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Public innovation intermediaries and digital co-creation

by

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Executive Summary

The emerging digital technologies pose new challenges to innovation intermediaries. In this paper we build on a case base of evidence on selected public intermediaries in France (pôles de compétitivité) and in the UK (digital catapults), to argue that public innovation intermediaries, which carry public policy mandates, have a specific role to play, particularly in the context on the emerging, complex, and yet not fully commoditised set of technologies underpinning the ‘fourth industrial revolution’. In particular, we reveal that by connecting a plurality of actors on the demand and supply side, public innovation intermediaries facilitate co-creation of complex technological solutions, and that in doing so, they create both social and economic value. The goals of examined co-creation activities revolve around finding highly innovative solutions to complex problems triggered by the digital transformation. The co-creation initiatives that we study take place at the national level, but their outputs have broader impact on the activities of the parties involved.

Our evidence suggests that, when co-creating a complex technological solution, the intermediary is involved in two complementary, often intertwined, but distinct processes that bring together organisations that demand technology and those that supply technological solutions. On the demand side, the intermediary helps the organisation looking for a technological solution (a large company, an SME, or a municipality) to articulate their demand, and eventually find it as well. We call this ‘demand-led’ co-creation. On the supply side, the intermediary brings together a system of technology providers (large companies, SMEs, universities and public research organisations) able to devise, develop and implement a technological solution to match

the needs of the organisation on the demand side. We call this ‘supply-led’ co-creation. The intermediary is present from the beginning to the end of the co-creation processes, with its activities extending beyond co-creation processes to ensure post-project continuity between the involved actors.

Among demand-led co-creation processes, we identified at least two different approaches devised by Catapults and Pôles de compétitivité - the development of an open challenge, and the development of a proof-of concept. On the supply side, we noted the creation of the so-called ‘groupement’ of SMEs by pôles de compétitivité, whereby the pôle facilitates the creation of a value-chain that is able to respond to complex demands of organisations looking for technological solutions.

Our study shows that public intermediaries are able to play their unique role in co-creation processes thanks to several factors: the legitimacy they have to act as intermediaries, as they are endowed with public mandates; the presence of long-term public funding that enables intermediaries to be perceived as neutral agents, to gain reputation and trust over time; the networks of trusted experts on whom they can rely to successfully complete their mission; a well functioning evaluation process that spurs intermediaries to act effectively and efficiently and to be responsive to demands from their stakeholders.

Keywords: Innovation intermediaries; digital technology; Internet of Things; Fourth Industrial Revolution; emerging technology

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1. Introduction

The ‘fourth industrial revolution’ uses the power of digitalisation to connect people and objects globally (Schwab, 2016). The so-called Industry 4.0 technologies, such as robotics, 3D printing and Internet of Things (IoT) are reshaping production processes and the associated value chains (McKinsey, 2013; World Economic Forum, 2016). Whilst digitalisation, by enabling global connectedness, generates new opportunities (new markets, new products and services, new and more efficient processes), these opportunities can be adequately exploited only by those companies that are able to redesign their activities in order to align with the new paradigm. Moreover, reshaping company operations by introducing digital technologies is a radical change that requires not only a set of specific resources and competencies but also organisational flexibility and readiness for change. Different companies might encounter different challenges in adapting to the new technological paradigm. For example, smaller firms might lack the required resources, larger firms might lack flexibility (Mittal et al., 2018; Müller et al., 2018; Horváth et al., 2019).

Innovation intermediaries can play an important role in helping companies to address the challenges brought about by the digital transformation. They can help companies to adopt and integrate new technological and organisational systems and processes, foster collaborations among SMEs and between SMEs and large companies, and unveil market opportunities (Lee et al., 2010; Russo et al., 2018; Weking et al., 2018). However, despite the growing interest in innovation intermediaries and the growing awareness of the need to support companies in the process of digital transformation, little research exists on the different roles played by different types of innovation intermediaries, and, in particular, on the specific role of *public* or *publicly-funded* innovation intermediaries in this context.

This is significant because, given the rapidly changing context that characterises the ‘fourth industrial revolution’, what we know about intermediaries from even a few years ago might no longer be current. Public innovation intermediaries like technopoles, technology transfer agencies and technology and innovation centres, have needed to adapt in order to be able to provide services relative to the digital transformation. Additionally, new types of intermediaries are emerging, in particular within the private sector, placing additional pressure on public intermediaries to evolve in order to remain effective and preserve a rationale for their position within the innovation ecosystem.

In this paper, we discuss the specificities of the role of public innovation intermediaries in supporting the digital transformation. We build on a base of evidence composed of extensive interviews with selected public intermediaries in France and in the UK, innovation experts and companies, carried out between 2018 and 2019, to argue that public intermediaries, which carry public policy mandates, have a specific role to play, particularly in the context of the emerging, complex and yet not fully commoditised set of technologies underpinning the ‘fourth industrial revolution’. We

argue in particular that, by connecting a plurality of actors on the ‘demand’ and ‘supply’ side, they are able to facilitate the co-creation of complex technological solutions, and that in doing so they create social as well as economic value. We illustrate these co-creation processes with examples drawn from the activities of Pôles de Compétitivité in France and Technology Catapults in the UK.

2. Innovation intermediaries and the ‘fourth industrial revolution’

Although intermediation is not a recent phenomenon in the context of innovation processes (Brusco, 1992), the interest in innovation intermediaries has gained momentum in the last two decades, as policymakers have increasingly invested resources in creating these organisations. The creation of innovation intermediaries through policy interventions builds on the notion that innovation is an open, distributed activity (Chesbrough and Bogers, 2014; Coombs et al., 2003), uncertain, complex and collaborative in nature (Howells, 1999; Lane and Maxfield, 2005), necessitating the participation of different players each of which undertakes specific parts of the innovation process. In this complex system perspective, there is a need for individuals or organisations that connect the many actors - such as companies, research institutions, scientists, government - participating in innovation networks and systems (Pollock and Williams, 2016).

Various attempts have been made to categorise the activities of intermediaries, although there is no established consensus around any one classification. Moreover, scholars agree that these activities and roles change and evolve over time due to a myriad of factors, internal and external, and due to the evolution of the innovation system itself (Kilelu et al., 2011; Russo et al., 2018; Kivimaa et al., 2019a).

Nonetheless, the existing literature highlights some patterns in relation to innovation intermediaries’ activities. First, interorganisational networking is a crucial task of intermediaries. This activity is about creating and supporting networks, by building linkages with external knowledge providers and supporting knowledge flows (Bessant and Rush, 1995; Klerkx and Leeuwis, 2009), providing information and advice, diffusing information and best practices (Colovic and Lamotte, 2014), scanning and locating new sources of knowledge (Bessant and Rush, 1995; Howells, 2006). Second, most intermediaries use their expertise to provide knowledge-intensive services to other organisations in their network, particularly companies. These services include: providing access to expertise (Howells, 2006), testing new technologies (McEvily and Zaheer, 1999), adapting technologies (Mazzoleni and Nelson, 2007), articulating and selecting technology options (Bessant and Rush, 1995), developing and implementing business and innovation strategies, intellectual property management, as well as technology foresight and diagnostics, accreditation, validation and regulation, commercialisation, evaluation of outcomes (Howells, 2006). Third, intermediaries also engage in other activities less directly connected with innovation management, such as providing physical space (as is the case for incubators and science parks; Phan et al., 2005), undertaking training

(McEvily and Zaheer, 1999) or marketing and sales activities (Bessant and Rush, 1995). Some intermediaries are also supposed to play a relevant role in sustainable transition processes (van Lente et al., 2003; Kivimaa et al., 2019a, 2019b).

The emerging digital technologies underpinning the ‘fourth industrial revolution’ pose new challenges to innovation intermediaries. With the convergence of complex technologies and the emergence of related new industries, a new ‘innovation space’ emerges, characterised by complex, open, multi-level and multi-party innovation processes (Park, 2018). Because of the need for a panoply of competences and skills when connecting products and objects to the Internet and establishing connections between objects, innovation within this domain is highly collaborative (Leminen et al., 2015; Kim et al., 2016), more so than in the case of non-connected products (Southin and Warrian, 2017). In this emerging scenario, intermediaries need to evolve from their more traditional networking role (brokering between demand and supply of established products or services, facilitating networking and communication between different actors) towards the important and more demanding role of co-creators of complex technological solutions involving many different organisations, each contributing only to one part of the technological system. The innovation intermediary is involved from the start in a co-creation project, developing the vision of the project, identifying the participants and holding together the different layers of relationships (Lee et al., 2010). In this paper we adopt a broad perspective to the concept of co-creation, understanding it as a process in which the resources, competencies and capabilities of two or more actors are combined to create an output that provides a solution to a specific technological challenge or that has an innovative technological dimension.

When co-creating a complex technological solution, the intermediary is involved in two complementary, often intertwined, but distinct processes that bring together organisations that ‘demand’ technology, on the one side, with organisations that ‘supply’ (full or, more often, partial) technological solutions, on the other side:

- (i) On the ‘demand’ side, the intermediary helps the organisation that is looking for a technological solution (which could be a large company, a SME, or another actor like a municipality) to articulate their demand for such solution, and eventually to find it as well (we call this ‘demand-led’ co-creation process).
- (ii) On the ‘supply’ side, the intermediary brings together a system of technology providers (large companies, SMEs, universities and public research organisations) able to devise, develop and implement a technological solution which responds to a client’s needs (we call this ‘supply-led’ co-creation).

The intermediary can be involved in either one of these processes, or more often in both at the same time. There is a critical role that intermediaries play in these co-creation processes, which we

have termed as demand-led and supply-led: it is the creation of a demand and of a supply. The presence of agents that could potentially contribute on both sides, but which have no specific ability to express a demand or to coordinate a supply, is exactly the reason why intermediaries are needed.

Intermediaries performing these roles do not necessarily have to be public or publicly-funded. In fact, an increasing number of private companies are positioning themselves as ‘system integrators’ in the provision of complex technological solutions (European Commission, 2019). Those companies bring together component subsystems into a whole, and ensure that everything functions well together. Our interviews with sector experts suggest that the companies acting as system integrators of complex digital technological solutions are of several kinds. Some are large companies that provide an important component of the architecture of the technology, and which bring together and coordinate a network of suppliers so as to be able to provide the client with a complete, off-the-shelf solution. For example, software platforms providers coordinate networks of more specialised software and hardware providers, in order to present client companies with a complete solution to automate a production process. Another example are telecommunication companies that, again thanks to their reliance on a network of partners, complement their offer of network connectivity with additional services like data collection, monitoring and analytics. Other actors that play the role of system integrators are consulting companies, which rely on their expertise of business processes and knowledge of technologies to bring together networks of suppliers to deliver technological solutions to their clients, for example in order to automate production or service delivery processes. Increasingly, companies that produce goods for final users also attempt to move up the value chain by coordinating the activities of other suppliers in order to augment their goods with highly valuable services in a variety of sectors, e.g. providing farmers with data collection and analytics services that allow them to optimise their use of seeds and fertilisers based on real time data about weather and environmental conditions in their fields; or providing their client companies with real time monitoring of their tools to allow prompt maintenance and replacement without disrupting production.

In this crowded landscape, one might wonder whether there is any need at all for public innovation intermediaries. Building on a unique base of qualitative evidence, we have singled out the specificities of public innovation intermediaries that allow them to play a unique role in the co-creation of complex technological solutions, assigned to them by the public policy mandates.

3. Evidence base

Our evidence base consists of interviews with 20 technology experts, policymakers and public innovation intermediaries (Pôles de Compétitivité and Technology Catapults) in France and the UK (listed in Table 1) carried out in 2018 and 2019, together with secondary sources (information from websites, promotional and grey literature provided by the interviewees). The interviews were recorded (altogether we have more than 20 hours of recorded material), transcribed, and analysed with the help

of content analysis software (Atlas.ti), in order to identify patterns addressing our research question (the materials were coded separately by three different coders and the codes were then integrated and reconciled by a fourth researcher). The analysis was complemented with the reading of relevant secondary sources.

Table 1. Evidence base. Interviews conducted between June 2018 and November 2019

ID	Position	Organisation	Type	Country
1	Manufacturing lead in business development	Technology Catapult	Intermediary	UK
2	Senior Innovation Programme Lead	Technology Catapult	Intermediary	UK
3	Communications Director	Technology Catapult	Intermediary	UK
4	Délégué Adjoint	Pôle de Compétitivité	Intermediary	France
5	Responsable Communauté EdTech & Transformation du travail	Pôle de Compétitivité	Intermediary	France
6	Directeur Développement des Entreprises et des Territoires	Pôle de Compétitivité	Intermediary	France
7	Director	Institut Carnot Curie	Intermediary	France
8	Economics, performance and strategy lead	National innovation agency	Policymaker	UK
9	Evaluation Specialist	National innovation agency	Policymaker	UK
10	Relationship Manager	National innovation agency	Policymaker	UK
11	Lead on Investment Analysis, International Science and Innovation Directorate	Ministry	Policymaker	UK
12	Chargé de mission	Ministry	Policymaker	France
13	Owner	Private consultancy	Technology expert	UK
14	Professor	Engineering school member of Pôle de Compétitivité	Technology expert	France
15	R&D Manager	Company member of Pôle de Compétitivité	Technology expert	France
16	Associate professor	Business School	Innovation policy expert	France
17	Professor	Business School	Innovation policy expert	UK
18	Director	Policy think tank	Innovation policy expert	UK
19	Consultant, former head of regional incubator	Consulting firm	Innovation policy expert	France
20	Chargé de mission	Regional development agency	Innovation policy expert	France

Both Pôles de Compétitivité and Technology Catapults are examples of public innovation intermediaries. They are both given public funding for periods of several years. In particular, the Pôles were initially funded by the central government which, through its departments and agencies, provided funding to run the Pôles' operations. It also provided specific funding for innovation projects that were created and endorsed (labeled) by the Pôles. Over time, regions and regional-level public actors have become increasingly involved. They have participated in the strategic orientation of the Pôles, the determination of their priorities, design of their activities etc. Moreover, they have started to fund the Pôles directly, in particular their operations. Nowadays, for most of the Pôles, the national funding

covers about only one fourth or one third of Pôles' operation costs, while regional agencies are the biggest funding source. There is also some funding received through the Pôles membership model and through the provision of some services to Pôles members.

The creation of the Catapults was fully funded by the UK's national innovation agency Innovate UK. Over time, the share of public funding has been reduced and currently covers only part of Catapult's activities: they do receive some public money from Innovate UK, but they also have to work competitively with businesses. The Catapults' funding model is based on three complementary sources (in thirds). They get a third of their funding from Innovate UK; another third must come from industry and the final third must come from their participation in collaborative research and development (e.g. funds from international or national funders). Several interviewees mentioned that, while this is the funding model the Catapults should aspire to, few of them manage to attain it, and several Catapults in practice receive more than a third of their funds from public sources.

4. The role of public intermediaries

Public innovation intermediaries that co-create complex digital technologies have a number of specificities. These specificities manifest in relation to both supporting the articulation of the demand on the part of the organisation that is looking for a technological solution, and to coordinating the provision of the technological solution.

In relation to the first key co-creation role of innovation intermediaries – helping an organisation that is looking for a technological solution to articulate their demand, and find the appropriate solution ('demand-led' co-creation) - one important specificity of public innovation intermediaries is that they are agnostic with respect to different technologies (and they are seen as such by the organisations they work with). That is, unlike many private companies that act as intermediaries, public innovation intermediaries are not wedded to a particular technological solution or product around which they want to build their system, and which they have a strong motivation to 'sell'. Instead, they can offer different technological solutions depending on the need to solve a particular problem, without any particular 'constraints' around which the system should be built. This offers the organisation that is looking for a technological solution a greater variety of potential options, as well as the possibility to customise the technological solution around that organisation's needs to a greater extent that would be possible using a more 'off-the-shelf' offering. And this leaves many doors of technological innovation open to support the development of new and more effective technological solutions (Rosenberg, 1997). An example from one of the Technology Catapults we interviewed is the case of a gas company that needed a system to monitor the location of the gas canisters it distributed to clients; while most proposed solutions involved the installation of interconnected sensors to monitor the canisters' location, a very cost effective solution proposed was based on the development of a highly accurate probabilistic model that relied on the installation of only a small amount of physical technology. This

solution was proposed by statisticians, something that would not have emerged had the company worked with a commercial intermediary.

In principle, some private system integrators whose primary activity does not consist in the provision of parts of the technology's architecture or in the sale of specific products around which the technological solution is built - such as consulting companies - would be able to also offer solutions customised to their clients' needs and unwedded to specific technologies. In practice, however, these system integrators will seek to maximise efficiency by commoditising the technological offer as much as possible, and thus they will rely on standard configurations of suppliers in order to provide their systems, which reduces variety. Furthermore, because the activity needs to generate profits for the private consultant as well as for all the suppliers involved, many SMEs are priced out of these services.

Another related specific feature of public intermediaries is that by their very nature they have the mandate and ability to talk to a plurality of actors, public and private, rather than seek to fill specific market segments and specialise in those, as most private system integrators would do. Most intermediaries have a specific mandate to support SMEs and their competencies, and over time they have refined their ability to talk to these actors. Some intermediaries also have a regional development mandate, and as such are interested in supporting a broad array of projects that enhance the development of their region, including projects that do not have primarily commercial aims.

The independence of public intermediaries from specific technological offerings and their ability/mandate to engage with a plurality of actors are valuable in numerous contexts. By working with public intermediaries, SMEs that would not be able to afford the services of private system integrators (and which may not be considered a relevant market by the latter), can develop affordable systems built around their requirements. Large companies can also benefit from the variety and customisation of the technological solution. Some examples of activities through which intermediaries help a company to identify solutions are presented in Box 1. Furthermore, in the case of technological implementations that are designed to meet the requirements of a collectivity, such as smart mobility projects in municipalities, working with public intermediaries allows them to build systems with unique requirements, and to avoid depending on a single private system integrator for the design of the overall system, which might not be acceptable to local taxpayers. The public intermediary may also have an advantage over other intermediaries that do not have a public mandate, since it can more easily act as a resource integrator in co-creation projects that have a public interest. This can be illustrated by the case of a Smart Water Metering project for a small town, in France. The Municipality - the promoter of the project - wishing and having to avoid the expensive proprietary solutions proposed by the global players operating in the sector, turned to a local public innovation intermediary. The latter, which was connected to the local university, promoted the formation of a

small local ecosystem that involved the university and a local IT company. The collaboration between these agents has allowed the creation of a local ecosystem that is sustainable in several ways.

In relation to the second key co-creation role of innovation intermediaries – helping to co-creating a technological solution by coordinating the activities of many suppliers (‘supply-led’ co-creation) - public intermediaries are particularly helpful in coordinating the activities of highly specialised SMEs operating in digital technologies. These companies are flexible, innovative, and do not suffer from the burden of heavy, hierarchical organisational structures. However, due to their small size, specific competences and limited resources, these companies usually do not have the capacity to provide complete solutions. They therefore need to either become partners of a large company’s network and work within the constraints of the latter’s technological platform, or join forces with other SMEs that design and develop complementary technological solutions. Joining forces not only gives them greater independence but it allows them to scale up, to increase the value of their technological solution and to further develop their competencies through collective actions within their ecosystems. An example of how the activity of the public intermediary benefits SMEs is the ‘groupement’ of SMEs described by one of the Pôles de Compétitivité (Box 2).

Moreover, public intermediaries can keep the configuration of the network of their suppliers open and flexible, which gives those SMEs the opportunity to collaborate with a wider variety of partners. Public intermediaries can do this more often than private system integrators because, while experimenting with new partnerships and solutions can be expensive (e.g. it can generate high transaction costs), they are provided with public resources specifically to perform their networking function. Therefore, over time: they tend to have developed vast networks of contacts (including companies and individual experts in business, government and academia); they have in-depth knowledge of the competences of various actors in their region (often having worked with local companies and performed technology assessment exercises for them); they have a good understanding of the position of specific regions and industries in a broader industry landscape, and have contacts and working relationships with counterparts in other countries, opening up opportunities for cooperation internationally (Colovic, 2019). In this sense, they create public goods that benefit all the SMEs entering in the ecosystem.

Alongside the benefits for the clients and suppliers of the technological solution, the co-creation activities of public intermediaries can generate broader social value.

First, in supporting SMEs that would normally be priced out the implementation of sophisticated one-off technological projects, public intermediaries play an important role in supporting technological diffusion to a broader range of adopters, particularly in the early stage of technological development where commoditised solutions are available only to a limited extent. Hence, they can

contribute to speeding up early stage technology diffusion, broadening the range of early adopters, and strengthening the transition to the new technological paradigm.

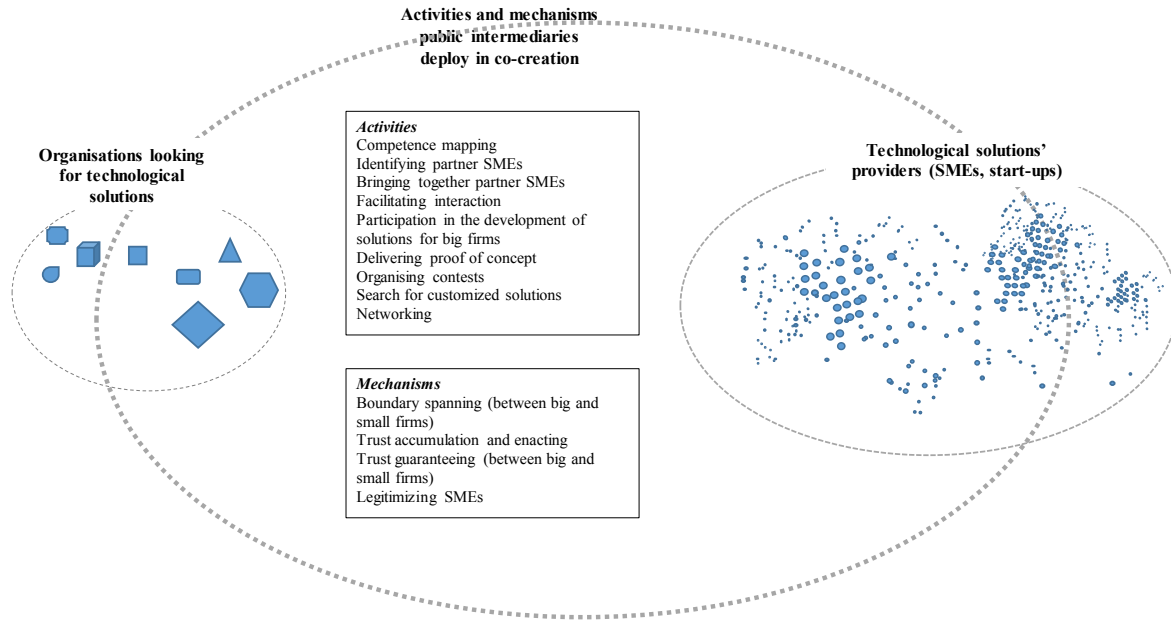
Second, not being wedded to a pre-existing technology, intermediaries can allow the emergence of ecosystems around non-standard, often more frontier technological solution. This is valuable in the context of emerging technologies where it is desirable not to close technological opportunities too early around a small set of proprietary technologies, but allow variety to continue over time (Shapiro and Varian, 2009).

Third, by identifying practical and real challenges for companies to work on, and by allowing companies to prototype new solutions, intermediaries can accelerate the general process of innovation around the emerging technology, and create the groundwork for further innovations down the line.

Figure 1 outlines the activities and mechanisms that public intermediaries deploy to perform their role in spurring and facilitating co-creation.

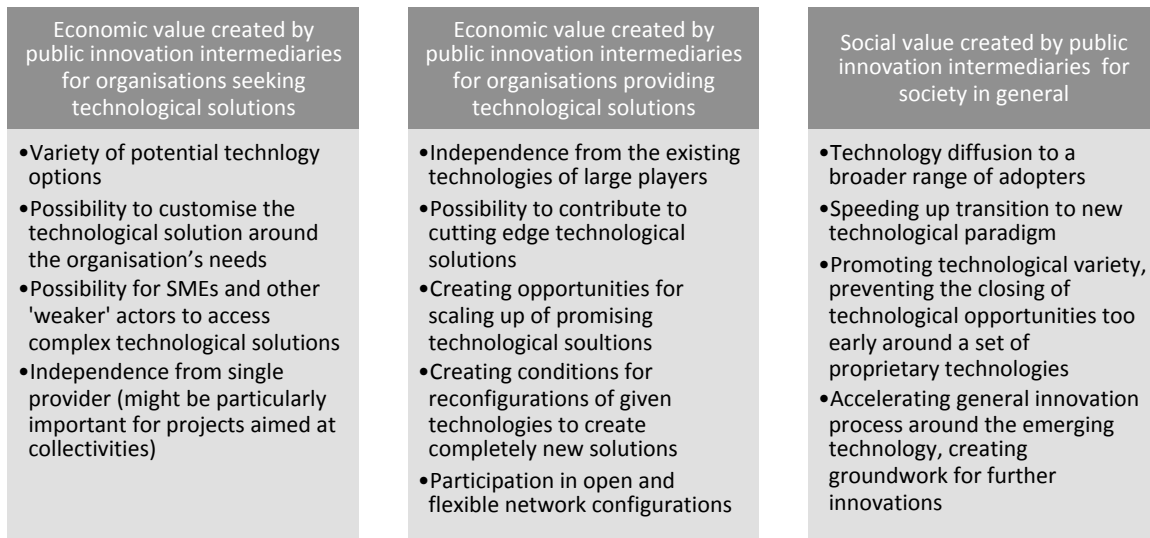
Figure 2 summarises the economic and social value created by public innovation intermediaries through digital technology co-creation processes

Figure 1. Public intermediaries' activities and mechanisms involving in co-creation organisations looking for technological solutions and potential providers of solutions



Source: authors' elaboration

Figure 2. Economic and social value created by public innovation intermediaries' digital technology co-creation processes



Source: authors' elaboration

Box 1. 'Demand-led' co-creation approaches

Several public intermediaries we interviewed described various approaches to co-creating complex technological solutions to solve the needs of business. One of these co-creation approaches is the development of an open challenge. One of the Catapults we interviewed described the process as follows. First, the Catapult staff try to understand what the organisation's specific need is and in what context it has emerged. Once the problem has been articulated in form of a challenge (by generalising the problem and (sometimes) making the bearer of this problem as anonymous as possible), an open call is issued to the Catapult's network.

"An example of this (...) is from a company called X (...) They basically came to us with this challenge saying, 'Can you help us?' We go through a process which we call a pit stop, which is this open innovation methodology, which basically goes into a deep dive on what the actual challenge is. Who are the customers? Who are the stakeholders? What is the data available? What is the state of the data? Really trying to uncover it. Then we bring that up a number of levels and put it into an open call which we send out to our network of tech start-ups and scale-ups. We have about 12,000 companies in our network and we've worked directly with about 2,500 of those. We basically say, 'If you've got any ideas, bring them in.'" (Interviewee 2)

In the second stage, the best solutions are selected together with the customer and then the process goes on with this subgroup. The problem is better defined and, again, there is a challenge to find a solution.

"We basically get all the applications in, we interview all the companies on there, do a bit of research, and figure out which we think are the best ideas and proposals to take back to X in this case. Then we run a workshop over a couple of days with, not just the tech companies that have been down selected, but people from academia, people from across other industries who've done things differently, with the actual customers of the client as well, and we get everybody into a room and follow this pit stop methodology that

we've developed to try and come up with new ways of solving that challenge. At the end of it, the companies that have been through the session are invited to present proposals back."

(Interviewee 2)

This type of service is mainly conceived for large firms that are aware of their needs. These companies may want to look for a solution to be applied internally, or they may want to streamline their internal organisation and then look for external partners.

Another example of open innovation challenge comes from one of the Pôles de Compétitivité. The Pôle organised an innovation challenge for a large player in the airplane engine manufacturing sector, around five areas: Materials and processes, Systems and Sensors, Industry 4.0, Services and Pods of the future. Five SMEs, members of the Pôle were selected to provide solutions to the client company in these areas. Another open innovation challenge was organised for a large automotive company. Thirty SMEs were selected by the Pôle to participate in the challenge. Company experts evaluated the 30 SMEs pre-selected by the Pôle and from these they selected

A slightly different co-creation approach is the development of an actual proof-of-concept project. To do this, the Catapult can rely on its internal experts in technology, but it may also activate its network of contacts to find all the competencies that are needed to do the job.

"We've developed a number of different sprint methodologies that we can actually take some of these ideas through and go ahead and do the development work ourselves. An example of this would be what we did with [organisation Y], for example. They had a fairly well-defined challenge in that they wanted to understand the health and location of high-value assets in remote, hazardous locations. We went and deployed a private LPWAN network for them. We found some sensors that are about this big and they cost about £20. In the field they last for about five years in terms of battery life. You can sense where the asset is from between 5 to 10 kilometres away depending on how rural the

environment is. You can sense temperature, humidity, whether it's been dropped or not. We built them a dashboard to prove that concept. We tested it under a bunker under six metres of concrete. Then we demonstrated that at [a trade fair] and [organisation W] found out about what we were doing and so we went and deployed it with them, and [organisation Z] are interested in

us doing some things. [...] As part of that work [...] we go and find companies – a sensor provider here and another one who can do a gateway and another one who can do dashboards – to bring together an overall solution. We're starting to do this more and more in AI and machine learning as well.” (Interviewee 1)

Box 2. 'Supply-led' co-creation approaches

One of the Pôles we interviewed spurs and accompanies SMEs in the creation of the so-called “groupement” of SMEs to create a business strategy that will generate additional business for each of the SMEs involved. An example is a groupement of technology providers in the area of systems of driving assistance, which involves 10 SMEs. In addition to creating the groupement, the Pôle has put it in contact with the clients. According to the Director of operations of one of the groupement members, the Pôle's help was instrumental to create trust-based relationships with the clients. He adds that it is unusual for large industrial firms in the automotive sector to work with an SME groupement on very sensitive topics, such as driving assistance solutions. That is why the “*[the Pôle's] brand and the operational support of the Pôle were crucial to support the legitimacy of our value proposition. The Pôle has also played an important cohesion role to maintain the collective dynamics and the pursuing of our common objectives*” (Mov'eo success stories, 2018 edition). The involvement of a member of the Pôle's management team, in the coordination of the work of the groupement and the communications with the clients, was particularly appreciated by the groupement. An example of a project on which the groupement is currently working is a technical study relative to Adaptive Cruise Control for a large automotive group. The groupement has developed a solution aiming to identify with certainty an immobile vehicle, without the risk of confusing it with the surrounding infrastructure. The groupement has joined forces with academics to respond to the specific demands of the client company; it has made prototypes, integrating algorithms and validation means. Following the technical study, the client company was able to launch the

implementation of one of the proposed functions. The groupement and the company are currently working on other projects together. According to the General Director of one of the SMEs that are part of the groupement, the advantage that they derive from being part of the groupement is that they can share contacts and build interfaces between the technologies of each member, so as to be able to provide more complete and integrated solutions, with an increased visibility. The groupement was for example able to provide a complete automatisable vehicle (an open platform for the development of an autonomous vehicle) to a client, which would not have been possible for each of the SMEs individually.

“[The Pôle] is a privileged partner that accompanies us, the SMEs, in numerous topics. Because of its sectoral specificity and its knowledge of the market, the Pôle is a particularly efficient generator of contacts. It has a complete vision of the value chain, and also of the support and assistance available” (Mov'eo success stories, 2018 edition).

Another groupement promoted by the same Pôle brings together five SMEs, all located in the region of Normandy. The Pôle has instigated and supported the establishment of this groupement, with the aim to propose concrete and rapid responses to the needs of large industrial firms, involved in the digitalisation of their production sites. At the end of 2016, the five members of the groupement have decided to create a legal entity. By joining forces, the five founding members of the groupement are able to propose a value chain to large firms, which is capable of generating technologies and new usages for the “Factory of the future”. The groupement offers expertise in the areas such as man-machine interface, Internet of Things, planning and supply chain software,

design of the workspace, acquisition and processing of signals and of images. From the outset, an important player in the automotive industry has been interested in the groupement's solutions. This company has procured several solutions from the groupement, such as a new design of the workspace, real-time production control and optimisation solutions, an alert tool in case of over-consumption of tools or maintenance. This collaboration is ongoing, and the automotive client has been recently awarded the European Digital Award for the digitalisation

of one of its factories. Other factories of the same client, including some located abroad, will deploy digital solutions designed by the groupement. The groupement has also been working for other large industrial firms. It has won the call for projects relative to the digital transformation of the industry, and is working on two sites of a very large automotive company. It also works for a large household goods company in areas such as location of packaging and modelisation of flows.

5. What allows public intermediaries to play their unique role?

According to the evidence we have collected, there are a number of features of public innovation intermediaries – which relate to their public nature and funding – that allow them to play their specific role in the co-creation of complex technological solutions.

First, they have the legitimacy to act as intermediaries, because they have been mandated to do so by a public agency endowed with authority. Thanks to their public mandate, and to the fact that they receive public funding to perform their activities, they are regarded as neutral, impartial actors that respect and protect the interests of all involved parties. For example, the Pôles de Compétitivité have been mandated by the public policy to enhance the competitiveness of territories in specific technologies, with a specific focus on technologies of the future. They have to ensure that all actors' interests are respected, and that the intellectual property of the weakest actors in the Pôles (in particular SMEs) is protected. The Catapults also have a mandate to support the competitiveness of the UK economy.

Second, public funding can facilitate the survival of public intermediaries for a long time, even in difficult economic times. This can enable intermediaries to gain reputation and trust over time. For example, putting together complex R&D projects that involve the mobilisation of high skills and specific technological competencies and leading the projects to obtaining funding and accompanying their evolution, has allowed the Pôles de Compétitivité to gain the trust of actors involved in these projects. The Pôles de Compétitivité have also gained the trust of SMEs by assisting them to find innovation and business opportunities and by promoting their competencies within the region and beyond. Their management teams are considered as knowledgeable, reliable partners, who strive to find the best solutions to a variety of challenges the companies face in their operations.

Third, as mentioned previously, over time, through their operations, intermediaries can build networks of trusted experts, on whom they can rely to successfully complete their intermediation mission. They have gained a good understanding of competencies in the relevant regions and sectors, and are able to mobilise the competences of various actors for the purpose of specific projects or to

respond to specific needs. They establish contacts and working relationships with counterparts in other countries, opening up opportunities for cooperation internationally.

Finally, an important element that allows the public intermediaries to operate successfully is a well functioning evaluation process that spurs them to act effectively and efficiently and to be responsive to demands from their stakeholders. The intermediaries we analysed undergo rigorous evaluation processes that can lead the government to renew their commitment to fund the intermediary, or to undertake some other action aimed at improving the intermediary's effectiveness. If the performance of the intermediary is not satisfactory (measured against targets and objectives, sometimes, as in the case of the Technology Catapults programme, defined together with the intermediary itself), the intermediary is given the opportunity to turn around their performance in a relatively short time (a year or two). If that fails, intermediaries can be terminated or merged with other intermediaries. In France, Pôles are also evaluated against their targets and objectives in different domains such as: facilitating R&D projects, funding obtained by the projects labeled by the Pôle, assistance to SMEs, international relationships, network membership, organisation of events and others. The most recent evaluation of Pôles, conducted end of 2018-beginning of 2019, has resulted in the termination of certain Pôles, so that currently 56 competitiveness Pôles, as compared with 71 initially in 2005, are supported by the national government. In the UK, two Catapults have merged, while a new one has been launched.

6. Further issues and research

Our analysis has shown that public innovation intermediaries' policy mandate and the long term horizon of their operations, are crucial factors that enable them to play their unique role. These factors are necessary to establish their reputation and to acquire the relevant competences, both through a set of internal experts and through a network of competences distributed across many different organisations (SMEs, universities, research centers, large companies) that intermediaries bring together. A funding model that is not too rigid in relying on marketable activities and an effective evaluation process, are crucial to allow the public innovation intermediaries to fulfill new objectives and to perform new functions that emerge as technologies change and as ecosystems become more complex. In this perspective, innovation policy measures should allow for such dynamic evaluation processes, including the definition of targets for assessing both the intermediaries' short-medium term performance, and the medium term changes they have promoted in the ecosystem.

Further research should investigate a broader range of public innovation intermediaries active in supporting digitalisation processes, in order to shed light on how their characteristics, for example their size, and the type of evaluation processes implemented, matter for their performance. The way in which the broader policy context supports the activities of intermediaries, for example through complementary policies, should also be explored.

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