billion would be saved over 15 years[40].

There is evidence that the policy helped strengthen agglomeration economies. The relocation initiative raised private sector employment of the relocation area and changed the sectoral distribution of local employment towards services [39]. There is also evidence of displacement and clustering, with private sector employment relocating to be in close proximity to public sector jobs.

Case Study 4: BBC Relocation to Media City

The BBC, starting in 2011, relocated 2000 mainly London-based jobs to Salford Quays as part of the creation Media City[41]. Part of the motivation was economic as the area had experienced economic deprivation following the closure of local docks in the 1980s. The move was a central part of a log term regeneration scheme with estimates that 15,000 jobs would be created.

The relocation was a major part of the succesful formation of a new economic cluster specialising in media. The relocation of 2,000 positions led to an additional 2,600 private sector job, approximately 2,000 of which were in TV, radio and other media. This included significant displacement and clustering from other areas of Great Manchester.

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[37] Faggio. (2019) Relocation of Public Sector Workers: Evaluating a place-based policy

[38] Centre for Cities. (2017) Should we move public sector jobs out of London

[39] Faggio. (2019) Relocation of Public Sector Workers: Evaluating a place-based policy

[40] Social Market Foundation. (2021) The Government's case for civil service relocation doesn't stack up

[41] Centre for Cities. (2017) Should we move public sector jobs out of London?

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4.5   Policy 5: Research and development tax incentives

Introduce Research & Development (R&D) tax incentives within the KIEC to attract high-tech knowledge sectors, incentivise innovation and create knowledge spillovers.

R&D credits positively impact R&D expenditure with the effect particularly pronounced for smaller firms[42]. Econometric analysis suggests that the UK government's Research and Development Tax Credit scheme resulted in between £1.53 and £2.35 of additional R&D investment for every £1 forfeited by the exchequer[43]. OECD analysis suggests 1 unit of costs results in 1.4 units of R&D[44]. Further evidence points to R&D tax credits having a positive effect on innovation. There is limited evidence of the wider economic impacts of R&D policy so impacts on employment and wages is difficult to ascertain. However, there is some evidence that for G7 countries (United States, Germany, Japan, the United Kingdom, France, Italy, and Canada), higher spending on R&D lead to increased economic growth[45]. This may be partly due to agglomeration externalities and so supports the case for this policy.

Through increased research, development and innovation this policy will increase the wealth of knowledge within the KIEC, increasing the potential for knowledge spillover. It will also attract high-tech research-intensive firms, increasing the density of the knowledge economy and strengthening agglomeration externalities.

Policy detail

R&D tax subsidies can be implemented via the business rates that local authorities set. Companies will be required to fill in a rebate form at the end of the financial year in which they will provide proof of the R&D expenditure they have made. To be eligible the research operations must be located within the defined cluster.

Things to avoid

A common issue with R&D tax subsidies is the extent to which companies re-label existing expenditure as R&D. This expenditure would have taken place anyway so will not contribute to agglomeration impacts. As such this is simply lost tax income for the local authorities. Steps should be taken to avoid this.

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[42] What Works Centre for Economic Growth. (2015) Innovation: R&D Tax Credits,

[43] HMRC. (2015) Evaluation of Research and Development Tax Credit

[44] OECD Publishing. (2020) The Effects of R&D Tax Incentives and their Role in the Innovation Mix

[45] Sylwester, K. (2001) R&D and Economic Growth,

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4.6 Policy 6: Attracting knowledge-workers by improving the public realm

Provide the amenities that knowledge-workers value to attract them to residential areas.

A key component of attracting and retaining knowledge-workers to a city is quality of life[46] . The characteristics of a residential area considered attractive are subjective and vary by individual. However, evidence suggests that knowledge workers, and particularly young and creative workers, value the presence of cultural activities and certain amenities. These include galleries and performance art venues, music venues, and 'authentic' and 'historical' shared spaces[47]. Also of importance to these workers are 'softer' needs, such as being part of a community of strangers and having picturesque spaces, such as parks and squares, in which they can interact with this community

This policy would provide investment in the public realm that will help attract knowledge-workers to residential areas. Knowledge-workers prodice greater agglomeration externalities and provide the workforce for the KIEC.

Policy Detail

Stations that have the potential to attract knowledge-workers should be identified and an analysis undertaken to identify an amenity gap. These areas are likely to be 'up and coming' areas of city with these policies acting as an accelerator of a process that is already taking place. A public-private partnership should be explored that would provide the funding necessary to invest in the identified amenities. Knowledge-workers value shared public spaces, so parks, well-designed urban spaces, and shared cultural spaces should be prioritised.

4.7 Policy 7: Pioneer businesses

Attract pioneer business to residential areas to attract knowledge-workers

It is well known that the location of new businesses in specific industries linked to cultural, recreational and creative industries can predict the gentrification of an area[48]. A study of New York and Philadelphia found that business such as artists, architects, and art dealers who are usually found in wealthy neighbourhoods, when found in poor neighbours, often foreshadow the migration of wealthy individuals to the area. This 'signalling' has been well documented by social scientist over the years[49]. But there is some evidence to suggest that pioneer businesses have an active and causal role to play in gentrification. As such, policies that aim to attract these businesses to an area could help stimulate the migration of knowledge-workers.

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[46] Florida. (2000) Economic Geography of Talent

[47] Yigitcanlar and Baum, 2007. Attracting and Retaining Knowledge Workers in Knowledge Cities,

[48] Behrens et al. (2019) Gentrification and Business,

[49] Ley, D. (2003) Artists, Aestheticisation and the Field of Gentrification,

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Although evidence is limited, Behrens et al (2019) argue that business have an active role to play in the 'gentrification' of an area. Behrens et al (2019) believe these businesses have a causal impact in three ways. Firstly, they employ workers who are young and educated, typical characteristics of 'gentrifiers'. Second, they provide a signalling effect to potential residents and investors. Third, these pioneer businesses may lead to consumption businesses such as restaurants and bars opening in the area. These secondary businesses are an attractive amenity for educated and wealthy people.

By attracting pioneer businesses to the area this policy would act as a catalyst to attract knowledge-workers to an area. However, there are potentially negative consequences to a policy that aims to attract highly educated and high-income individuals and households. This migration will likely lead to upward pressure on house prices, rising rents and the closing of shops that cater for the incumbent population. Policies that mitigate these issues should be explored.

Policy details

Areas identified as potentially attractive to knowledge-workers should seek to attract pioneer businesses to the area. They can do this through reduced business rates and by working with local commercial property owners to help these businesses find appropriate premises.

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Conclusions and further research

Significant improvements to the transport network lead to agglomeration benefits through an increase in effective economic density. Other factors also impact the strength of agglomeration economies. As such, careful policy interventions based on these factors and their associated dynamics can be used to help realise and accelerate the benefits of the investment. Many of these policies aim to increase the size of the knowledge economy and attract higher numbers of knowledge-workers. This is because there is strong evidence that these agents create stronger agglomeration externalities. Further to this there are policies that aim to increase the frequency and intensity of interactions. We have recommended policies that address both of these areas. Future transport schemes would benefit from considering the use of these policies.

The polices in this report have been recommended and designed largely on the basis that local authorities will be responsible for their implementation. The formation of a Cluster Management Vehicle, the creation of incubators and accelerators, attracting anchor tenants and pioneer businesses, and planning public realm improvements all fall naturally under the responsibility of local authorities, Local Economic Partnerships (LEP) and Combined Authorities, who are best places to make informed decisions into local issues. A key component for most of the policies is a responsible body and its representatives who are members of the local community who are able to provide virtual and actual spaces where various agents of the economy can meet and thus maximise knowledge spillover opportunities.

However, there are also natural partners in central government such as DLUHC, BEIS and HMT. The migration of public sector jobs would best be achieved through collaboration between local authorities and a range of central government departments. The suggested design for the R&D tax incentive policy makes use of business rates, a policy tool under the control of local authorities. However, central government intervention could make this policy more effective by using tax incentives controlled by the treasury (see Table 1).

Table 1: Summary of policies and their potential responsible authority

Policy	Responsible authority
Cluster Management Vehicle	LAs, LEPS, Combined Authorities, BEIS
Accelerators and incubators	LAs, LEPS, Combined Authorities, BEIS
Anchor tenants	LAs, LEPS, Combined Authorities, BEIS
Public sector relocation	LAs, LEPS, Combined Authorities, other central government departments

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R&D tax incentives	LAs, LEPS, Combined Authorities, HMT
Improvement to the public realm	LAs, LEPS, Combined Authorities, DLUCH
Pioneer businesses	LAs, LEPS, Combined Authorities, BEIS

This report raises significant areas for further research. There are potential polices
in areas that we have not explored in detail. These lead to the following research
questions:

- How can urban and spatial design be used to increase the frequency and
  intensity of interactions?

- How are shared working spaces impacting the economy through
  agglomeration dynamics and what policies can be implemented to support
  these effects?

- How is remote working impacting agglomeration economies and how can
  policy can be used to take advantage/mitigate these effects?

The growth of agglomeration economies resulting from significant improvements
to transport infrastructure may also have negative consequences which the policy
recommendations above could exacerbate. For example, the growth of high-tech
jobs may also lead to growth in low paid service jobs and a reduction in wages for
low-skilled workers. Further to this, the migration of knowledge-workers to a
residential area may 'crowd out' low-income households. This leads to an
additional research question:

- What are the potential negative consequences of large transport
  interventions and what can be done to mitigate them?

Policies that encourage the development of new commercial space were dropped
at the long list stage to give this research piece more focus. However, some of the
policies included in this report would benefit from new developments. For
example, the anchor tenant policy would benefit from new commercial space
specifically designed for maximum agglomeration spillover. Further research into
these development-focussed policies would also be of benefit.

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Annex 1: Literature Review Long List

Title	Authors
A long-term evaluation of the first generation of French urban enterprise zones	Givord et al (2018)
Accelerators and the Regional Supply of Venture Capital Investment	Fehder, Hochberg (2014)
Agglomeration, Innovation and Spatial Reallocation: the Aggregate Effects of R&D Tax Credits	Alexandre Sollaci (2020)
Anything new in town? The local effects of urban regeneration policies in Italy	Albanese (2021)
Anything new in town? The local effects of urban regeneration policies in Italy	Albanese (2020)
Assortive Labour matching, city size, and education of workers	Leknes, Rattso, Stokke (2020)
Building Specialization, Anchor Tenants and Agglomeration Economies	Stuart Rosenthal, William Strange (2017)
Building Specialization, Anchor Tenants and Agglomeration Economies	Rosenthal, Strange (2017)
Churning in thick labor markets: Evidence of heterogeneous responses along the skill and experience gradients	Leknes (2017)
Cities and the creative class	Florida (2003)
Contracts, externalities, and incentives in shopping malls	Gould et al (2005)
Cross-country evidence on the contributions of research institutions to innovation	OECD (2019)
Efficiency of road pricing schemes with endogenous workplace locations in a polycentric city *	Romain Gaté (2019)
Endogenous Local Labour Markets, Regional Aggregation and Agglomeration Economies	Jordy Meekes, Wolter Hassink (2019)
Estimating the social return to higher education: evidence from longitudinal and repeated cross-sectional data	Moretti (2004)
Exposure, timing, and vulnerability: The role of public transport in inducing gentrification	Fernando (2021)
Gentrification and Pioneer Businesses	Kristian Behrens, Brahim Boualam, Julien Martin, Florian Mayneris (2019)
Gentrification and Pioneer Businesses	Kristian Behrens, Brahim Boualam, Julien Martin, Florian Maynerisl, (2019)
How do we encourage innovation through clusters?	Centre for Cities (2017)
Identifying Knowledge Spillovers from Universities: Quasi-experimental Evidence from Urban China	Jing Li, Shimeng Liu, Yifan Wu (2020)

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Impact of Workplace Communication Networks on Productivity: A New Approach Using Wearable Sensors	Kentaro Nakajima, Tsuyoshi Tsuru, Katsuhito Uehara (2018)
Impacts of commercial property development	BEIS, 2018
Innovation: R&D tax credits	What works centre (2015)
Investment Tax Credits and the Response of Firms	Adrian Lerche (2019)
Labor Force Demographics and Corporate Innovation	francois derrien, Ambrus Kecskes, Phuong-Anh Nguyen (2020)
Labor Force Demographics and Corporate Innovation	Francois Derrien, Ambrus Kecskes, Phuong-Anh Nguyen (2020)
Labor Market Matching, City Size, and the Education Level of Workers	Stefan Leknes, Jorn Rattso, Hildegunn Stokke (2020)
Land Use Regulations and Housing Development: Evidence from Tax Parcels and Zoning Bylaws in Massachusetts (Student Prize Submission)	Brendan Shanks (2021)
Learners in Cities: Agglomeration and the Spatial Division of Cognition	Marigee Bacolod, Bernardo Blum, Marcos Rangel, William Strange (2009)
Local Market Scale and the Pattern of Job Changes Among Young Men	Wheeler (2008)
Monopsony and Mobility in Urban Labour Markets	Alan Manning (2019)
Multipliers From a Major Public Sector Relocation: the BBC's Move to Manchester	Max Nathan, Henry Overman, Capucine Riom, Maria Sanchez Vidal (2017)
New road infrastructure: The effects on firms	Gibbons (2019)
Novel Ideas: The Effects of Carnegie Libraries on Innovative Activities	Enrico Berkes (2019)
Novel Ideas: The Effects of Carnegie Libraries on Innovative Activities	Enrico Berkes (2019)
Place-based policies	Neumark, Simpson, NBER (2014)
Public Transport Provision under Agglomeration Economies	Daniel Hörcher, Woubit Seifu, Bruno De Borger, Daniel Graham (2020)
R&D and economic growth	Sylwester (2001)
R&D and economic growth: How strong is the link?	Pessoa (2010)
R&D Tax Incentives: Design and Evidence	Organisation for Economic Co-operation and Development (2016)
Reconstructing Cities: Stimulating Redevelopment Through the Tax Code	Geert Goeyvaerts, Erik Buyst (2021)
Regulatory Sandboxes and Financial Inclusion	CGAP, Jenik & Lauer (2017)
Relocation of Public Sector Workers: Evaluating a place-based policy	Faggio (2019)
Road Congestion and Public Transit	Martin Adler, Federica Liberini, Antonio Russo, Jos Van Ommeren (2020)
Rush Hours and Urbanization	Tobias Seidel, Jan Wickerath (2019)
Should we move public sector jobs out of London	Nathan, Overmann (2017)

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Skills in the City	Bacolod (2009)
Smart cities and attracting knowledge workers: Which cities attract highly-educated workers in the 21st century?	Betz, Partridge, Fallah (2015)
Spillover Effects from New Housing Suppl	Pampillon (2019)
Tales of the City: What Do Agglomeration Cases Tell Us About Agglomeration in General?	Giulia Faggio, Olmo Silva, William Strange (2020)
The attenuation of human capital spillovers	Rosenthal, Strange (2008)
The Economic Impacts of Help to Buy	Felipe Carozzi, Christian Hilber, Xiaolun Yu (2019)
The Effects of Cluster Policy on Innovation	Nesta (2012)
The effects of R&D tax incentives and their role in the innovation policy mix	OECD (2020)
The Geography of Social Connectedness and Knowledge Flows in the United States: New Evidence from Patent Citations	Andreas Diemer, Tanner Regan, (2020)
The Geography of Unconventional Innovation	Berkes (2021)
The impact of buseinss accelerators and incubators in the UK	NESTA, 2019
The Impact of buseinss accelerators and incubators in the UK	BEIS (2019)
The Impact of Commuter Market Access on a City's Structural Density: Evidence from a Substantial Investment in Transport Infrastructure	Kenzo Asahi, Andrea Herrera, Hugo E. Silva (2021)
The impact of enterprise zone tax incentives on local property markets in England: who actually benefits?	Bond, Gardiner and Taylor (2012)
The location of human capital accumulation – Learning by working in large regions or in large firms?	Peters (2020)
The Marginal External Costs of Street Parking, Optimal Pricing and Supply: Evidence from Melbourne	Ommeren, McIvor (2018)
The Role of Demand in Land Re-Development Felipe Carozzi	Carozzi (2018)
The Shadow Cost of Parking Minimums: Evidence from Los Angeles County	Sofia Franco, Bowman CutterSkyler Lewis (2020)
Toolkit: Business Advice: incubators	What works centre
University decentralization as regional policy: the Swedish experiment	Andersoon et al (2004)
University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry?	Mendley (2007)

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Urban Agglomeration and Firm Innovation: Evidence from Asia	Liming Chen (2021), Asian Development Bank
Urban Agglomeration and Firm innovation: Evidence from developing Asia	Chen, Hasan, Yang (2020)
Why do cities pay more? An empirical examination of some competing theories of the urban wage premium	Yankow (2006)
Youth Drain, Entrepreneurship and Innovation	Massimo Anelli, Gaetano Basso, Giuseppe Ippedico, Giovanni PERI (2019)
Youth Drain, Entrepreneurship and Innovation	Massimo Anelli, Gaetano Basso, Giuseppe Ippedico, Giovanni PERI, (2019)
Zoning and the Density of Urban Development	Delventhal, Kwal, (2020)