Entrepreneurial drivers, intermediary institutions and policy in regional industrial ecosystems: A comparative study of Emilia Romagna and Piedmont, Italy

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Abstract

The effectiveness of industrial policies and institutions depends dramatically on the extent to which they target specific features of industrial ecosystems, in particular their more *vertical* vis-à-vis *horizontal* organisational structure. This binary stylisation is introduced here to distinguish industrial ecosystems according to their reliance on different *types* and number of "entrepreneurial drivers" for industrial emergence and renewal. These entrepreneurial drivers can be big system-integrator firms (both domestic and foreign), but also first-tier suppliers orchestrating regional supply chains, or specialised contractors and start-ups working in partnership with international organisations (private, public, or both). The government can also play an entrepreneurial function in terms of coordinator, matchmaker and market creator, especially in areas affected by high uncertainty and market failures. Industrial ecosystem renewal and emergence are such areas. By comparing the industrial trajectories and current ecosystems of two regions in Italy – Emilia Romagna and Piedmont, the paper studies the functioning and effectiveness of different types of intermediary institutions in driving industrial emergence and renewal.

Key words: Entrepreneurial drivers; industrial ecosystems; vertical and horizontal organisational structure; intermediary institutions; renewal and emergence; industrial policy.

1. Introduction

The financial crisis led to a dramatic acceleration in the ongoing structural transformations of the global manufacturing landscape, both in terms of the total industrial output and, more critically, with respect to its distribution between mature industrial countries (and their regional ecosystems) and developing countries. During the first peak of the crisis, the manufacturing loss estimate reveals the collapse of industrial production worldwide with respect to both the zero growth scenario (for the period 2008-9) and the sustained growth rate scenario (based on the average annual growth rate achieved in the pre-crisis period between 2000 and 2007). Specifically, the world manufacturing loss was US$ 361.32 billion (with respect to the zero growth rate scenario) and US$ 875.72 billion (if we compare it with the sustained growth rate scenario). This latter figure comes to more than 1 US$ trillion in current prices.

The manufacturing loss was unequal both *across* and *within* countries. Industrialised countries in North America, Europe and Asia witnessed a severe manufacturing loss calculated to be US$ 671.01 billion (with respect to the zero growth rate scenario) and US$ 814.58 billion (with respect to the sustained growth rate scenario). In contrast, the manufacturing value added (MVA) in developing countries (led by China) continued growing at least with respect to the zero growth rate scenario so there was a total manufacturing gain of 309.68 billion US$ (Andreoni, 2015).

Within industrialised countries, the global financial and economic crises exacerbated existing differences in growth, technology dynamism and value addition performances among regions. Regions where (i) the industrial structure was characterised by a high presence of low-medium tech sectors, (ii) the industrial ecosystem (and production organisation) was mainly dependent on (and orchestrated by) relatively few driving firms and, finally, (iii) products were becoming increasingly uncompetitive in the global market (both in terms of pricing and technology content), witnessed the collapse of entire industrial sectors and the near disintegration of their industrial ecosystems. On the contrary, other regions characterised by a more horizontal organisational structure and diffused innovative entrepreneurship, showed relatively higher degrees of resilience. In some cases, these resilient regions experienced innovative processes of industrial renewal and organisational restructuring which allowed them to exploit the opportunities offered by the emergence of global production networks in innovative ways.

Given the variety of regional industrial ecosystems and organisational structures within mature industrial economies, and the different renewal challenges and innovation opportunities faced by each of them, this paper argues for the design and adoption of specific packages of policies and institutions reflecting the specific organisational structure of industrial ecosystems. The effectiveness of these policies and institutions depends dramatically on the extent to which they target specific features of different industrial ecosystems, in particular their more *vertical* vis-à-vis *horizontal* organisational structure. In this sense, we consider industrial ecosystems to be *vertically organised* when they are characterised by highly structured relationships along the supply chain (e.g., the high-volume automotive industry, with its tight relationships between OEMs, Tier 1 and

Tier 2 suppliers). Conversely, industrial ecosystems can be considered to be *horizontally organized* when there are strong relationships among peer companies and/or among firms offering complementary products and services (e.g., as in industrial districts). This binary stylisation is introduced here to distinguish industrial ecosystems according to their reliance on different types and number of "entrepreneurial drivers" for industrial emergence and renewal. As it will be discussed in the following section, entrepreneurial drivers are the key potential agents of change and renewal that can be identified in an industrial ecosystem. Depending on the specific case, the role of entrepreneurial drivers can be covered by a variety of actors, such as large firms, SMEs, or even startups.

The government can also play an entrepreneurial function in terms of coordinator, matchmaker and market creator, especially in areas affected by high uncertainty and market failures. Industrial renewal and emergence are such areas. By comparing the industrial trajectories and current ecosystems of two regions in Italy – Emilia Romagna and Piedmont, the paper studies the functioning and effectiveness of different types of institutions in driving industrial emergence and renewal.

In the Emilia Romagna region, particular emphasis was given to the role of a diffused network of public technology intermediaries matching a "horizontal" industrial ecosystem structure characterised by multiple innovative entrepreneurial drivers, effectively linked to global system-integrator firms (both domestic and foreign multinationals). The economic performance of Emilia Romagna appeared to benefit from this policy approach both in terms of growth and employment (i.e., renewal), as well as in the capability to nurture innovative startups (i.e., emergence).

The case of Piedmont, instead, exhibited scant economic growth and startup generation capability. It can therefore be argued that the policy approach, based on a network of innovation poles and startup incubators, probably failed to fit with a relatively complex ecosystem made up of "vertical" supply chains and relatively de-linked "horizontal" clusters, which did not clearly exhibit entrepreneurial drivers on which policy efforts could be leveraged.

Based on these two stylised cases, the paper concludes by sketching a policy framework for nurturing entrepreneurial drivers and regional industrial ecosystems in which the form and function of the supporting intermediary institutions reflect the specific type of industrial ecosystem structure and its needs, both in terms of industrial emergence and renewal.

As a disclaimer, the paper stems from the comparison of the two regions' policies and economic evolution, carried out by the two authors on the basis of their academic and professional knowledge of the phenomena. The conclusions of the paper therefore remain at the level of an impressionistic reasoning, albeit well-grounded from a conceptual point of view. Moreover, the paper has the aim of highlighting the role of entrepreneurial drivers when defining industrial policy, and it must not be considered as a comparative assessment regarding the soundness of specific industrial policies.

2. Entrepreneurial drivers

Drafting policy responses to the dramatic impact that globalization and the financial and economic crises since 2008 have had on a number of economies is not easy. The years since 2008 have globally been characterized by economic growth, but in a very uneven way, with specific countries and regions falling into deep crisis due to inadequate industrial structures and lack of competitiveness vis a vis competition coming from emerging countries and changing technological paradigms.

Industrial policy therefore requires carefully crafted strategies to be designed and implemented, in order to restructure these industrial ecosystems and renew their competitiveness. In doing this, policymakers must strike a careful balance between different approaches and priorities (Warwick, 2013; Andreoni, 2016; Andreoni and Chang, 2016).

Among the possible lines of action, they must decide whether they want to support change in a broad way, for instance by investing into common infrastructure or knowledge assets, or whether they want to focus on stimulating 'winners' and pruning 'losers', thus favoring a rapid reallocation of capital and skills to newly competitive firms.

In a similar way, policy-makers must decide the amount of effort to be spent on the 'renewal' of existing firms vs. on supporting the 'emergence' of new firms, including innovative startups, that may take the place of firms that have reached the end of their lifecycle.

Moreover, they must decide on whether policies should focus on the supply side of innovation or on the demand side. Examples of the former type of action include providing publicly funded inputs to the innovative process (e.g., public grants for R&D projects) as well as creating incentives for privately-provided inputs (e.g., tax breaks associated ex-ante with R&D expenditure). Examples of the latter type of policy include creating early-adopter markets for innovative goods and services (e.g., public technology procurement and tax breaks for adopters of new technology) and, to some extent, increasing the returns on risky investment (e.g., tax breaks associated 'ex-post' with successful innovating firms).

Finally, policy-makers must decide on the role, on the business model, and on the investment to be allocated to innovation-support institutions and intermediaries. This is a crucial point, knowing that, while properly run 'bridging' and 'intermediary institutions' can be instrumental in generating a virtuous 'triple helix' of innovation (Etzkowitz and Leydesdorff, 2000), these same institutions are always at risk of becoming an economic deadweight interested in self-perpetuation, which may waste public resources and crowd-out private initiative.

Whatever the strategy being followed, it is clear that - in a market economy - no kind of industrial policy will succeed if it fails to appropriately identify and leverage the 'entrepreneurial drivers' that are in the position to enact change and transformation within a given industrial ecosystem.

In times of uncertainty and change, not all economic actors are in the position to create significant economic growth. Some may lack a much too significant part of the capital and knowledge assets that are necessary to restore competitiveness. Others may lack the strategic vision or the psychological mindset to understand the direction to take and actually initiate entrepreneurial action. Others still may not have adequate managerial skills to execute such a vision successfully.

On the contrary, some economic actors may have the right mix of assets, entrepreneurial vision and managerial skills to become – either autonomously or if appropriately stimulated - the forerunners of renewal for an entire industrial ecosystem, both by virtue of their own growth and/or by progressively stimulating other firms either via direct interaction or by inspiring imitation. We define these actors as 'entrepreneurial drivers'. In this context, the use of the term 'entrepreneurial' is associated to the etymological meaning of the word 'entrepreneur', as an economic actor that is willing and capable to 'grab an opportunity'.

Entrepreneurial drivers can be big system-integrator firms (both domestic and foreign), but also first-tier suppliers orchestrating regional supply chains, or specialised contractors and start-ups working in partnership with international organisations (private, public, or both). According to the entrepreneurial role they play in a given industrial ecosystem we can distinguish different organisational structures. Industrial ecosystems relying on few and relatively concentrated entrepreneurial drivers tend to present a relatively more *vertical organizational structure*. Entrepreneurial innovations stem from few big players with investment capacity whocontrol the value chain and access to final markets. On the contrary, industrial ecosystems whose organisational structure is more horizontal tend to have multiple entrepreneurial drivers operating at different stages of the value chain and across sectors. Moreover, in horizontal industrial ecosystems entrepreneurial drivers not only are characterised by distinctive technical capabilities, they *also* show a strong entrepreneurial/opportunities-driven attitude.

A policy maker that does not understand which economic actors have the potential of being 'entrepreneurial drivers' will be quite likely to waste public resources and – even worse – might even hinder their autonomous emergence by sustaining the market presence of uncompetitive and directionless firms. On the contrary, shaping industrial policy around 'entrepreneurial drivers' may lead to a more effective and efficient allocation of public resources, which may be used to overcome initial friction, but then allow market mechanisms and private initiative to drive most of the change.

To make things clear, the idea of an industrial policy that looks at 'entrepreneurial drivers' does not imply spotting 'entrepreneurial drivers' and making them awash with public funds. First of all, there is no clear way to identify entrepreneurial drivers *ex-ante*. Moreover, the transformation of an industrial ecosystem also depends on the slower change that will affect other firms as well, and this requires the correct balance of measures supporting both leader and follower firms. Rather, an industrial policy that looks at 'entrepreneurial drivers' should at least make an attempt at understanding what economic actors are in the best position to drive the change and tailor a policy mix of measures and support institutions that may support and amplify their independent drive to gain competitive advantage.

There is not clear recipe for understanding what economic actors can assume the role of an 'entrepreneurial driver' in a given time and territory. Depending on the case, this role may be expected from incumbent firms or startups; from large firms or SMEs; from entrepreneurs and firms that are already operating in the territory, or actors that must still be attracted to it. It is clear that each of these alternatives would lead to completely different choices with respect to policy measures and support institutions. Moreover, the role of 'entrepreneurial drivers' is not necessarily limited to private profit-making firms. Depending on the case, this role may also be assumed by public institutions, universities and non-profit organizations. All of this points to the crucial role of making a correct reading of the status of an industrial ecosystem, with the aim of properly directing industrial policy.

The remaining part of the paper will present a comparison between the cases of the Emilia Romagna and Piemonte regions in Italy. While the two regions are apparently quite similar in economic terms, they exhibited markedly different trajectories over the last decade, and the paper will make a preliminary and coarse discussion on how a failure to identify entrepreneurial drivers and to shape industrial policy around them could be responsible for this gap.

3. Varieties of regional industrial ecosystems and organisational structures

Emilia Romagna and Piedmont are two of the main industrial regions in Italy and – more generally – in Europe. Table 1 reports a number of relevant indicators, showing how the two regions are very similar in population and focus on manufacturing (NACE C). However, the table also shows how the last decade – on the backdrop of Italy's dismal economic performance over the same period – exhibited a widening gap between the two regions. Piedmont ran into a rather steep crisis, as shown by GDP variation and unemployment, whereas Emilia Romagna managed to grow. The dataon innovative startup creation is also quite interesting, since it shows that the initial dynamism recorded in Piedmont lost pace, while the opposite happened in Emilia Romagna. This shows how a social and industrial milieu that was already known to be conducive to entrepreneurship quite readily embraced the challenge of nurturing high-tech startups.

Table 1: Emilia Romagna and Piedmont: regional comparisons

	Emilia Romagna	Piedmont
Population	4.4 million	4.4 million
GDP (2014)	144.14 B€	122.94 B€
GDP growth (2005-2014)	+13.2%	+2.4%
Unemployment (2006-2015)	3.4% (2006)→ 7.7% (2015)	4.1% (2006) → 9.2% (2015)
Firms (2014)	370,259	336,338
Employees	1,518,243	1,331,000
NACE C Firms (2014)	38,742	33,454
Employees	453,089	415,161
Share of national innovative startups (2013->2016)	10.1% (2013) → 14.7% (2016)	8.43% (2013) → 4.83% (2016)

Source: own elaboration with official data from ISTAT and Registro Imprese

3.1 The Emilia Romagna industrial structure

Since the late 1970s the Emilia Romagna (ER) region has been widely studied to the extent that the dynamics within its sectoral districts and their distinctive features forged concepts such as industrial district, flexible production, constellation of firms and 'Third Italy' (Brusco, 1982; Piore and Sabel, 1984; Best, 1990). Indeed the ER's industrial ecosystem has been traditionally characterised by a plurality of districts; including automotive, machinery, packaging, biomedical, agro-tech, food, textile, ceramics and plastics. Originally these industrial districts emerged as regional (and often sub-regional) networks of companies specialised in specific sectors and products, and linked by multiple backward and forward linkages.

Despite the emergence of major domestic players as leaders ofsectoral value chains (in automotive, packaging and automation), and the attraction of international companies in the region (e.g. medical device and pharma), the organisational structure of the ER industrial ecosystem maintained a traditional horizontal organisational structure. This means that even when the sectoral value chains and the access to the international markets became mainly mediated by big system integrator firms, the regional suppliers and contractors maintained a relatively high degree of independence and explored similar and complementary productive opportunities, both within and across sectors. The ER industrial ecosystem remained characterised by the existence of a diffused network of innovative entrepreneurial drivers operating both in traditional industrial sectors and emerging new areas. As shown in Andreoni et al. (2016), the packaging industry, for example, was capable of shifting towards higher value product segments and transforming the region into a world-leading producer of packaging machinery for pharmaceuticals.

Over the years, each sectoral system of innovation in the region has developed complementary technology and a number of inter-sectoral symbiotic relationships, up to the point that the sectoral boundaries are becoming today increasingly difficult to discern. The Emilia Romagna region has developed as a complex manufacturing ecosystem whose strength resides on a combination of export oriented value chain drivers and a diffused system of specialised contractors and suppliers. The functioning of this complex system has been made possible by the continuous and sustained process of of development and accumulation of 'industrial commons' (i.e., a body of shared knowledge and competencies that can be used across sectors and complementary technology competence areas - Andreoni and O'Sullivan, 2014).

Emilia Romagna is today one of the most advanced manufacturing ecosystem in Europe. This Italian region counts leading international positions in a number of related industrial sectors and manufacturing niches, including mechanics and automotive, agro-tech and food, medical devices and life science, advanced materials and integrated ICT technologies. Emilia-Romagna has one of the highest per capita GDP's of any Italian region, and has been ranked for many years as one of the richest regions of Europe. Its very dynamic economy, present throughout the territory, has enabled Emilia-Romagna to achieve an employment rate of 67.4%, which is well over the Italian and European averages.

In 2014 the ER region counted 430,000 companies, 1,014 companies per 10,000 inhabitants, including 50,000 manufacturing companies (see table 2 and 3 in Annex). The industrial sector exports reach more than 1/3 of the regional GDP (34.4% of GDP) and is composed for almost 2/3 by high and medium-high tech products (59% of exports). These numbers make the region the second for exports (after Lombardia) in Italy. Advanced mechanical engineering is the key sector of the regional economy, with more than 28,000 companies exporting around 55% of their output and making up 64% of regional export turnover. Distributed throughout the territory, these mechanical engineering companies are divided into various areas of excellence including food processing, agricultural machinery, automotive, hydraulics, construction and ceramics machinery and packaging.

The regional industrial ecosystem also includes a complex public-private technology infrastructure: 10 centres of excellence, 38 research labs, 11 centres for innovation and technology transfer, 23,000 researchers, of which 13,000 in the private sector. ER is the 3rd Italian region for investment in R&D and the first one for the number of EPO patents.

3.2 The Piedmont industrial structure

Piedmont is often considered to be the birthplace of Italian industry, with recurrent waves of industrialization occurring over time, starting from textile in the 19. century, moving to automotive and aerospace in the 20. century and – more recently – shifting towards IT and services (Zamagni, 1993). Industry in Piemonte is mainly centered in the area surrounding the city of Turin, which used to be the capital city of the Duchy of Savoy, was briefly the capital city of Italy, and then became one of the main industrial centers of the country. In addition, territorial clusters with different specializations exist in the provinces outside Turin, such as - but not limited to - textiles in Biella, jewelry in Valenza, water taps and valves in Novara, or winemaking machinery and equipment in Canelli.

The difference between the industrial history of Turin and of its provinces is quite significant. Over the decades, Turin has built a tradition for large-scale manufacturing of complex goods, such as railroad stock, automobiles, industrial machinery and airplanes. Economies of scale that are inherent to these industries have therefore led to the emergence of large companies and their supply chains. In fact, FIAT was the dominant economic actor in Turin for decades, and the city was often dubbed ‘the Detroit of Italy’. This industrial specialization deeply shaped local entrepreneurship. The dominant business model for local industry was to be a supplier to a large customer, sometimes providing only manufacturing competencies and resources, and sometimes providing competencies in product development as well. In the end, local industry was characterized by a few leading customer companies (FIAT being the main one), a number of relatively large first-tier suppliers with relatively limited strategic autonomy, and a large number of SMEs acting as second-tier suppliers.

Competitive advantage in this environment could be traced to having strong technical competences, a good capability in complying with the designs or specifications drafted by a few well-identified large customers and, finally, significant effort in preserving these customers' hard-gained trust. On the other hand, local industrialists had little need to work on strategic analysis and investigate new opportunities for diversifying in new industries and markets, embrace radical innovation, or even develop new business relationships. An example of this propensity to shun away from proactive product development can be seen in the IT industry that developed in the city from the mid '80s of the 20. Century. Despite the fact that software products enjoy minimal marginal costs, hardly any local company pursued the business model of developing software products, while virtually all of them chose to operate software development services for large-scale projects as suppliers for large corporations (Cantamessa et al., 2007).

Concerning ownership of firms, about 2/3 of firms can be classified as family businesses both in Turin and in Piedmont at large (Unioncamere Piemonte, 2015), with the majority being run by the "second generation". As it often happens in Italy, family ownership is often associated with management by family members, both at CEO and operational level. Family-owned businesses in Piedmont are not particularly open to external managers (Quirino, 2010), which amount to only 1.2 % of the workforce (whereas it is 2% in Emilia Romagna). In face of distress, it is also quite common to sell the business, rather than to entrust it to someone who is not a family member. Altogether, these elements point to the difficulty of enacting strategic change, especially when facing radical technological innovation, unless this is not required and driven by an external party.

At the same time, territorial districts outside Turin are relatively similar to the ones that typify Emilia Romagna, with a prevalence of SMEs and with a few medium-large companies with significant innovation capabilities and international reach.

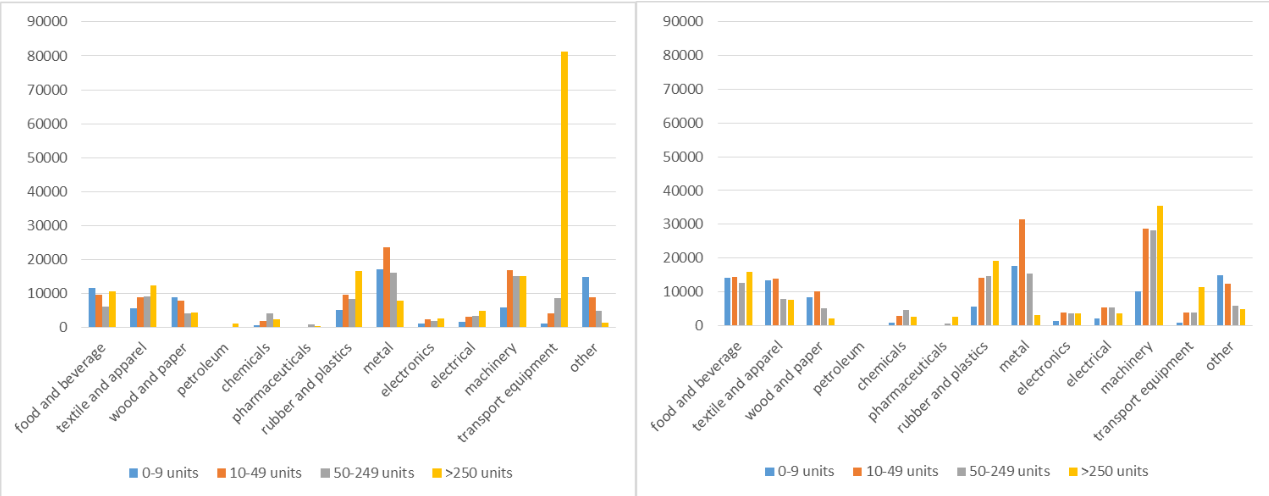
Economic performance of Piedmont is quite strongly correlated with the evolution of these two strands of industry, which experienced a progressive decline already before the economic crisis of 2008 (due to offshoring of production both to other regions of Italy and then abroad) which was enhanced by the crisis that began in 2008. In terms of GDP and employment, Piedmont has been a laggard in comparison to other northern Italian regions. In addition to figures already shown in Table 1, ISTAT data shows that, between 2008 and 2014, per capita GDP in Piedmont declined by 12.4%, compared to an Italian average of 10.4 % and 9.7% in Emilia Romagna.

3.3 Looking for entrepreneurial drivers in the two regions

In order to recognise entrepreneurial drivers in the two regions, one can start by comparing their industry structure. Given the key role of manufacturing, one can focus on the corresponding category (C) in the NACE statistical classification. What emerges is that– based on employment – both regions exhibit the same levels of specialization (the Shannon Entropy Index for Piedmont is 2.21, compared to 2.23 for Emilia Romagna). The most significant differences appear in the greater occurrence of Electronics and Machinery in Emilia Romagna, and the hugely important role of transport equipment in Piedmont.

However, if one looks at firm size distribution, Piedmont appears to have a significantly larger share of employment in large companies (38.8% instead of 24.8%), which is balanced by a significantly smaller share in small firms with 10-49 employees (23.39% instead of 31.27%) and medium-sized firms with 50-249 employees (19.9% instead of 24.0%). The following figure 1 shows firm size distribution in subsectors of NACE C (which – as mentioned – defines manufacturing) , with Piedmont on the left and Emilia Romagna on the right. This prevalence of large companies is particularly evident for subsectors such as transport equipment, textile and rubber and plastics.

Figure 1: Firm size distribution in regional industrial ecosystems.



Source: own elaboration with official data from ISTAT

What therefore comes to mind is that the industrial structure of Emilia Romagna is centered around medium-sized companies that are active in the context of 'clusters' operating with strong 'horizontal' links – *horizontal* organisational structure. These companies are particularly interesting candidates as 'entrepreneurial drivers', given the long-term vision that is associated with family ownership, the fact that such firms are nonetheless large enough to initiate a sound innovation and internationalization strategy, and tend to attract professional managers to run them.

Conversely, the situation in Piedmont appears to be more complex and much less favorable. On the one hand, medium-sized companies operating in clusters have a lesser role in Piedmont, and are located outside the main industrial center of Turin. Besides being geographically isolated, these clusters are highly specialized, making spillovers and synergies less likely. The other potential candidate 'entrepreneurial drivers' would therefore be the large firms that lead 'vertical' supply chains in transport equipment, textile and rubber and plastics – *vertical* organisational structure. The scale enjoyed by these firms suggests that the likelihood of assuming the role of 'entrepreneurial drivers' essentially depends on the presence of entrepreneurial vision and the capability of policy-makers to engage with such firms on an equal basis.

Concerning entrepreneurial vision, the situation can be highly varying. In the period examined, many of these large firms were family-owned but their leadership was distracted by living through a crucial phase of their existence, either by negotiating acquisitions with large multinational groups, or by pursuing relocation of their headquarters to other countries. Other large firms were local subsidiaries of multinational corporations, and therefore lacked essential strategic autonomy. Moreover, the relationship between the regional government and very large firms, which had a long-standing tradition, was potentially fraught with political problems, because of the need to comply with strict EU state aid regulations and to avoid any impression of complacency between politicians and the successors of former 'captains of industry'.

Concerning startups, it has already been mentioned that the Emilia Romagna start up ecosystem appears to have significantly outgrown the Piedmont one. From the perspective of the specialization of these startups, Emilia Romagna and Piedmont respectively exhibit 25% and 20% in NACE C (i.e., manufacturing), compared with a national average of 19%. For Emilia Romagna, this is quite in line with the overall weight of NACE C (29% of employment), but significantly less so for Piedmont (31% of employment). It therefore appears that, while both regional industrial ecosystems have remained somewhat faithful to their manufacturing tradition when it comes to high-tech startup creation, this is more significant for Emilia Romagna than for Piedmont.

In a way, it appears that startup creation dynamics in Emilia Romagna followed the direction of a tighter connection to existing industry and of an 'industrial renewal' approach. Conversely, startups in Piedmont originated more independently from existing industry, thus hinting at an 'industrial emergence' phenomenon.

4. Nurturing the renewal and emergence of regional industrial ecosystems

4.1 The role of public technology intermediaries (PTIs) for industrial renewal: the Emilia Romagna case

The ER regional government has adopted a wide and articulated range of industrial policies since the 1970s. Today's its manufacturing system contributes to one fourth of the regional GDP and employment and it counts around 50.000 companies spanning across strongly related industries including machine tools, packaging, medical devices, plastics, agrotech and automotive. A number of studies highlighted the entrepreneurial approach of the regional government in different historical conjunctures (Brusco, 1982; Bianchi and Bellini, 1991; Amin, 1999; Bianchi and Labory, 2011) and its capacity to align industrial policies to the structural transformation cycles characterising its main industrial sectors (Andreoni et al., 2016). In those industries affected by profound technological and organisational transformations, the effectiveness of industrial policies strongly depends on their alignment with the industry's structural cycles. The reason is that the specific needs of business organisations change along these structural cycles. Therefore, matching these needs (as well as steering certain transitions) requires aligned public policies, including appropriate technology support, production services and training.

Since 1970s the ER's industrial policies went through three major phases and developed along two main axes, that is, sectoral and technology policies *and* industrial training policies. While the former witnessed significant adjustments in each three major industrial policy phases, industrial training policies remained substantially the same during the first two phases (1974 – 1985 and 1985 - 2003) and underwent an important reform during the last phase (2003 –). The machine tool industry and production technologies have been among the main industrial policy targets of the ER regional government and received various forms of direct and indirect support.

The sectoral and technology policies started in 1974 with the establishment of *ERVET* (ER Governmental Agency for the Economic Valorisation of the Territory). This coordination agency launched and organised a regional network of sector-focused research centres targeting SMEs (Regional Law no. 44/1973). ERVET's service centres provided various types of manufacturing extension services, including technology diffusion, technical assistance and consultancy, market analysis and scouting, fair and exhibition services, specialised and continuous training. These activities were aimed at supporting SMEs in resource and capabilities development, technology absorption, scaling up production capacity alongside increasing quality, product certification and standards. All these activities were extremely important for domestic and international system integrators firms and their first tier supplier whose production relied extensively on the local SMEs. Without reaching a certain threshold of production quality in the provision of components, SMEs would have remained de-linked from the technological changes and organisational reconfigurations driven by the leading industrial firms.

During the 1980s the ERVET network was further extended, however the regional government started realising that SMEs (and indirectly the new emerging system integrators) were facing new types of production and technology challenges. For example, from the mid-80s, the medical device and packaging industries started integrating mechanics and electronics within their technology platforms as well as increasing their operational scale and markets. In response to these industrial transformations, in 1985 the regional government launched a new Agency for Technological Development called *ASTER*. ASTER was established as a Consortium for industrial research, technology transfer and innovation, with the aim of promoting technological innovation in industry, creating link between researchers and enterprises and identifying the great frontiers of science which will influence future economy and on which business and research can work and invest together. ASTER is a non-profit making consortium company working, even with external activities, in the interests and on behalf of the partners themselves. It is publicly owned company, in which the majority shareholding must be held by the Emilia-Romagna Regional Authority, public universities and public research organizations and their related associations, working in the area. Partners are bound to not sell to any third party the research findings of the Consortium or the know-how acquired through their relationships with ASTER, unless so authorised by the Board of Directors.

ASTER's stated mission is "to promote and coordinate actions for the development of the regional production system of services and systems connected to it, in furtherance of industrial research, technology transfer and innovation actions for the transfer of knowledge and technology skills and actions for the development of a research facilities network". ASTER represented an important shift in two main respects.

First, regional industrial policies became more technology focused and the support services started targeting the most innovative and dynamic SMEs. The emergence of a local 'network of innovating SMEs' providing smart technology solutions at the level of production technologies, materials and product components became one of the key competitive assets for the entire region and its emerging leading companies (Andreoni and O'Sullivan, 2013; Andreoni et al, 2016).

The creation of ASTER was followed by a gradual reform of the overall regional technology infrastructure culminated in the Regional Law no. 25/1993. The many research and service centres run by ERVET (including ASTER) were encouraged to take a more entrepreneurial approach, including targeting European Structural Funds Projects and engaging more proactively with business organisations. Since then, ASTER has established a long lasting experience in participation and coordination of European funded networks (e.g. Enterprise European Network, E-RAIN European Network of Regional Innovation Agencies, ERIK Network focused on regional economy based on knowledge).

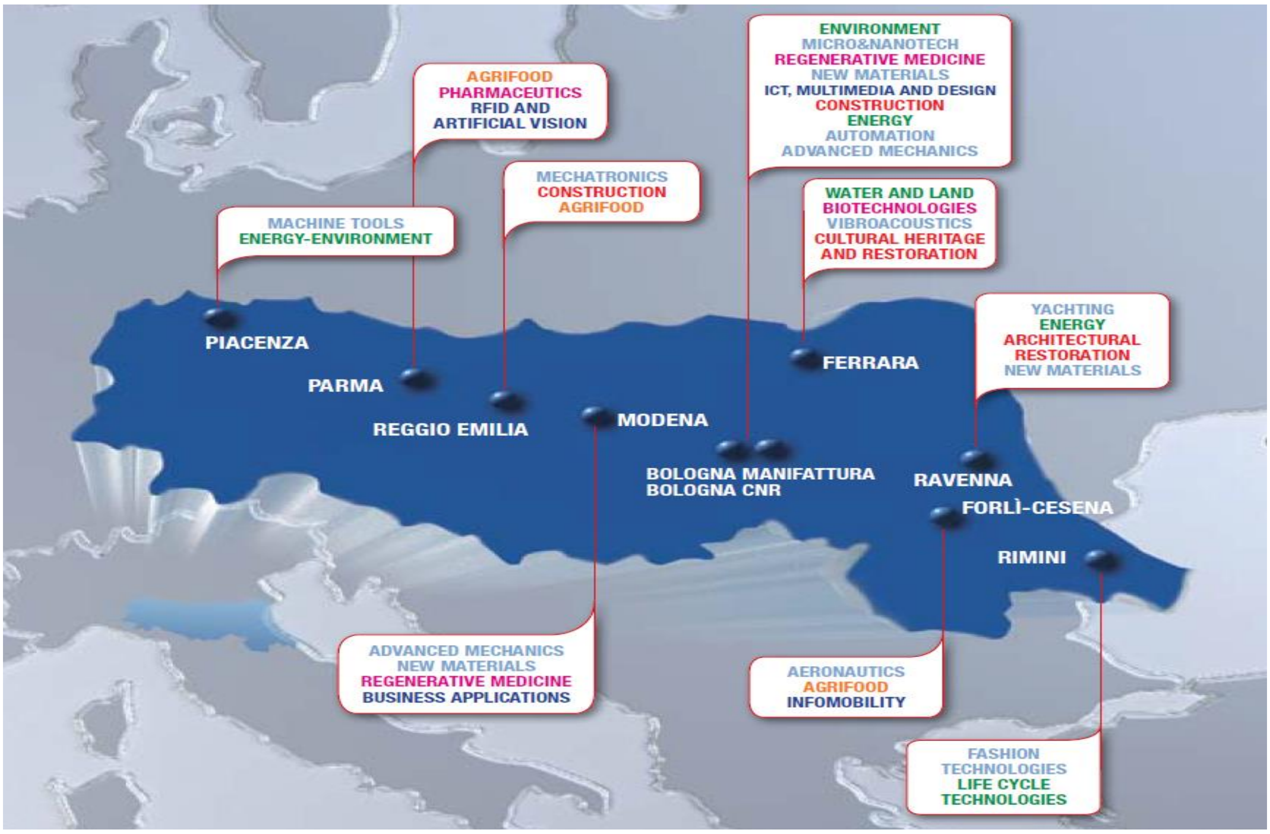
The last industrial policy phase started in 2003 with the PRRIITT (Regional Program for Industrial Research, Innovation and Technology Transfer). The PRRIITT was the regional government's most systematic attempt to re-align its public technology intermediaries (PTI) to the industrial transformations characterising the manufacturing landscape since the late 1990s. This policy re-alignment consisted in a major technology upgrading of the regional system of PTIs and the adoption of a more flexible and cooperative approach to various public-private partnerships (PPPs). First, he PRRIITT Measure 4 instituted a regional network of applied research laboratories and technology transfer innovation centres named *High Technology Network* (HTN). The HTN marked a transition from a sector focused industrial policy to a technology policy focused targeting six major technology platforms (mechanics and materials, ICT, agroindustrial, construction, energy and environment and life sciences). ASTER was restructured and a number of regional Universities and research institutions (CNR and ENEA) located in Emilia-Romagna were involved (Regional Law no. 7/2002). Since 2005, ASTER activity is mainly dedicated to the development and coordination of the Emilia-Romagna High Technology Network, also in partnership with private sector representatives sitting in the management board.

The Emilia-Romagna HTN includes multiple and heterogeneous PTIs organised around *6 Thematic Platforms*. Specifically, it includes 35 Research Laboratories and 66 Operating Groups spread on the regional territory. It is organised along two axes:

- *Location*: 10 Technopoles
  Technopoles are facilities dedicated to industrial research located and spread on the regional territory. They include multi-thematic competences (Equipment - Human Resources) and constitute a meeting place for research offerings and demand on behalf of enterprises.

- *Competence*: 6 Regional Thematic Platforms: Agrifood, Constructions, Energy & Environment, ICT & Design, Mechanics & Materials, Life Science.
  A Regional Thematic Platform (RTP) is a virtual network bringing together researchers, industry and industrial association, in a particular technological field in order to foster regional research and development in the concerned area.

Figure: The High-Technology Network in Emilia Romagna



Source: ASTER HTN.

ASTER performs the following set of functions through the HTN:

- **Vision-setting for the regional industrial ecosystem**
  - Defining medium-long term research and technology development objectives
  - Keeping a close contact with the European Technological Platforms (Identify the most promising technology paths to which give priority in regional, national and European research programmes)

- **Coordination and management of the PTIs network and international gatekeeper**
  - Promoting and coordinating research initiatives related to areas of strategic interest for the regional manufacturing system in liason with Universities or other research centres, or in

collaboration with single or associated enterprises, business associations, trade unions, as well as other bodies and authorities;

- Developing initiatives enabling companies to access and participate, together with regional Universities and research institutions, in industrial research programmes at national, European and international level;

- **Industrial scaling up and matchmaker**

  - Organising and managing physical infrastructure and technological facilities, also through the establishment of other companies, mainly public joint-stock companies;

  - Developing initiatives to facilitate, promote and support the creation and development of new companies for the use of results and expertise derived from research activities;

  - Setting up and managing integration tools, through the Research Catalogue database (internet portal), to use the scientific and technological skills existing in the Emilia Romagna Regional High Technology Network.

  - Supporting the establishment of research and service contracts to augment the Network's collaborative research output.

  - Giving support to industrial enterprises which upgrade theirlabs with the most suitable instrumental equipment and tooling

  - Involving the entire economic value chain, making sure that the knowledge generated by research is readily converted into technologies and processes, and thus into commercially viable products and services

The specific production and technology functions offered by the HTNare organised around the 6 technology platforms. While some of these platforms are more critical for certain sectors than others, they are not sector-specific. The HTN provides opportunities for technology diffusion, innovation and renewal across sectors by organising an open technology and production service offering (centred around technologies) to different sectors.

AGRI-FOOD PLATFORM

The Agri-Food Platform represents a reference point for the innovation needs expressed by enterprises belonging to the food and agro-mechanical sectors by offering qualified support for:

- the development of new products and processes;
- the characterization and selection of new raw materials;
- the design and validation of equipment and plants for food processing and packaging.

The Platform in particular operates in the following fields:

- raw materials quality and safety,
- final products and processes,
- industrial equipment and plants,
- health,
- functional foods,
- the promotion of typical regional productions.

CONSTRUCTION PLATFORM

The Construction Platform focuses on industrial research and innovation for the entire construction sector, especially on issues regarding energy saving, high performance and environmental sustainability for new buildings and for the recovery of building heritage.
The most targeted Platform intervention fields are:

- new construction methods, in terms of urban design and planning,
- materials,
- components,
- building equipment and processes,
- building and cultural heritage maintenance and remodelling,
- museum and exhibition design,
- restoration and maintenance of historical and artistic monuments and their economic valorization.

ENERGY-ENVIRONMENT PLATFORM

The Energy-Environment Platform aims at developing and transferring innovative technologies and methods regarding:

- environmental quality control,
- natural resources management,
- development of renewable energy sources, analysis and reengineering of products,
- systems, production processes and anthropic activities in general, with the purpose to optimize the use and maximize material and energy recovery.

The major Platform interaction organizations are those dedicated to:

- environmental control and protection;
- companies specifically focusing on technology production and providing environmental services;
- the organizations involved in the energy production sector,
- enterprises belonging to all sectors interested in minimizing environmental impact.

ICT AND DESIGN PLATFORM

The ICT and Design Platform promotes the development, tuning and adoption of ICT for:

- tackling social challenges related to the environment, health, aging; supporting business organizations through intelligent management of process and product information;
- addressing individual needs.

In consideration of ICT *cross-sector application*, the Platform promotes in particular the cooperation with the other High Technology Network Platforms in order to enhance the offer of innovation opportunities for other business sectors.

MECHANICS-MATERIAL PLATFORM

The Mechanics-Materials Platform is dedicated to all enterprises - not only to those belonging to the mechanics sector - with industrial research needs in relation to

- product and process optimization,
- development and characterization of high performing materials
- efficiency and productivity augmentation.

The Platform intervention fields are:

- design,
- prototyping and testing,
- processing and nano fabrication,
- development and characterization of new materials,
- surface treatments,
- fluid dynamics,
- noise and vibration,
- automation: control and diagnostics, actuators; and
- sensors.

LIFE SCIENCE PLATFORM

The Life Science Platform aims at transferring advanced scientific research results towards personalized medicine, with particular emphasis on:

- regenerative medicine,
- pharmaceutical innovation,
- omics and the development of bio-informatics tools,
- innovative biosensors,
- personal health systems
- diagnostic and therapeutic technologies, and
- translational medicine.

Over the years, the access to the HTN was facilitated by the creation of specific tools for increasing the interaction between business organisations and the PTIs as well as aligning their technology efforts. In particular, the establishment of a regional web platform called 'Catalogue of Competencies' played an important role in mapping existing technology offerings and production services in the region. The technology offerings and services for the mechanics, materials and ICT platforms include a wide range of critical activities for high-value manufacturing sectors. These include embedded systems, automation and control, robotics, high performance and cloud computing, internet of things, software engineering, interoperability, protocols and standards, mechatronics applications, vibration and harshness analysis. Since its constitution leading firms and a number of their suppliers have established collaborations with the local universities, innovation centres and laboratories involved in the HTN.

The regional government also managed to re-align the interactions between private research institutions as well as between business organisations and the HTN. In the packaging industry, for example, at the apex of the technology transition from the mechanics to the mechatronics platform, twenty six Emilian packaging companies, including IMA, created a private company called *CRIT Research.* Before the PRRIITT, CRIT was the main technology intermediary within the packaging industry and between the Emilian packaging valley and international research centres. Since 2003, the CRIT was integrated within the public PTIs system and new initiative of this type started receiving public support. Thanks to regional funding opportunities, in 2011 five among the companies who founded CRIT Research (IMA, SITMA, SACMI, SELCOM and Tetra Pak Packaging Solutions) created a new intermediate institution called LIAM (Industrial Laboratory for Packaging Automated Machines). This research centre offers technology services such as virtual prototyping, solutions for predictive diagnostic, machine-independent and platform-independent software architecture, access to instrumentation for testing and benchmarking different technology solutions and platforms adopted by international competitors (Andreoni et al, 2016).

In sum, the interaction between the regional government and the business organisations have been changing since mid-1970s. Throughout this period the ER regional government has opened a new space between the public and business organisations, including initiatives by leading companies as well as SMEs. The resulting private-public nexus appears today as a complex and thick system of interlocking relationships including multiple technological and organisational dimensions.

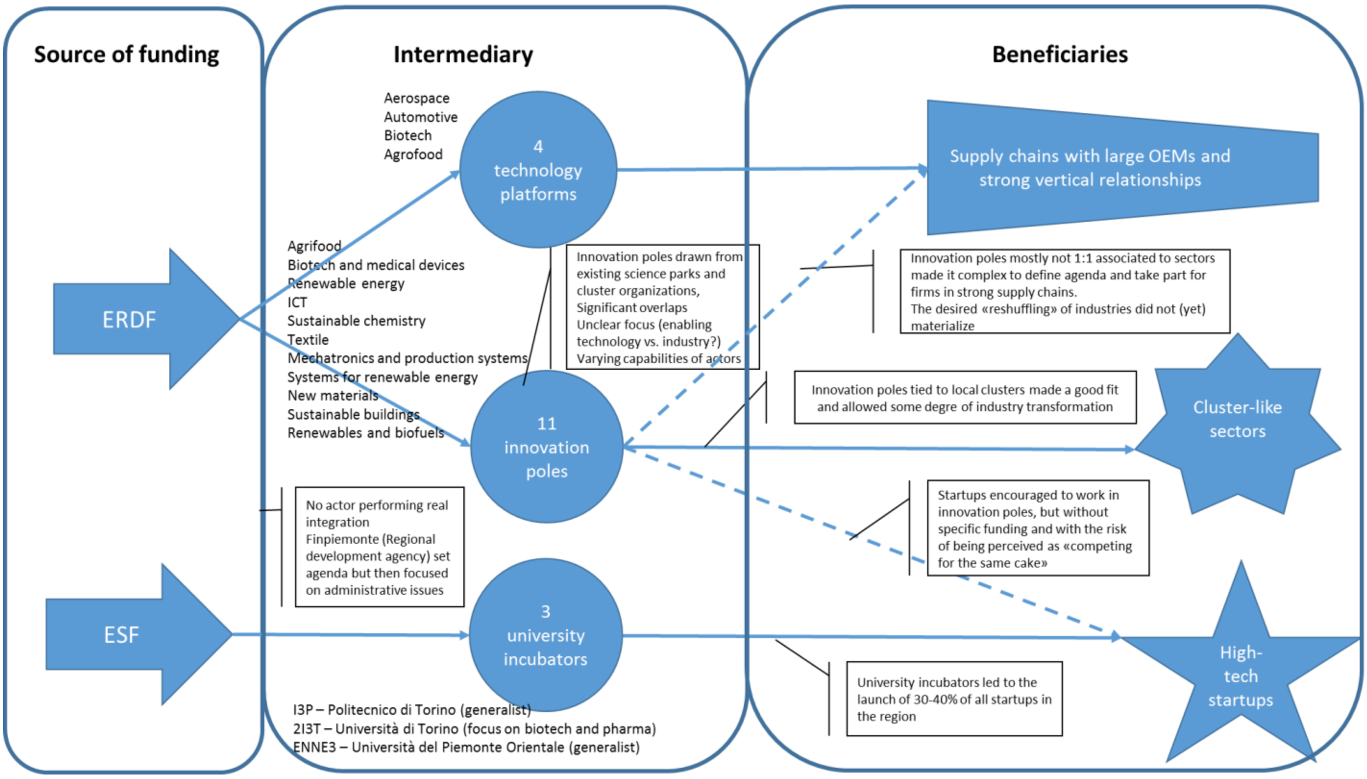
4.2 The role of intermediaries and incubators: the Piedmont case

Like Emilia Romagna, Piedmont has always been one of the main innovating regions in Italy, with the defining feature of significant private sector investment, when compared to the national average. According to ISTAT, in 2012, R&D expenditure was 1.94 % of GDP in Piedmont (compared to 1.63 % in Emilia Romagna), of which 1.51 % from businesses (1.09% in Emilia Romagna).

However, the progressive dwindling of this investment, tied to the gradual decline of industrial production, led the regional government to realize that a strong innovation policy had to be enacted in order to redress the situation, especially in order to increase production of high value-added goods that could effectively compete against goods being offshored to emerging countries. This strategy also coincided with a constitutional change at national level, which devolved innovation policy to Regions, and led to a regional law on innovation in 2006, which framed the EU structural funds budget for 2007-2013, which were the main source of funding for the policy, through the ERDF (European Regional Development Fund) and the ESF (European Social Fund).

The following figure attempts to provide a compact representation of the way with which innovation policy was structured.

Figure 3: The Innovation policy system in Piedmont



Source: Authors

The ERDF was managed by the Finpiemonte funding agency. Compared to Emilia Romagna's ASTER, which also incorporated technical competencies and activities, Finpiemonte had a stronger focus on structuring and running administrative processes for awarding grants.

The main policy enacted on ERDF funds was based on 11 innovation poles, inspired by the French experience of the 'poles d'innovation et competitivite'. The role of 'innovation pole' was mainly awarded to existing bridging entities, such as science parks and cluster organizations, sometimes to leverage on a sound performance, but in other cases in the attempt to revitalize entities whose performance was somewhat lackluster. This led to a relatively high number of poles, with significant overlap (e.g., three poles were associated – though with some differences – to the field of environmental sustainability and renewable energy). Moreover, the focus of innovation poles, which had been subject to significant debate, remained quite unclear, with some poles being clearly aimed at fostering innovation in a specific industry (e.g. textile) and other ones aimed at supporting the development of technologies which might be used in different industries (e.g., ICT, sustainable chemistry, etc.). In any case, the policy intentionally avoided focusing on industries with dominant large firms since the intent was "*not to start supply chains, but to stimulate interfirm collaboration among existing firms*" (Regione Piemonte, 2013). Altogether, the program led to the awarding of grants amounting to 111 M€ at a 50% cofinancing rate. The number of projects funded amounted to 548 and the number of beneficiaries to 1744. The average funding was therefore equal to 202 k€ per project and 63.6 k€ per beneficiary. Very limited resources (only 0.2% of the budget) were specifically dedicated to startup companies. Startups were of course eligible to take part in projects, provided their balance sheets passed a minimum-size threshold. This ERDF policy could therefore be considered to be intermediate between emergence and renewal. On the one hand, it aimed at creating new cooperation links between firms (independently of their focal industry and supply chain). At the same time, the policy pointed in the direction of industries and supply chains in which competencies were already present, but avoiding the ones in which supply chains were significantly structured.

In parallel to the Innovation Poles, the Regional Government supported existing supply chains by structuring four Technological Platforms and funding large-scale and strategic projects run in cooperation with research centers and universities. Technological Platforms were funded by the ERDF with about 120 M€. The main effort was dedicated to Aerospace, which absorbed 42% of resources, while Automotive received 25% and Agrofood and Biotech took up about 16.5 % each. Innovation Poles had the explicit objective of bringing together SMES, large firms and academic researchers, especially to achieve a greater inclusion of SMEs in innovative processes. While the policy appeared to be well-received by the actors involved, evidence of its impact in terms of economic and employment growth is quite inconclusive (Regione Piemonte, 2014).

Finally, attempts were made to coordinate the ERDF with attraction of Foreign Direct Investment, with the objective of increasing the role of large multinational firms in the Region. Outcomes of the policy are still to be evaluated, but it is quite apparent that the general economic climate and the relatively low attractiveness of Italy had a role in preventing a full success.

Resources from the ESF were also used to enhance innovation policy – among many other purposes – especially in the context of high-tech startups. In this case, a portion of the ESF and other funds (amounting to about 6.2 M€) was funneled through three high-tech start up incubators affiliated with the three main Piedmontese universities. I3P of Politecnico di Torino (with a generalist orientation, with the exception of biotech and pharma), 2I3T of the Università di Torino (generalist, but with a clear focus on biotech and pharma) and ENNE3 of the Università del Piemonte Orientale (generalist). The ESF funding was explicitly aimed at supporting scouting, pre-incubation and – partially – incubation of high-tech startups associated with research results. The program subsidized the services provided to startup firms arising from the academic community (i.e., academic spinoffs and startups founded by either students or recent alumni). However, the three incubators also provided services to high-tech startups whose founders had no prior affiliation to the university, as long as the core technology of their ventures had something to do with the competencies of the university itself. Moreover, while the incubators were being funded to create startups, there was a clear mandate from their public sector shareholders that incubators' mission also included stimulating the local 'startup ecosystem' so that it could eventually become more fertile for startups that were not being assisted by an incubator.

The services provided to startups went well beyond the traditional granting of office space, and can be summarized as follows:

- **Scouting** of entrepreneurial ideas was carried out through an open application system and systematic one-to-one meetings, along with a sequence of events (startup weekends, hackatons, business plan competitions).
- **Consultancy** to entrepreneurial teams was provided both by in-house tutors (for the more ‘strategic’ part, having to do with the definition of business models and business plans) and by external professionals services firms (for accounting, tax, legal, IT, etc.). This choice allowed cost savings and stimulated local professionals to provide high-level professional services to startups.
- **Human Resources matchmaking** in order to facilitate the composition of entrepreneurial teams with balanced competencies and to recruit initial personnel, both from the university and theexternal market.
- **Fundraising support** in order to facilitate contacts with equity investors (business angels, venture capital firms, corporate investors) and banks that could provide loans on preferential terms.
- **Support to business development** by taking part in trade fairs, organizing ‘demo days’ and open innovation events tailored to the needs of specific large companies.

Incubation programs are not easy to assess, and literature provides mixed evidence on their effectiveness (Cantamessa 2016). Therefore, there is considerable risk in enacting policies aimed at supporting incubators. On the one hand, a very strict policy that does not correctly consider the breadth of their impact and the time required to achieve results may deny incubators potentially useful resources. On the other hand, generous policies that do not hold incubators accountable for results may lead to ineffective or inefficient operations and may provide insufficient incentives for improving and/or imitating other successful programs. Most of all, a lax policy may induce incubator managers into ensuring the self-perpetuation of their entity, with the ensuing waste of resources and the risk of ‘crowding-out’ private sector initiatives. This would contradict their original mission of creating startups *and* stimulating the local ecosystem[1].

In order to avoid this risk, the ESF funding was structured around a rather innovative mechanism, by which incubators were authorized to report expenses to be reimbursed proportionally to effectively recorded results (i.e., the number of validated business plans produced, and the number of startups being incorporated through the incubator). In a way, the policy makers recognized that there was a market failure in the pre-incubation and incubation activity but – instead of simply awarding grants – they created a market-like mechanism in order to provide appropriate incentives to the intermediary entities. In addition, the program was evaluated based on measurable metrics, such as startups being launched, equity investment being attracted and jobs being created. Policy-makers were particularly interested in the average cost of creating a single job, which amounted to about 6.000 €, which was recognized to be a very attractive result.

[1] In a way, innovation intermediaries should always ask themselves “what would really happen if my entity disappeared overnight? Would anyone notice or care?”

As a result of this policy, the three incubators mentioned above became the avenue through which 35-40% of the start ups incorporated in the Piedmont region. This policy followed a clear strategy aiming at the emergence of new companies, industries and supply chains.

The two initiatives, ERDF and ESF, ran in parallel with relatively limited synergies. While startups were encouraged to take part in project consortia financed by innovation poles, there was no specific funding for this. Startup participation did occur, but at times with the feeling by incumbent companies that – instead of being complementary to them – startups were competing for the same budget.

Though it is still early to perform a systematic evaluation of the impact of this policy, a few outcomes are quite apparent, and they have been strongly influenced by the way the policy was structured. The main reflections are the following:

- Firms operating in supply chains with strong vertical relationships were involved in projects to the extent that the innovation pole was clearly aimed at their industry. This made it easier to generate a common agenda, while pre-existing relationships among participants facilitated their participation. This was the case of textile, but not of transportation equipment (since there was not an “automotive” innovation pole). One of the objectives of the innovation poles was to stimulate new cooperation links among firms, which could have led to the reshuffling of existing industries and supply chains, thus favoring diversification and redeployment of existing technological assets to new industries. However, no particular examples of this phenomenon arose. Probably, the reason for this is that firms which did not belong to a ‘tightly knit’ supply chain did not have an easy access to the research agenda of poles they were alien to. Moreover, these tightly-knit supply chains were characterized by large OEM firms and small suppliers. It not surprising that their strategic orientation would not change, the former because of inertia, and the latter because of limited strategic autonomy.
- Firms in cluster- like sectors (e.g., bioplastics) found it easier to participate in the activities of the innovation poles, both because of the closer fit with the poles’ innovation agenda, but also because of the presence of medium-sized companies large enough to invest in innovation activities, but nimble enough to shape new strategies based on project results.
- Interaction between startups and incumbent companies remained very low and did not support – as it would have been desirable – industrial transformation and open innovation processes. As a matter of fact, the relatively low incidence of manufacturing startups in Piedmont suggests that the startup ecosystem developed in an environment of its own, and with relatively limited interaction with existing industries.
- The innovation intermediaries that have been cited (poles and incubators) operated with limited synergies among themselves. Also due to the type of personnel available, the Regional development agency had a role in setting up the overall agenda and defining the structure and objectives, but then focused on administrative tasks (this contrasts with the more proactive role of Aster in Emilia Romagna).

The limited synergies between poles and incubators (and – therefore - between a ‘renewal’ and an ‘emergence’ strategy) raises interesting questions. From an ‘open innovation’ perspective, it is fairly obvious that a tighter connection between the two types of actors could have been beneficial to both startups and incumbent companies. Startups must find markets and partners among existing firms, while incumbents may strongly benefit from innovations that startups bring to the market. At the same time, the activities, processes, objectives are metrics of the poles and incubators are so far apart from each another that synergies among the two types of actors should not be stretched to the point of conflating their roles and activities. The obvious implication is that it is necessary to have entities orchestrating and coordinating the activities of poles and incubators in order to promote a balanced renewal vs. emergence strategy. Regional development agencies can be good candidates for these roles, provided they have enough technical competencies and do not limit their focus to purely administrative activities.

4.3 A comparative policy analysis

In sum, it is possible to identify some quite clear differences between Emilia Romagna and Piedmont in terms of policies. In impressionistic terms, these differences may explain the different trajectories followed by the two regions' industries. Specifically, the relative success of Emilia Romagna compared to Piedmont may be traced to the following elements.

First, Emilia Romagna managed to identify medium sized firms in existing clusters as 'entrepreneurial drivers' on which to leverage policies. This was probably due to the fact that such candidates were quite obvious, if compared to the more complex situation that characterized the Piedmont region.

Second, Emilia Romagna's industrial structure, centered around clusters that were well-defined according to industry and geography, made it easy to create a network of public technology intermediaries whose mission was clear to the intermediary itself and to participating actors as well. In a first phase, this favored intra-cluster activity (since anyone would know which PTI was responsible for a given topic or industry). In a second phase, this also favored inter-cluster activity and – potentially – a reshuffling of industries and supply chain according to emerging paradigms.

Third, the Emilia Romagna enacted a tighter policy coordination on training, innovation, start up creation, etc., thus making it easier for different actors to move forward along the strategic directions identified. This was probably due to the nature of the ASTER organization, whose footprint was not limited to administrative activities, but also encompassed technical support.

At the same time, policy in Piedmont exhibited some interesting elements that, however, did not seem to be sufficiently effective in countervailing the economic decline. The following policy interventions were particularly interesting: the attempted coordination between ERDF funds and FDI strategy, the use of 'quasi-market' mechanisms to achieve a proper alignment of incentives with university incubators, and the attempts to engage large firms operating in 'vertical' supply chains.

5. A policy framework for nurturing regional ecosystems

The description made in section 4 of the two cases of Emilia Romagna and Piedmont clearly exhibits the complexity inherent in the task of structuring a system of actors and intermediary institutions that may enact and/or support innovation policy in a regional industrial ecosystem. The complexity stems from:

- the number of functions that such a system and different institutions must fulfil;
- the variety of industries (and organisational structures) and geographical areas that must be covered;
- the variety of objectives – sometimes complementary and sometimes conflicting – that the innovation policy must pursue, with regeneration and emergence being two clear examples.

Moreover, systems and institutions supporting innovation policy are characterized – like all organizations – by path dependency and organizational inertia. On the one hand, assets and organizational competencies accumulated in 'bridging' and 'intermediary' institutions' are potentially valuable resources to be fully exploited. On the other hand, some of these same institutions are often quite poorly performing, and it may be by no means easy to enact change by bringing in new functions and introducing new processes (i.e., "bringing innovation to innovators"). The apparent reason of this difficulty may be traced to the fact that bridging institutions generally are government-funded entities that work in market failure areas. Since by definition they do not act in a market system, defining performance metrics and structuring appropriate incentive mechanisms becomes a complex and error prone endeavor. Omitting to do so can lead their managers to view policymakers as their real customers, instead of the firms they should support.

The ESF mechanism for funding university incubators in Piedmont may be seen as a way to solve this problem. The policy-maker created a 'synthetic' market-like mechanism where there was a market failure. The solution found (paying by the business plan and the startup incorporated) could however be dangerous, since it can entice the incubators into launching many startups, rather than working to make them successful. In order to make sure this would not happen, the mechanism was supplemented by metrics that looked at broader outcomes, rather than the immediate results (e.g., the employment created by startups and the 'cost of each job').

The comparison between the two regional cases (section 4.3) also highlighted how a sparse collection of institutions having disparate functions and roles may easily lead to ineffective outcomes if there is no clear coordination between them. This raises the issue of linking the intermediary institutions in a coherent systemic whole. While desirable, cooperation and coordination among intermediary institutions is by no means easy to achieve. Institutions compete among themselves for the same budgets, and perform activities that are often quite similar, if not overlapping. The issue raises the idea that relatively strong coordination systems, such as ASTER in ER can be highly beneficial in ensuring that the innovation ecosystem operates in a harmonious way.

The development of a systematic policy approach to foster innovation in industrial ecosystem – both in terms of industrial renewal and emergence of new sectors, products, technologies – calls for an analysis of the organisational structure of the ecosystem itself and, in particular, its entrepreneurial drivers. According to the relatively more horizontal or vertical organisational structure, the government can target its policies and design effective intermediary institutions. Ultimately, intermediary institutions like the one promoted in the Emilia Romagna and Piedmont regions, address fundamental "industrial ecosystem failures". These can emerge in the form of traditional market failures (e.g. underinvestment in quasi-public good technologies), coordination or system failures (e.g. de-linked or polarised industrial ecosystem) and uncertainty (e.g. lack of investments in industrial renewal or in emerging technologies).

However, the extent to which these interventions will be effectively targeted and designed will depend on the capacity of the government to *identify entrepreneurial drivers* in the industrial ecosystem. While it is obviously easier to recognise entrepreneurial drivers ex-post, rather than spotting them ex-ante, the organisational structure of the industrial ecosystem suggests areas for potentially successful intervention, that is, areas in which the policy push will be matched by a strong entrepreneurial response and pull from potential entrepreneurial drivers.

The assessment of the "entrepreneurial driver potential" of different actors, that is, their capability to playing an entrepreneurial driver role both across the economy, or working on a single cluster/supply chain, should take into account the following set of variables:

- Quality of assets (physical and knowledge)
- Relevance of these assets with respect to emerging technological paradigms
- Degree and quality of entrepreneurial vision
- Degree and quality of managerial execution capability
- Likelihood of the actor to grow organically
- Likely impact of the actor on other companies because of direct economic involvement (e.g., using other firms as suppliers, acquiring weaker firms, etc.)
- Likely impact of the actor on other companies because of imitation (e.g., reputation, etc.).

Once the organisational structure of the industrial ecosystem and each potential actor has been rated, the government can target its interventions focusing on the entrepreneurial drivers with the highest potential (given the industrial ecosystem organisational structure) and work on leveraging its strengths and compensating its weaknesses in order to maximize the outcomes of the policy.

The two regional cases highlighted how this can be done in more or less successful ways, and how regional governments can play an important role in fostering processes of industrial renewal and emergence. The policy approach and tool (entrepreneurial driver scorecard) proposed must be tailored to the different industrial ecosystems and, thus, involves intense public-private interactions. Intermediary institutions are particularly critical in this respect, as they do not simply provide key services and help in overcoming industrial ecosystem failures, but they can also offer opportunities for innovative public-private dialogue and partnerships. The role played by the

Fraunhofer Institutes in shaping the Industry 4.0 Strategy in Germany is a powerful example here (Andreoni, 2016). While the challenges in shaping such partnerships and the risk of failures remain, mature industrialised economies have no other options than re-developing their production systems on which the creation and distribution of wealth of the societies critically depends.

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Annex

Table 2: The industrial structure in Emilia Romagna (absolute and percentage figures, by sector and firm size), 2015

	0-9 employees		10-49 employees		50-249 employees		>250 employees		Total	
	Firms	employees	Firms	employees	Firms	employees	firms	Employees	firms	employees
NACE A (agriculture)	3369	5360	57	975	3	190	1	344	3430	6869
NACE B (mining)	109	239	21	409	6	553	0	0	136	1201
NACE C (manufacturing)	30077	90328	7410	141688	1070	108786	185	112287	38742	453089
Other NACE	316039	562908	10667	185916	1053	99361	192	208899	327951	1057084
Total	349594	658835	18155	328988	2132	208890	378	321530	370259	1518243

	0-9 employees		10-49 employees		50-249 employees		>250 employees		Total	
	firms	Employees	firms	employees	Firms	employees	firms	employees	firms	employees
NACE A	98.22%	78.03%	1.66%	14.19%	0.09%	2.77%	0.03%	5.01%	100%	100%
NACE B	80.15%	19.90%	15.44%	34.05%	4.41%	46.04%	0.00%	0.00%	100%	100%
NACE C	77.63%	19.94%	19.13%	31.27%	2.76%	24.01%	0.48%	24.78%	100%	100%
Other NACE	96.37%	53.25%	3.25%	17.59%	0.32%	9.40%	0.06%	19.76%	100%	100%
Total	94.42%	43.39%	4.90%	21.67%	0.58%	13.76%	0.10%	21.18%	100%	100%

Source: own elaboration with official data from ISTAT

Table 3: Breakdown of the NACE C (manufacturing) subsectors in Emilia Romagna (absolute and percentage figures), 2015

	0-9 employees		10-49 employees		50-249 employees		>250 employees		Total	
	Firms	employees	firms	employees	firms	employees	Firms	employees	firms	employees
food and beverage	4094	14214	794	14426	118	12793	22	15920	5028	57353
textile and apparel	4562	13342	782	13930	78	7964	13	7617	5435	42853
wood and paper	2992	8418	550	10155	49	5191	5	2079	3596	25843
petroleum	3	13	4	73	2	171	0	0	9	257
chemicals	272	981	127	2876	47	4647	5	2762	451	11266
pharmaceuticals	8	9	10	261	6	628	4	2810	28	3708
rubber and plastics	1703	5654	691	14144	141	14731	34	19089	2569	53618
metal	5425	17834	1694	31595	173	15422	8	3204	7300	68055
electronics	487	1461	171	3874	35	3706	6	3581	699	12622
electrical	705	2265	279	5507	53	5505	8	3623	1045	16900
machinery	2813	10221	1447	28696	266	28129	55	35389	4581	102435
transport equipment	335	1022	172	3817	41	4019	17	11336	565	20194
other	6678	14894	689	12334	61	5880	8	4877	7436	37985
Total	30077	90328	7410	141688	1070	108786	185	112287	38742	453089

	0-9 employees		10-49 employees		50-249 employees		>250 employees		Total	
	Firms	employees	firms	employees	Firms	employees	Firms	employees	firms	employees
food and beverage	81.42%	24.78%	15.79%	25.15%	2.35%	22.31%	0.44%	27.76%	100.00%	100.00%
textile and apparel	83.94%	31.13%	14.39%	32.51%	1.44%	18.58%	0.24%	17.77%	100.00%	100.00%
wood and paper	83.20%	32.57%	15.29%	39.29%	1.36%	20.09%	0.14%	8.04%	100.00%	100.00%
Petroleum	33.33%	5.06%	44.44%	28.40%	22.22%	66.54%	0.00%	0.00%	100.00%	100.00%
Chemicals	60.31%	8.71%	28.16%	25.53%	10.42%	41.25%	1.11%	24.52%	100.00%	100.00%
pharmaceuticals	28.57%	0.24%	35.71%	7.04%	21.43%	16.94%	14.29%	75.78%	100.00%	100.00%
rubber and plastics	66.29%	10.54%	26.90%	26.38%	5.49%	27.47%	1.32%	35.60%	100.00%	100.00%
Metal	74.32%	26.21%	23.21%	46.43%	2.37%	22.66%	0.11%	4.71%	100.00%	100.00%
Electronics	69.67%	11.58%	24.46%	30.69%	5.01%	29.36%	0.86%	28.37%	100.00%	100.00%
Electrical	67.46%	13.40%	26.70%	32.59%	5.07%	32.57%	0.77%	21.44%	100.00%	100.00%
Machinery	61.41%	9.98%	31.59%	28.01%	5.81%	27.46%	1.20%	34.55%	100.00%	100.00%
transport equipment	59.29%	5.06%	30.44%	18.90%	7.26%	19.90%	3.01%	56.14%	100.00%	100.00%
Other	89.81%	39.21%	9.27%	32.47%	0.82%	15.48%	0.11%	12.84%	100.00%	100.00%
Total	77.63%	19.94%	19.13%	31.27%	2.76%	24.01%	0.48%	24.78%	100.00%	100.00%

Source: own elaboration with official data from ISTAT

Table 4: The industrial structure in Piemonte (absolute and percentage figures, by sector and firm size), 2015

	0-9 employees		10-49 employees		50-249 employees		>250 employees		Total	
	Firms	employees	Firms	employees	Firms	Employees	firms	employees	firms	employees
NACE A (agriculture)	1219	1892	29	449	0	0	0	0	1248	2341
NACE B (mining)	122	435	27	464	5	577	0	0	154	1476
NACE C (manufacturing)	27327	74255	5117	97102	848	82714	162	161090	33454	415161
Other NACE	292007	519230	8470	143716	849	84639	156	164437	301482	912022
Total	320675	595812	13643	241731	1702	167930	318	325527	336338	1331000

	0-9 employees		10-49 employees		50-249 employees		>250 employees		Total	
	firms	Employees	firms	employees	firms	employees	firms	employees	firms	employees
NACE A	97.68%	80.82%	2.32%	19.18%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%
NACE B	79.22%	29.47%	17.53%	31.44%	3.25%	39.09%	0.00%	0.00%	100.00%	100.00%
NACE C	81.69%	17.89%	15.30%	23.39%	2.53%	19.92%	0.48%	38.80%	100.00%	100.00%
Other NACE	96.86%	56.93%	2.81%	15.76%	0.28%	9.28%	0.05%	18.03%	100.00%	100.00%
Total	95.34%	44.76%	4.06%	18.16%	0.51%	12.62%	0.09%	24.46%	100.00%	100.00%

Source: own elaboration with official data from ISTAT

Table 5: Breakdown of the NACE C (manufacturing) subsectors in Piedmont (absolute and percentage figures), 2015

	0-9 employees		10-49 employees		50-249 employees		>250 employees		Total	
	Firms	employees	firms	employees	firms	employees	Firms	employees	firms	employees
food and beverage	3645	11727	510	9626	65	6059	10	10656	4230	38068
textile and apparel	2192	5619	440	8876	93	9041	15	12309	2740	35845
wood and paper	3727	8912	442	7886	40	4085	8	4467	4217	25350
petroleum	5	15	4	57	2	146	2	1093	13	1311
chemicals	208	688	88	1951	37	4104	4	2413	337	9156
pharmaceuticals	11	24	9	229	6	862	1	517	27	1632
rubber and plastics	1643	5260	516	9606	95	8474	23	16565	2277	39905
metal	5778	17197	1297	23712	176	16175	17	7840	7268	64924
electronics	424	1179	115	2333	16	1875	6	2531	561	7918
electrical	548	1667	160	3163	34	3315	6	4809	748	12954
machinery	1747	5836	824	16789	154	15060	24	15122	2749	52807
transport equipment	394	1184	194	4037	78	8558	42	81249	708	95028
other	7005	14947	518	8837	52	4960	4	1519	7579	30263
Total	27327	74255	5117	97102	848	82714	162	161090	33454	415161

	0-9 employees		10-49 employees		50-249 employees		>250 employees		Total	
	Firms	employees	firms	employees	firms	employees	Firms	employees	firms	employees
food and beverage	86.17%	30.81%	12.06%	25.29%	1.54%	15.92%	0.24%	27.99%	100.00%	100.00%
textile and apparel	80.00%	15.68%	16.06%	24.76%	3.39%	25.22%	0.55%	34.34%	100.00%	100.00%
wood and paper	88.38%	35.16%	10.48%	31.11%	0.95%	16.11%	0.19%	17.62%	100.00%	100.00%
Petroleum	38.46%	1.14%	30.77%	4.35%	15.38%	11.14%	15.38%	83.37%	100.00%	100.00%
Chemicals	61.72%	7.51%	26.11%	21.31%	10.98%	44.82%	1.19%	26.35%	100.00%	100.00%
pharmaceuticals	40.74%	1.47%	33.33%	14.03%	22.22%	52.82%	3.70%	31.68%	100.00%	100.00%
rubber and plastics	72.16%	13.18%	22.66%	24.07%	4.17%	21.24%	1.01%	41.51%	100.00%	100.00%
Metal	79.50%	26.49%	17.85%	36.52%	2.42%	24.91%	0.23%	12.08%	100.00%	100.00%
Electronics	75.58%	14.89%	20.50%	29.46%	2.85%	23.68%	1.07%	31.97%	100.00%	100.00%
Electrical	73.26%	12.87%	21.39%	24.42%	4.55%	25.59%	0.80%	37.12%	100.00%	100.00%
Machinery	63.55%	11.05%	29.97%	31.79%	5.60%	28.52%	0.87%	28.64%	100.00%	100.00%
transport equipment	55.65%	1.25%	27.40%	4.25%	11.02%	9.01%	5.93%	85.50%	100.00%	100.00%
Other	92.43%	49.39%	6.83%	29.20%	0.69%	16.39%	0.05%	5.02%	100.00%	100.00%
Total	81.69%	17.89%	15.30%	23.39%	2.53%	19.92%	0.48%	38.80%	100.00%	100.00%

Source: own elaboration with official data from ISTAT