Actors of change for regional path creation: Roles and Characteristics. The case of IoT in Toulouse

Abstract

New path creation to diversify the regional economy is a fundamental process to achieve sustainable regional development. However, despite the fact that new pathways are not created by disembodied economic forces, the role of the actors involved in new development paths, the so-called actors of change, remains understudied. This paper contributes to fill this gap. It offers an analytical framework to characterize different processes of path creation depending on the features of the actors of change involved, and the roles they are playing. Then, it links these different processes to different types of new regional paths. We show that multiple configuration of the actors' type-role space give rise to different path creation processes, and not all of them are equally adapted to generate certain types of new regional paths. We empirically illustrate this with the case of Toulouse and the development of a new regional path around Internet of Things, a nascent technological domain.

Keywords: Actor of change, new regional path, path creation process, Internet of Things

1 Introduction

Explaining how regions diversify their economy and develop new growth paths is a topic that ranks high in the agenda of policy makers and regional scientists. Such an interest is grounded on two well documented results. First, the positive effects of (related) variety on innovation and growth thanks to inter-industry spillovers (Jacobs, 1969; Frenken et al., 2007). Second, the effects of diversification to avoid regional stagnation and decline since the development of new paths can provide the bases for future economic growth (Todtling and Trippl, 2004; Treado, 2010). This paper studies the role and features of actors involved in the process of regional path creation.

In the past decade, evolutionary economic geography has developed the concept of *regional branching* to explain how regions diversify thanks to the redeployment of capabilities and the existence of spillovers across cognitively close industries (Boschma and Frenken, 2011). Thus, existing regional capabilities, as an outcome of a long historical process (Maskell and Malmberg, 1999), define the set of possibilities for regional diversification, and *relatedness* is the underlying logic behind regional branching. These advances have been inspiring for policy makers who have quickly adopted them to design new strategies for regional development. The aim is to build competitive advantages in high value-added activities around existing place-based capabilities (Barca, 2009; Foray et al., 2011). The Smart Specialization strategy for R&D policy of the EU is a well-known example of that. However, blind spots still remain because relatedness is mostly underspecified (Tanner, 2014), because there is few geographical wisdom (Isaksen, 2015), and because there is a lack of micro-perspective on the role of actors creating and extending regional paths (Boschma, 2017). This paper builds on that last point. Since regions are composed by a multitude of actors with different characteristics and motivations, "new pathways are not created by disembodied economic forces but by knowledgeable agents" (Simmie, 2012, p.760). Who are the actors that introduce regional change and build the new path, the so-called *actors of change* (Garud and Karnøe, 2001)?

Path dependence literature is tightly related to this issue too. From this perspective, several studies have analyzed how particular types of actors may contribute to new path creation: Klepper (2002) focused on start-ups and diversifiers, Crescenzi et al. (2015) on multinationals, Grillitsch and Nilsson (2015) and Trippl et al. (2018) on non-local linkages or Dawley (2014) on public actors. Moreover, Isaksen and Trippl (2017) distinguish different "routes" for new path creation in organizationally thick and thin regions. Nevertheless, these studies tend to treat new paths as a uniform category. Moreover, by focusing on particular actors, they rarely look at how agency is distributed among heterogeneous actors.

Gertler and Vinodrai (2009), by looking at regional specialization in life science domains, have shown that there is a diversity of processes through which new paths may emerge. By studying the structure of agency distribution, we aim to gain better understanding of the relationship between the actors features and behavior (micro-level), and the regional diversification through path creation (macro-level). We argue that multiple articulations among heterogeneous actors are possible, and they may produce various types of new regional path depending on the specific configuration of the path creation process. To do so, actors of change are classified on the base of two criteria. First, a multi-factor classification

regarding the intrinsic features of actors, such as their organizational nature, their pre-entry experience or their spatial embeddedness. Second, the role they play in the path creation process, which is defined according to their moment of entry and their focus activity. On the base of these two criteria, different processes of path creation are identified depending on which types of actors are playing which types of roles. Then, we discuss how these different processes, i.e. different configurations of the actors' type-role space, may produce different outcomes, i.e. different types of new regional paths. We empirically illustrate this with the case of Toulouse and the development of a new regional path around the Internet of Things (IoT) technological domain.

The reminder of the paper is organized as follows. Section 2 discusses the different nature new regional paths may have. Section 3 presents the building blocks for the actors' type-role framework. It defines what are *actors of change*, discusses some of their intrinsic features, and classifies the roles these actors may play in the process of path creation. Section 4 builds the framework to analyze the multiple configurations of path creation processes and argues that all configurations are not equally adapted for each type of new regional path. Section 5 uses the framework to explain how a new path around the IoT technological domain has emerged in Toulouse. Section 6 concludes.

2 Path dependence and regional development paths

Regions are complex systems with multiple components (workers, firms, industries, networks, institutions...). Path dependence may concern the evolution of each of these components, part of them and the evolution of the system as a whole. Our focus is on regional *industrial* paths, so a path will refer to the evolution of a particular industry in a specific region. Regions often have several industrial paths, that might be related through direct input-output linkages, indirect interdependences and externalities. In such a context, each regional *industrial* path follows its own evolution, although it will be influenced by the dynamics of the other regional industrial paths.

Since the 90's, path dependence models (David, 1985; Arthur, 1994) have been widely used in economic geography. From this perspective, *historical accidents* influence later events thanks to various forms of increasing returns with a marked local dimension. However, those models omit explanations about path creation and path transformation (Martin, 2010), and become models of stability rather than change. Martin and Sunley (2006) propose a "path as process" approach to make change endogenous. According to it, first, new paths emergence is conditional to the pre-existing industrial, economic and institutional structures that constitute the regional environment. This environment is both, the product of accumulated legacies from old regional paths, and the base defining the set of opportunities and barriers for the development of new regional paths. Second, paths transformations are not spasmodic, they occur by transformation of micro-level components that contribute to gradually change the system.

Consequently, path dependence does not necessarily lead to lock-in and stability, because multiple alternative evolutions implying change and transformation of regional configuration are possible too. Analytically, the literature distinguishes four possible development paths for regional industries (Martin, 2010; Isaksen, 2015): path extension and path exhaustion,

associated with stability, and path renewal and path creation, associated with change.

We focus on path creation, it occurs when a new industrial activity emerges and develops in a region, i.e. the region diversifies. This implies an increase in the number of actors, employment and production of goods, services and technologies in this particular industry that was not present in the region before. Their arrival goes with larger transformations of the regional environment that enable the development and prosperity of this new regional industry. However, new regional paths are not a uniform category. According to Boschma et al. (2017), new regional industries can be characterized on the base of two criteria: relatedness and newness. Firstly, through time, regions cumulate bundles of resources, skills, infrastructures and capabilities that are adapted to the specific industries in which they are specialized (Lawson, 1999). When regions diversify, they should (re)build resources and capabilities that fit the new industry specifications. Relatedness enhances these shifts, it refers to the degree of proximity (similarity and complementarity) in terms of skills, resources and capabilities between the existing industries in the region and the requirements of the new one (Boschma, 2017). Numerous studies have shown that regions diversify more easily towards industries related to their existing bases (Neffke et al., 2011; Rigby, 2015). However, relatedness is neither necessary nor sufficient condition for new path creation. Although a rarer event, with an appropriate institutional setting (Boschma and Capone, 2015), regions may create unrelated paths, i.e. develop new industries that require specific capabilities very different to those existing in the region.

Secondly, the industrial arena is dynamic too. With time, new industries emerge and grow while others mature and renew or decline (Klepper, 1996). Therefore, we distinguish new regional paths by the industrial stage (Boschma et al., 2017). On the one hand, there are *new to the region paths* on already established industries or socio-technical regimes. In these existing industries, there are few new firm entries and exists tends to increase. Product solutions and business models are established, and so they are industrial standards and the regulatory framework. In this exploitation context, competition is mostly driven by prices and costs, so process innovations, production in large scale and barriers of entry become more important. On the other hand, there are *new to the world regional paths* on emerging industries which are still developed in niches. In emerging industries uncertainty is high, innovation and knowledge intensity are still the main competitive forces in order to define product features and solutions, production processes, business models and even user needs. Therefore, in this explorative stage there are numerous opportunities, lower entry barriers and higher entry rates (Simmie, 2012). Both criteria, relatedness and newness, can be combined to define four types of new regional paths:

Table 1 – New paths typology

	Related to regional bases	Unrelated to regional bases
New for the region	Replication	Transplantation
New for the world	Exaptation	Saltation

Source: Boschma et al. (2017)

3 Actors of change

3.1 Definition

In spite of the explicative value of relatedness arguments, the role of agents in regional path creation remains, with some exceptions, understudied (Sydow et al., 2010; Dawley, 2014; Dawley et al., 2015; Neffke et al., 2017). After the seminal paper of Garud and Karnøe (2001), the key actors involved in the creation of new paths that progressively transform the region are known as *actors of change*. According to Garud and Karnøe (2001), actors of change are knowledgeable agents that make mindful deviations from the existing paths. These are intentional actors that avoid myopic reproduction of existing rules and practices in order to explore and exploit new opportunities. To do so, they draw on and mobilize resources, competences and power in an attempt to transform the existing environment, overcome cognitive, institutional and technological barriers, and move towards a new path.

Creating a new path is a complex process because multiple components of the regional system are affected. Binz et al. (2016) identified knowledge, markets, financial investment and legitimacy as key resources for path creation, and defined the associated process for their generation. However, new path creation needs the co-evolution of all of them, otherwise the emerging industry will face significant development barriers and bottlenecks. To do so, none single actor has the capacity to influence and transform all parts of the system, create and adapt all key resources. Similarly, not all of them can influence the same regional components and resources. Therefore, path creation is a cumulative process involving multiple actors rather than an instantaneous event resulting from a single actor effort (Martin and Sunley, 2006). Thus, agency is distributed (Garud and Karnøe, 2003) conforming a complex constellation of interacting actors (Djelic and Quack, 2007). Actors of change may include inventors and innovators with new ideas (entrepreneurs), policy actors, informed customers and other stakeholders, i.e. they are not a uniform group. They differ by their intrinsic features and by the degree of involvement or their role in the path creation process.

3.2 Intrinsic features

The development of a new regional path implies that there is an increasing number of actors entering (producing and employing) and prospering on the new regional industry, as well as a set of new or existing actors surrounding them and enabling (or hampering) their action. All these actors may differ according to multiple characteristics. To explain path creation processes, we focus on their organizational form and mission, their core of activities defined by their capabilities, their past experiences and their geographical embeddedness.

First, actors of change differ in their organizational form (private, public, non-profit) and mission, i.e. the nature of goals they seek and accept as legitimate (Dasgupta and David, 1994). Thus, although they may all mindfully deviate from existing regional paths, the motivation or purpose behind these deviations might be different (Miörner and Trippl, 2017), and so will be their influence in the path creation process. Some actors, such as private firms, deviate in order to explore and exploit new industrial or technological opportunities that strengthen their competitive and market position, and increases their profit (Garud and Karnøe, 2001). To this end, their decisions may contribute to transform the regional

environment and the development of the new regional paths, but the path development in itself is not their main motivation. It is a side result of their action that may be necessary or have positive impacts on their own activity. Nevertheless, public actors, either the policy subsystem or Public Research Organizations (PROs), have different objectives, system of rewards, channels of diffusion and sources of power to rely on. The firsts seek regional development (employment, growth...) rather than private profit, and path creation might be a valuable strategy for that. Then, the policy subsystem may act as process facilitators by enabling the decisions/actions of those producing and employing in the new regional industry. The scope of action can be very large (Dawley et al., 2015) including horizontal measures (infrastructures, regulatory frameworks, markets, R&D, entrepreneurship support) and sector-based vertical policies, both at different geographical scales. Concerning PROs, they may deviate from existing paths motivated by the scientific potential or societal relevance of the field. Their motivations are neither path creation, nor profit maximization, although while seeking their missions of generation and diffusion of knowledge, PROs may contribute to path creation by generating specific skills and new firms. Finally, non-profit organizations may act as actors of change too. These are industrial associations, civic associations or standardization agencies among others that aim to enhance information and knowledge exchange, coordination, or lobbing and representation for their affiliate actors rather than profit maximization for themselves. Thus, they mostly contribute to transform the supportive environment to favor path creation. For some of them, like clusters associations, the development of the new regional path is the main goal. For others, like standardization agencies, it is a side result of their action.

Second, the evolutionary theory of the firm argues that organizations accumulate knowledge, resources and routines over time thanks to learning processes (Nelson and Winter, 1982). However, actors only master a limited set of knowledge, resources and routines (Nooteboom, 2000), so they cannot do everything. Consequently, actors, and actors of change, specialize in a limited set of activities in which they have a competitive advantage founded on the specificity and uniqueness of their capabilities and rely on other actors to get inputs and complementary services. Some actors chose to specialize in a reduced number of activities while others have more diversified portfolio. This diversification may concern either several activities along a unique industrial value chain, or the same activities applied to several industrial value chains. The emergence of a new industrial path in a region needs to involve a variety of actors that specialize in different but complementary activities along the industrial value chain, as well as in supportive activities related to them. Thus, the specificity of competences and specialization of each actor will characterize its participation in the path creation process. We will come back to this in the next subsection.

Third, actors of change involved in path creation may also differ by their pre-entry background, i.e. past industrial activity, that conditions the success of their entry. Competences and routines are built over time and difficult to transfer (Nelson and Winter, 1982), so actors with greater similarity between their pre-entry competences, and the new industry requirements will have more chances to succeed in the entry, prosper and survive longer, while those with lower fitness are more likely to fail and exit (Klepper, 2002; Agarwal et al., 2004). Thus, pre-entry experiences of actors of change influence their survival and growth, and so the probability of creating and consolidating a new industrial path in a region. We follow Klepper (2002) to categorize actors of change by their pre-entry industrial

background. On the one hand, they might be established firms of three types. First, those already active in the same industry that is now emerging in the region but so far located elsewhere. They are *relocating actors*. Second, *related diversifiers* are those getting involved in the new regional path by extending their portfolio of activities from other industries that rely on similar specialized resources. Third, when the new industry requires specialized resources quite different from those the actor was using before, the redeployment is hindered and it can only rely on generic resources for diversification. It is an *unrelated diversifier*. Teece et al. (1994) showed that firms' diversification is not random, it is more likely and successful when it occurs towards related activities. However, unrelated diversifiers may exist too (Chatterjee and Wernerfelt, 1991). On the other hand, new regional paths may be populated by de novo entrants. i.e. actors that get involved on the new regional path from their birth. By looking at the pre-entry background of the founder we can distinguish two types of de novo entrants. *Spin-offs* are de novo stand-alone firms whose founder was previously working in an established firm of the same or closely related sector. *Start-ups* are de novo firms whose founder has no previous experience in the industry, in a related industry or with entrepreneurial activities. Several studies have argued that spin-offs inherit valuable knowledge and capabilities from their parents to explain the fact that spin-offs have higher survival rates than start-ups (Klepper, 2002; Agarwal et al., 2004).

Finally, actors of change differ by their geographical embeddedness. Regions are open systems where non-local linkages are the more and more important. Indeed, path creation is also contingent on the ability of regional actors to mobilize external resources and anchor them to the region to transform it (Binz et al., 2016; Vale and Carvalho, 2013). Non-local context matters for local actors because it offers access to new potential demand, missing relevant resources (inputs, funding, knowledge…), and allow embeddedness of regional actors in the global industrial domain as part of global production networks, standards, communities of practice and lobbies. Regional new paths get linked with non-local contexts through two main complementary decisions of actors: location and collaboration. We first differentiate actors of change by their location before getting involved in the new regional path. *Local actors* are those that get involved in the new path and were already located in the region before that entry. They might be either already locally established companies that diversify or entrepreneurs already working/studying in the region. *Non-local actors* are those that arrive to the region and get involved in the new path, although they were not present in the region before. Moreover, actors often tie external relationship to access complementary resources that they miss in house. According to the geographical scope of their external relationships, there are *outward looking actors* that build most of their external relations with non-regional actors, and *inward looking actors* that have regional partners for most of their external relations.

3.3 Roles for path creation

Agency is distributed, so the transformation of regional environment for path creation involves various mindfully deviating actors. However, not all of them contribute to path creation in the same way. Actors of change play different roles. We rely on two criteria to characterize these roles.

Inspired from the work of Rogers (2002) on diffusion of innovations, the first criterion we

use is the *involvement timing*, i.e. the moment at which an actor takes decisions and/or makes actions favoring new path creation is relatively earlier than other regional actors. From this criterion, we distinguish three categories: antecedents, triggering, and followers. *Antecedent actors* are present in the region before the path constitution starts and, even if they might not be directly involved in the creation of the new path, their presence is important to launch the process. They are part of the initial conditions of the region, built over time, upon which new paths branch out (Boschma and Frenken, 2011; Simmie, 2012). In a strict sense, they are not actors of change because, at this stage, there is no mindful deviation and the process of path creation has not started yet. However, for their current activities, they exploit resources and capabilities (knowledge, labor force, networks...) that, to certain extent, might be (will be) redeployed for the development of new industries in the region.

Triggering actors are those that mindfully deviate from existing paths at early stages of the new path creation, the firsts movers. Through their decisions and actions, they start to transform the regional environment (and eventually the industrial landscape) to favor the new industry. The particular features of triggering actors will be relevant for two reasons. First, they define the key resources or the environmental domain specific triggering actors are more likely to impact. Second, it will influence the capacity of triggering actors to achieve their goal, to transform the environment and to overcome change resistance. The transformative capacity of triggering actors is conditional to their size and financial resources, their local/global reputation and power, their credibility and their cognitive capacities and innovativeness. The success of triggering actors is particularly important for path creation because the survival and profitability of firsts entrants, the effective regulation shifts, or the relevance of new knowledge contribute to increase the visibility, reputation and influence of these triggering actors and of the emerging regional industry. This may cause, directly or indirectly, additional mindful deviations of other actors attracted by a reduction of the barriers of entry and by the generation of new opportunities. The new entries contribute to further consolidate the path. However, at this stage, there are still few actors involved, and the feedbacks and regional increasing returns are still rare.

Follower actors are those that decide to enter in the new path at later stages, when path creation is already in motion but still under consolidation. Their entry brings the mass through different attraction forces, such as usual agglomeration economies, spin-off dynamics, mostly a local phenomenon, or location cascades based on reputation effects (Appold, 2005) by which non-local actors are attracted to the region. As follower actors enter and positive feedbacks are generated, the new path progressively moves from its path creation phase to the path development one (Martin, 2010). Contrary, if follower actors are rare, the process may fail because the increasing returns and positive feedbacks generated are weak. Then, the transformation of the environment to accommodate the new path remains uncompleted. Although due to their size, reputation and influence big players may have larger impact on path creation processes, the effects of follower actors tend to be marginally smaller, they are relevant in aggregated terms (Arthur, 1994)[1].

[1] Triggering and follower actors are mutually exclusive categories (Rogers, 2002), but not antecedents. An actor will be exclusively antecedent, if it is a regional source of capabilities relevant for the new path, but it does not enter on it. An actor will be antecedent and trigger/follower, if it is not only regional source

Actors producing and employing in a new regional industry do not stand alone, their success is conditional to a surrounding environment composed by other actors that, although not directly active in the new industry, provide necessary conditions for the development and competitiveness of the those actually participating on it. Thus, the second criterion we use to characterize the role of actors of change concerns the actor's activity in relation to the new path. In particular, the extent to which the activities of the actor, defined by its specific set of capabilities, are at the core of the new regional industrial path or not.

Primary actors are those whose activities concern the core of the new regional path. They are active producers and employers in the emerging new regional sector. So, they aim to take advantage of the new opportunities and try to mobilize the resources and capabilities they need for that, either internally or externally through (local or non-local) collaborations. They may be active in one or several steps of the value chain of the emerging regional industry, but their focus is in that new regional industry.

Supportive actors are not directly producing or employing on the new regional industry, but their activities are related to it, so they are still necessary for the development of the regional path. They collaterally participate in the new path in different possible ways. First, as suppliers of specific relevant inputs or technologies, or as suppliers of more generic complementary services. Second, as users or customers of the goods and services produced by the actors in the new path, or as producers of complementary goods and services to be used together with those of the actors in the new path. Both of them may also contribute as potential partners for co-development of products and problem solving. This might be particularly relevant in early stages of the industry. Third, as architects of regional general conditions such as regulation framework, infrastructures planning and building, providing funding opportunities, research activities and training of specialized labor force, entrepreneurship support, or supportive organizations enhancing knowledge exchange.

4 From actors to paths

New path creation is a process that takes time and involves multiple actors with different features and roles. So, there is not a unique way for path creation. On the one hand, despite the fact that actors' particular features may affect their capacity to change different parts of the system, there is not a univocal correspondence between both, because certain roles may be played by actors with different features. On the other hand, the two dimensions characterizing roles, i.e. timing of involvement and activity, are independent. Thus, the involvement of primary and supportive actors does not follow an established sequential order, it is rather a co-evolutionary process that might be leaded by any of them.

Consequently, there are different types of path creation processes depending on the configuration of the features-roles space, or the agency distribution structure. This is, the type of path creation process at work for a particular new path depends on which types of actors are playing which types of roles. Moreover, path creation processes also differ by their

of capabilities, but decides to engage in the path creation process itself.

outputs, meaning that not all path creation processes are equally adapted to generate any type of new path. This is, the type of new regional path (replication, transplantation, exaptation or saltation paths) depends on the process of path creation behind it, which, in turn, is characterized by a particular structure of the agency distribution (Figure 1).

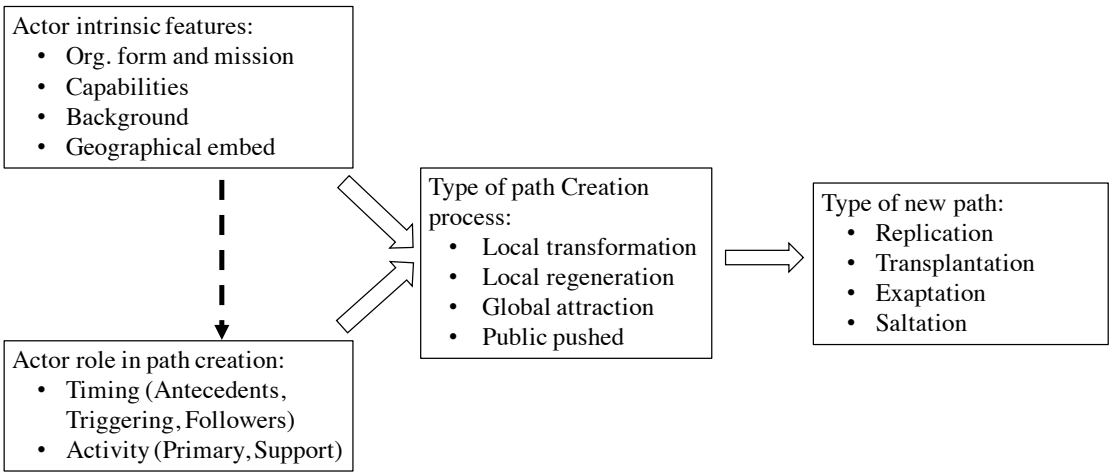

Figure 1 – From actors to paths: framework

According to section 3, actors of change are classified by several criteria regarding their features and roles. Thus, the combinatorial possibilities are very large. However, not all combinatorial possibilities are necessarily meaningful. Our discussion, rather than exhaustive, will focus on the four more relevant configurations: *i)* local transformation, *ii)* local regeneration, *iii)* global attraction, and *iv)* public pushed. Letting aggregation and dynamic issues aside, we mostly focus on early adopters leading the process to define its nature. With these precautions in mind, we next discuss both the most important process types, and how each of these processes relate to different types of new path.

The first type of process we focus on is *local transformation*. In this case, new regional paths are created by actors of change already located in the region. They are usually triggered by firms in the region who decide to diversify their portfolio of activities seeking to increase their performance by exploiting new business opportunities. However, in some cases, early movements for path creation may come from supportive actors such as other firms, or government agency, whose evolving needs (demand), products and aims open new opportunities and induce primary actors of the new path to take action. In these cases, although the path does not really develop until primary actors get involved, its birth is launched by supportive ones. The development of the new emerging path goes with the survival and growth of triggering primary actors, as well as with the continual entry of new diversifiers or new start-ups/spin-offs. The new arrivals will be influenced by the success of triggering actors, their contribution to adapt the local environment and their reputation. If entry and success continues, localization economies will flourish and strengthen.

On the one hand, diversification strategies of incumbent firms are not usually done at the expense of their internal coherence, because they tend to diversify into activities related to their current ones (Teece et al., 1994). Since local transformation is driven by actors already

established in the region, the new emergent industry will be related to the regional bases too. On the other hand, barriers of entry tend to be higher in already worldwide established industries, but incumbent firms tend to have better capacity to deal with that than de novo entrants, because they have more resources and longer term vision. Accordingly, local transformation processes can be associated to Replication new paths. However, incumbent firms may also participate in new emerging industries worldwide, because they tend to have larger R&D capacities to innovate, and because their market position, size, reputation and power are valuable assets to drive the transition from the niche, through the chasm, to the mass market. Thus, local transformation can be associated to Exaptation new paths too.

Local regeneration processes for path creation occur when a set of newly created local companies are at the origin of the new path. In these processes, although the region may host firms or universities in industries related to the new emerging one, they do not participate in the early development of the path. At this stage, they have mostly an antecedents' role, creating the favorable environment for the emergence of the new industry, but they do not make any explicit action for that development. At later stages, they may become involved either as diversifiers or as supplies of inputs and complementary services. Triggering spin-offs are created by workers of established firms or universities that decide to quit their job to create a new company by several reasons. On the one hand, workers of firms may identify business opportunities that the firm may strategically decide not to follow internally, or maybe not able to follow. On the other hand, the parent firm may go through some difficulties, exit or reduce its labor force, and so free capabilities. Those workers may try to apply their capabilities and experience in a new company of their own. These may concern start-ups creation too, the founder has not a direct background in a related sector, but when quitting his past employment, he uses his managerial skills to build a team with the necessary capabilities to enter the new emerging regional industry.

Path creation may be constrained by the small size of these de novo entrants and their little regional weight. Several factors may contribute to overcome this. First, at least one of the new entrants reaches high success to rise visibility. Second, the number of de novo entrants in a short period is relatively large, thus a minimal population is identifiable. Third, there are collaborations with big established firms that secures the development of new products and services, as well as a significant demand. Finally, if the new emergent industry is related to the activities already existing on the region, then new entrants may partially rely on the existing suppliers and complementary services. Most of these factors can be positively affected by organizations giving support to entrepreneurship, such as incubators or accelerators, and the richness of funding possibilities for new firms. In local regeneration processes, this type of organizations will have a key supportive role, both for triggering and follower actors. The consolidation of the new emerging regional path has two roads. On the one hand, the success of early entrants that keep growing, developing their activity and employing more and more people. On the other hand, by the entry of more and more actors, either additional start-ups and spin-offs or already established firms that decide to engage in the new regional path by relocation or diversification.

According to industry life cycles, mature industries tend to have big players competing on volumes and costs, with high barriers of entry and low entry rates. Spin-offs/start-ups are more likely to enter in new to the world industries. If the process is leaded by spin-offs, they

usually mobilize resources and capabilities related to those of its parent, already in the region. Thus, local regeneration would be association to Exaptation new paths. If the process is leaded by start-ups, whose capabilities might be less related to regional ones and relying more on non-local resources, the local regeneration process would be associated to Saltation new paths, a rarer event.

The third relevant process we focus on is *global attraction*. In this case, the new path emerges by a (re)location cascade, i.e. path creation is triggered and leaded by actors of change that were located elsewhere, and who establish in the region to realize activities in industries or domains that did not exist locally before. They tend to be established firms that get attracted to the region by several reasons. If their industry is already existing, they may look for access to certain (geographical) markets, and/or benefit from advantageous productive conditions, such as privileged access to certain key inputs, closer location with key suppliers or collaborators, low production costs (e.g. labor or land), or favorable regulation (e.g. labor or environment regulation). If the industry is in its emergent stage, productive and market access considerations tend to be less relevant. However, colocation with strategic partners, rich knowledge environment, support for entrepreneurship or, in certain cases, favorable regulatory framework, become more important and better adapted to deal with its uncertain conditions. All these existing conditions, acting as attraction forces, play the role of antecedents in the path creation process, and the first non-local entrants play the role of triggering actors.

With time, the consolidation of the new path will need the entry of follower actors. On the one hand, the location cascade from the outside might continue as long as the regional conditions continue to be attractive. In particular, this will be so if the triggering actors have a strong positive reputation or a leading market position, because they may induce imitation behavior by competitors and collaborators. On the other hand, local actors, either diversifying incumbents or de novo firms, may decide to enter the new path too, to take advantage of the new business opportunities that the entry of non-local ones has generated. They contribute to build a richer supportive environment.

Triggering actors in global attraction processes are often motivated by market extension or resource access, so they usually concern existing industries in advanced stages of their life cycle. When non-local actors arrive to the region looking for specific inputs or capabilities produced by existing industries, emerging industry tends to be of related nature: triggering actors get attracted by the specificity of the antecedents. In this case, global attraction would be associated to Replication new paths. When the resources sought by re-locating actors are of generic nature or if they arrive looking for particular market access, the emerging industry might be unrelated to the existing regional bases. In this case, global attraction processes would be at the origin of Transplantation paths. In fact, they are often source of more radical structural change (Neffke et al., 2017). If regional actors succeed in anchoring these external capabilities, the consolidation of the unrelated diversification will be more likely (Vale and Carvalho, 2013).

We finally focus on *public pushed* processes. In this type of processes, the key triggering actors of change are public, either the policy subsystem or PROs. So, they are mostly launched by supportive actors transforming the regional conditions rather than by primary

ones. In fact, public pushed processes have a more generic nature. Depending on the particular policies applied or decisions taken by policy makers and PROs, the following primary actors getting involved may vary.

The actions of those public triggers might be of quite different nature, a non-exhaustive list would include giving priority funding to certain projects and initiatives, giving advantageous fiscal treatment for the establishment or realization of certain activities or types of actors (multinational companies or entrepreneurship), building or transforming specific infrastructure facilities, adapting the existing regulatory framework to favor the development of certain activities, or creating new specific training courses and research lines or labs. Depending on the particular measure, the primary actors concerned may change (local established firms, entrepreneurs, multinationals...). Therefore, public pushed processes can be declined on any of the other three above, resulting on a local transformation, local regeneration or global attraction process.

	Replication	Transplantation	Exaptation	Saltation
Local transformation				
Local regeneration				
Global attraction				
Public pushed				

Table 2 – Paths and processes

5 The case of IoT in Toulouse

In what follows, we apply the analytical framework laid out above to assess the path creation process that started in the late 2000s around the Internet of Things (IoT) domain in the Toulouse region (south-west of France). The empirical analysis of the features and roles of the actors involved in this new regional path is based on qualitative research methods. It mobilizes two types of sources. On the one hand, an intensive desk research on press, specialized reports and directories from specialized organizations. On the other hand, a set of 22 in-depth interviews with key actors representing firm and non-firm organizations. Interviews were conducted between March and October 2017. Interviewees were CEO or founders, top managers and firm trade union representatives. On the base of our desk research, local experts advise and analytical framework, interviewees were selected in order to capture both, the role of most important regional actors and a variety of actor types.

5.1 Internet of Things: a new technological domain

IoT is a system that enables devices (objects) to communicate directly with each other to realize certain tasks in a distant and autonomous way, without human interaction. Internet connected computers and allowed humans to send and receive information, smart phones made connectivity portable. IoT is a step further in this all-connected paradigm. IoT transforms any physical object into a digital product emitting information such as usage, location or stage. This information is processed and analyzed to automatically set in motion the coordinated action of the emitting object and/or other objects relying on this input. This is made possible by grouping together a number of technological developments which result

in a IoT value chain with four steps: *i)* the information generation, *ii)* the information transmission from the device to the cloud, *iii)* the information processing in the cloud, and *iv)* the information use in multiple application and services. According to the value chain steps, IoT builds on electronics, cloud computing, Machine-to-Machine communication and embedded systems, but it is considered a new to the world industry or technological domain for two reasons. First, its technical specificities bring communication possibilities one step further with new solutions not available yet for pre-existing technologies. Second, actors involved on it acknowledge themselves these new specificities of IoT and develop new positioning on it.

As Internet, IoT solutions are transversal and have many application domains such as city management (energy, environment, traffic), people life (healthcare, leisure, home) or industrial production (industry 4.0, maintenance, security, logistics) among others. With such a potential, the expectations for IoT market growth were very high from its beginning in the late 2000s. The forecasts were in double digits per year, and we were supposed to reach the 50 Billion of connected devises by 2020. Nowadays, the expectations are still high, but they have been reviewed downwards because mid-term figures were not met. Firstly, compared to internet, IoT is not only virtual: objects development and production take longer time. Secondly, the IoT ecosystem is still immature: too many and too small standards, weak interoperability, cybersecurity and privacy concerns (e.g. health), and regulatory challenges (e.g. autonomous cars). Finally, demand is partially lagging behind. IoT is an important technology for the current development of the industry 4.0, but for final consumers, IoT solutions remain in the gadget category, "nice to have" rather than "must have".

5.2 The Toulouse context: Antecedents

Toulouse, with almost 1.3 million inhabitants, is the fourth urban area of France, and the one with strongest population growth: 1.4% per year for more than 10 years (Insee, 2017). The growth is associated to a dynamic economic system dominated by some knowledge intensive sectors. This profile has been built along an historical process that combines entrepreneurial decisions with local and national political decisions (Grossetti, 1995).

Aeronautics is the flagship sector of the region. Airbus, the leading company, is organized as a network with multiple locations with defined tasks around Europe. However, it keeps in Toulouse its headquarters, the conceptualization center, main assembly lines, testing and marketing functions. Around these activities, we find some key avionics and systemic suppliers (Rockwell Collins, Thales, Safran, Liebherr...) as well as multiple smaller suppliers. Toulouse is specialized in aerospace activities too. It represents 25% of the sector employment in Europe. This employment is spread along upstream activities such as preparation of spatial programs and missions (CNES), midstream activities with two builders of satellite and ground sol equipment (Airbus Defence and Space and Thales Alenia Space) and downstream activities with services of data management, positioning and imagery done by a myriad of SMEs. A third historically relevant industry in the region is electronics, with two pillars. On the one hand, semiconductors and electronic components that emerged with the arrival of Motorola and CII in the 60s. For a while the main focus was production, but since the 90s, when production costs became not competitive, a shift towards R&D activities has taken place. The closure of Freescale production plant in 2012 was a symbolic event.

This shift has occurred through a re-organization of the local sector with successive acquisitions (Motorola, Freescale, NXP) and spin-offs (ON Semiconductors, Humirel...). On the other hand, conception of embedded systems mostly for the automotive industry, but not only (Continental, Actia, Hella, and more recently Renault). Close to this sphere, Toulouse also hosts activities of software and application development produced by a relatively large number of SMEs. This industrial world is completed with a strong education system and a rich set of PROs integrated by three universities and numerous engineering schools (INSA, ENSEEITH, Supaéro, ENSICA). They annually feed the local system of competences with new specialized labor force, and they host numerous research labs, like LAAS, with tight collaborations with local industrial actors.

We argue that the new industrial path in Toulouse created around IoT is an Exaptation path. On the one hand, although relaying on existing technologies, IoT is a new to the world industry or technological domain. On the other hand, it requires capabilities on electronics, radio-frequency, embedded system, software design, big data treatment... but many of them where already present in the Toulouse region, so the local system reorganizes to diversify into a related sector.

5.3 Triggering actors

The new path around IoT in Toulouse started to develop in the late 2000s. During the last decade, the path has progressively consolidated with more than 100 companies directly or indirectly working on it. The key actor on the emergence of this new path is Sigfox. Sigfox developed an innovative wireless network for data transmission at low frequency and long distance, one of the basic backbones for IoT. It was created in 2009 by Ludovic Le Moan, a local serial entrepreneur in the ICT domain (Anyware technologies, Goodjet), and Christophe Fourtet, an engineer expert on radio-frequency working at Freescale center in Toulouse. The innovative technology of Sigfox became rapidly attractive and succeed in several fundraising tours (100M€ 2015 and 150M€ 2017). This increased its popularity and visibility, and allowed the development of its low frequency network worldwide in short time. The success of Sigfox contributed to the new path development in several ways. First, the employment in the new path increases (in 2017 Sigfox employs more than 400 people, most of them in Toulouse). Second, it creates a reputation effect, and Toulouse showed up in the IoT map. Third, Sigfox, by participating in the foundation of the TIC Valley, transformed into IoT Valley later, willfully engaged on transforming the local context to favor the emergence of an IoT cluster in Toulouse.

However, the entry of Sigfox was not an isolated event. It was the most successful case of a relevant wave of actors entering the IoT domain in Toulouse such as Myfox (2005), Axible technologies (2007), Intesens (2009), BEENETIC Systems (2010), Adveez (2011) or Ubleam (2011) among others. Although these entries were mostly independent from each other they have some important features in common. Firstly, they are newly created companies that entered around the same moment in time: when the momentum for the technology appeared worldwide, and when some local companies where going through some difficulties and re-organization process. Founders were already established in the region, with a background in local companies of the electronics sectors such as Freescale/Motorola or Continental, as well as in local PROs (ENSEEIHT, INSA, LAAS-CNRS), who played a

major role as competences incubators. Most of these entrants focused on the development of products and services that use IoT technology, so they were primary IoT actors whose activity usually span several steps of the IoT value chain, basically information generation and application. At the very first stages of their development, they usually relied on local labor force with specialized knowledge and local funding. However, more important fund raising tours, cloud computing services and installation services were often non-local. For the production and assembling of devices, they follow different patterns: internal, local partners and non-local partners.

This entry movement of primary actors went with the action of other actors that created a favorable supportive environment. On the one hand, the local existence of specialized suppliers of electronic components such as Sierra Wireless or PTC. On the other hand, the local presence of industrial companies that saw in IoT great potential to improve the efficiency of their operations, and that were shifting towards a more open innovation strategy. They enhanced the success of early primary entrants by participating in products co-development, providing field for ground testing or becoming early customers. For instance, Enedis, in charge of the low-tension electricity network, saw in IoT an opportunity to substitute manual inspection of the network by automatic and distant location of network failures. Thus, they collaborate with Sigfox, when Sigfox was still in its early stages and needed larger scale tests. Airbus is another interesting case, it announced the end of new aircraft development programs and focused on increasing production pace and maintenance activities. In this context and given the complexity of its supply chain, IoT solutions for monitoring and logistics, as well as for predictive maintenance activities were valuable.

5.4 Followers

With time, the path keeps consolidating. In demographic terms, early entrants kept growing, there were few exits, mostly by merger/acquisition, and new entries continued, although the variety of entry types enlarged. Consequently, the employment associated to the new path increased too. Moreover, the supportive environment became thicker.

The inflow of local spin-offs and start-ups continued. New entrants were often involved into several steps of the IoT value chain too, and focused on the development of IoT applications to various domains such as healthcare (Telegrafik, 2013), logistics and pieces tracking (ffly4u, 2015; Uwinloc, 2015) or leisure gadgets (Catspad, 2015; Capturs, 2016). Moreover, actors with different features got involved in the IoT path. First, companies already established in the region that diversified their portfolio by creating divisions dedicated to IoT. They recognized the potential of IoT to transform their own sector. Not only to increase efficiency in production, but as a technology that would transform the products and services they were offering. For instance, Continental, already present in the region since 1979 with a plant dedicated to electronic systems for cars, in 2017, decided to establish in Toulouse the Continental Digital Services and its project eHorizon dedicated to the autonomous and connected car. Similarly, in 2016, Siemens established the headquarters for his autonomous metros (VAL) and the R&D Mobility center in Toulouse. Or still EasyMille, developing autonomous electric vehicles, a joint venture by Ligier and Robosoft Technology PTE created in Toulouse in 2014. From the path creation perspective, although fewer in number, these entries represent more important volumes of employment on the emerging domain.

Moreover, the choice of Toulouse face to alternative locations done by established firms favors the visibility and reputation of the region. Second, followers also entered by relocation. Some of them were established firms located elsewhere that decided to open a new center in Toulouse for their IoT activities. This was the case of Renault in 2017, that decided to take over the local plant Intel was closing and create in Toulouse the Renault Software Labs with the aim to accelerate innovations for connected and autonomous cars. These decisions by external actors do both, reinforce the local path and reflect its emerging strength. Other relocating actors were de novo entrants, i.e. companies recently created elsewhere, active in IoT, that got established in Toulouse for their development. Sometimes, they are only opportunistic entries to take advantage of acceleration programs such as Ekito or the ConnectedCamp from the IoT Valley, and when the program ends they quit (e.g. Ubeeko or Zenodys). In other cases, they stay in the region beyond the acceleration program (Flipr, Awacloud, Drust or Tarot Analytics).

In the path creation process, the supportive environment changed too. The IoT Valley was of particular relevance. It is a non-profit organization created by few IoT local entrepreneurs with a triggering role. It was created in 2009 as the TIC Valley by Marc Rougier and Ludovic Le Moan (at that time in Goojet). The aim was to group together start-ups with high growth potential on the ICT domain in order to develop synergies and share knowledge and resources to increase their visibility and efficiency. In 2015 the TIC Valley made a strategic shift, it reduced its scope from ICT generic to IoT specific and changed its name accordingly, it improves its structuration and enlarges its services. IoT Valley aims to facilitate the development and scaling of IoT projects. To do so, they build an ecosystem co-habited by around 40 start-ups developing products and services on the IoT domain (e.g. Connit, Citymeo, Axible, Intesens, Ubigreen), and by a set of big group partners. Some are sectoral partners interested on identifying, developing and integrating IoT solutions on their own activity (e.g SNCF, AG2R, Daher). Others are technological partners that provide technical advice and favor the use of their technology in the construction of IoT solutions (e.g. Sigfox, Microsoft, EBVElektronik, PTC). There are also technology integrators looking for new opportunities and solutions for their final customers (e.g. Cap Gemini, CGI). Finally, the IoT Valley (together with Sigfox) has had a prominent role in building a reputation that associates Toulouse with the IoT domain, increasing the visibility of the new emergent path both locally and non-locally. As such, it leads an urban planning project in the south-east of Toulouse to build an IoT Campus

Other actors contributed to change the regional supportive environment too. As visibility and regional employment on the domain grew, regional policy makers became interested on it, and took action to favor its development. The planning project to expand the IoT Valley surface was the most important one, but not the only one. Regional development agencies like Madeeli or Cap'tronic began to establish funding priorities in topics related to IoT (although not exclusive to it) such as the plan "Usine du Futur", and to organize events for knowledge diffusion and exchange on issues related to IoT (seminars, workshops, conferences). Additionally, other regional cluster associations in which IoT actors may participate such as Aerospace Valley, AgriSud-Ouest, Digital Place, Robotics Place or Automotech became more and more concerned by IoT activities. For instance, Digital Place wrote a White Book in IoT, Aerospace Valley added IoT to one of its 8 strategic domains (DAS): "Systèmes embarqués, Objets Connectés, Logiciels et Electronique", and IoT is an

important pillar of the DIVA project of Agri Sud-Ouest Innovation. Moreover, local PROs started to adapt their training offer to the IoT domain. For instance, in 2018, INSA proposes a master specialized on "Innovative and secure IoT systems".

According to this discussion, we argue that the exaptation path on IoT emerged in Toulouse through a local regeneration process. The process was leaded by local star-ups and spin-offs that build on existing competences. Although Sigfox was the most successful, many other de novo entrants were involved. Their involvement on path creation went beyond production and employment, some of them take willful action to develop the path by creating a local ecosystem dedicated to IoT entrepreneurship, the IoT Valley, that became an important player to achieve visibility and further encourage entries. Path emergence and the success of triggering actors was influenced by the local existing conditions (antecedents). The Toulouse region had strong competences (cognitive and productive) on electronics, signal and embedded systems. Furthermore, it also hosted numerous industrial actors whose productive needs (cost reduction, security, maintenance...) created a test ground and early demand for primary triggering actors. Later on, de novo entries continued, and it was reinforced by local and non-local established companies that open new plants in the region to diversify their activities and add connectivity solutions to them. Although fewer in number, they represent higher volumes of employment. Finally, the policy subsystem had little influence. It was not a triggering actor because, although generic programs or policies may have contributed as antecedents (incubators, entrepreneurship funding, unemployment schemas...), they did not take any explicit action that favored path creation in early stages. They become involved as followers by enhancing the development of the IoT Campus initiative and raising IoT in the priorities.

Antecedents	**Triggering actors**		**Follower actors**	
	Primary	**Support**	**Primary**	**Support**
Dominated by knolwedge intensive sectors: <u>Aeronautics:</u> -Airbus (headquarters, conceptualization, assembling, testing) -Systemic suppliers (Rockwell, Thales, Safran Liebherr...) and others <u>Aerospace</u> : -CNES, Satellite manufacturing (Airbus, Thales), SME ground equipment and image <u>Electronics</u>: -Semiconductor and components (Motorola/Freescale, ON Smei...) -Electronic systems (Continental, Actia, Hella)	A wave of entry of local spin-offs (2007-2011): -Success and rapid growth: MyFox, Axible, Sigfox, Intesens, BEENETIC, Adveez, Ubleam… -IoT core -Local employment. <u>Sigfox</u>: -Innovative technology for data transmission -Successful fund raising -Visibility and reputation effects -Willful engagement on regional transformation: TIC Valley & IoT Valley	Industrial partners working as early demand enhance testing and co-development: Airbus, Enedis... Local specialized suppliers with technical advise	Succeed and growth of early entrants Entry process continues but features of actors varies: -Local spin-off continues: Telegrafik, Parkisseo, ffly4u, Uwinloc… -Non-local spin-offs: Flippr, Awacloud, Drust... (long term presence not guaranted) -Local diversifiers (fewer in number but bigger in size): Continental (autonomus car), Siemmens (automatic metro), EasyMille -Relocators: Renault	-Foundation of IoT Valley (substitute of TIC Valley)→ Aim to created a dedicated ecosystem (start-ups and big groups). -Policy makers reaction: adapting infrastructure (land, transport), adding IoT activities as priorities in their funding schemas. -Business Assoc: more and more ”seminars”, “workshops”, “days” dedicated to IoT -Universities: new dedicated masters

Table 3 – IoT development in Toulouse

6 Conclusions

This article sets out to develop an analytical framework linking actors of change and new regional industrial paths. Prevailing conceptualizations were ill-equipped to address this question. The literature on relatedness explains regional diversification as a disembodied process, with little insights into the actors involved. The literature on path dependence and actors of change treats new paths as a uniform category and focuses on the role of certain actors, but rarely studies agency distribution and the various roles of these actors.

The article builds a framework to analyze agency distribution in path creation processes, and how they relate to particular types of new paths. To do so, three building blocks are mobilized. First, we distinguish four types of new regional paths depending on the degree of the relatedness of the new industry with the prevailing regional conditions, and the degree of newness to the world. Second, actors (of change) are heterogeneous in multiple dimensions, we characterize them on the base of four criteria: organizational form and mission, core activities, background, and geographical embeddedness. Third, we analytically distinguish five roles that actors of change involved in path creation may play. These roles are defined on the base the timing of their involvement (antecedents, triggering, followers), and the nature of their activity regarding the new path (primary, supportive). We argue that there is not a single agency distribution structure behind all new paths. For path creation, each of the roles may be played by various types of actors, this will define the nature of the process at work. By looking at the structure of the agency distribution, we define four types of processes: local transformation, local regeneration, global attraction and public pushed. Finally, we argue that each of these processes are differently adapted to create different types of new regional paths.

In summary, the presented framework helps to build a more structured view on regional path creation processes and to link the structure of agency distribution with new path creation. We apply this framework to the case of IoT emergence in Toulouse, an exaptation new path created via a local regeneration process from the late 2000s. Existing regional activities with numerous firms and PROs specialized on electronics, aeronautics, aerospace and embedded systems gave rise to a wave of local spin-offs. Their development was favored by the local presence of industrial actors demanding IoT solutions, and actors providing key inputs for those IoT solutions. Moreover, (some of) these triggering actors engaged on the local promotion of the path by creating a dedicated environment, the IoT Valley. With time, the path became strengthen in two ways: spin-off entries continued, and the entry of big diversifiers often located in the region. However, there was little role of specially designed policies to develop IoT.

But our study also faces several limitations opening venues for future research. Firstly, the analytical framework focuses on actors' features rather than on their actions. Nevertheless, in that sense, it brings a complementary block to papers such as Garud and Karnøe (2001) or Binz et al. (2016) that focus on process and actions rather than features of actors. Additionally, categorization of actors in not always obvious due to fuzziness of boundaries for industrial classification or geographical embeddedness. Secondly, the framework might be affected by aggregation issues. In a path creation process, the same role might be played simultaneously by actors of different types. In those cases, classifying the process as

aggregation of individuals is more complex. Similarly, the framework interpretation might be affected by process dynamics, i.e. the type of actors playing certain roles may change through time, so the type of process at work for path creation might shift. Related to that and concerning the case of IoT in Toulouse, the path creation process is still ongoing and the path is not fully stabilized yet. This analysis *in the making* has the advantage of reaching the actual actors of change driving the process of path creation, because they are still there, but future evolutions of the process might alter the current conclusions.

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