Into the Crisis: Fab Labs – a European Story

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Into the Crisis: Fab Labs – a European Story[1]

by Francesco Ramella and Cecilia Manzo

Does a relationship exist between the proliferation of Fab Labs (Fabrication Laboratories) that has taken place on a global scale in recent years and the economic crisis? Since the first lab was set up in Boston in 2003, these artisanal workshops – open to the public and offering tools and services for digital manufacturing – have multiplied exponentially.

At first, their spread was rather slow. While it is true that after just one year they numbered 32 in the world, there were only a few additions thereafter, just 13, giving a total of 45 laboratories in 2010. This was still a significant increase, over 40%, but nothing compared to what happened over the following six years, when a veritable explosion took place: the number of laboratories increased 15-fold, to reach the remarkable figure of 686 in 2016.[2]

Surprisingly, almost half of them, 331, were located in the European Union. This is a much higher number than in the United States (119), where the phenomenon originated: almost three times in absolute terms, and twice in relative ones, that is, in relation to population. There are in fact 6.5 Fab Labs for every 10 million European citizens, as opposed to only 3.7 for US citizens.

Why would such an increase have occurred in the 'old continent' and during the economic crisis? Considering that in Europe their foundation is often linked to the initiative of young-adult enthusiasts, passionate about new technologies, should the reasons be sought in the different economic trends on each side of the Atlantic? On average, for instance, between 2008 and 2015, GDP in the EU grew at a very modest rate (0.4%), three times less than in the US (1.2%), while youth unemployment in the EU reached critical levels (20.4% vs. 11.6%), increasing by 5 percentage points between 2007 and 2015 compared to just one percentage point in the States.

As we shall see, there is no simple, straightforward answer. The crisis has probably played its part, albeit indirectly: it raised awareness in a plurality of actors, both institutional and in civil society, with regard to the search for

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[1] This article is the result of the joint work of the two authors, and the assumptions and arguments developed are the result of their shared reflections. That said, section 2 was written by Francesco Ramella and section 4 by Cecilia Manzo. All the other sections were written jointly by the two authors.

[2] This number comes from the Fab Foundations website, August 6, 2016. The Fab Foundation is a non-profit organisation and part of the Fab Lab program at MIT's Center for Bits and Atoms. The Fab Foundation website shows the list of laboratories. The first list present globally was compiled in 2012 by the Center for Bits and Atoms. To be included on the list, it was necessary to send an e-mail with the details of the laboratory. Initially there were 128 Fab Labs, plus 27 "Planned Fab Labs" (on the point of opening). Shortly thereafter, management of the Fab Lab world map passed to the Fab Foundation, which developed the fablabs.io platform. With the new platform, the mechanism for access to the list also changed and at present new laboratories are expected to fill out a form within the platform. Their name is then added to the map and, once online, the effective existence of the laboratory must be confirmed by at least one other Fab Lab already on the list (and usually geographically close) and by the administrators of the site.

innovative ways to create social and economic value. It was not, however, the decisive factor in launching this phenomenon; rather, it was the scenario that facilitated its spread in light of the technological changes taking place in society and in economy. As will be seen, Fab Labs are a product of development rather than of the crisis, and tracing their source to the latter does not explain their different modes of propagation in the world.

To account for this *differential geographical diffusion*, certain 'contextual factors' have to be considered, such as the diverse *levels* and *models* of development and urbanization, not only in terms of the two sides of the Atlantic but also within the old continent itself. Similarly, 'agency factors' also have to be taken into account: the presence of specific actors, from different socio-institutional spheres, on hand to breathe life into this digital laboratories.

The goal of this article is threefold. First, it provides an overview of a new empirical phenomenon still rarely studied, Fab Labs, framing it in the debate on sharing economy, local development and open-innovation. Second, it presents an original dataset of Fab Labs and explains, through statistical analysis, the reasons for their differential geographical diffusion in the world (at a national level) and in Europe (at a regional level). Finally, through a mixed-methods analysis, the article shows the generative mechanisms and the typical operating modes of Fab Labs, using both the aforementioned dataset and qualitative evidence from Italy and France. We want to explore alternative mechanisms for producing innovations and how they are being utilised in some advanced countries.[3] These mechanisms are based on bottom-up generation of goods and services, and on the rationale of the so-called sharing economy and open innovation (von Hippel 2017). Drawing on research of local systems of development (Crouch et al. 2001), we argue that Fab Labs can be interpreted as providers of 'local collective goods' that are an essential component for regional development.

To address these issues, we have delimited the field of analysis from two points of view. The first boundary is typological in nature, with only labs of a certain kind taken into account: those that are members of the Fab Foundation. This international network was founded by MIT professor Neil Gershenfeld, who opened the "Center for Bits and Atoms" (CBA) in 2001. The idea behind this project was to promote centres where new objects could be created using digital design interacting with machines that operate on physical materials.[4] To join the global network of the Fab Foundation, local laboratories have to meet four essential requirements (although there are no strict formal checks): 1) They have to guarantee public access, either free or based on an exchange of services, for at least part of the week. 2) They have to subscribe to the principles of the Fab Charter.[5] 3)

[3] The issue is related to the potential impact of users innovation. For a review, see de Jong (2016).

[4] The birth of the Fab Lab project – with its first concrete realisations – is recounted in detail in Gershenfeld (2011; 2012).

[5] This subscription is the most important condition for registration. Regarding the topic we are dealing with, the Fab Charter stipulates - among other things - the lawfulness of the commercial

They have to adopt the tools and processes common to all Fab Labs belonging to the worldwide network.[6] 4) They have to actively participate in the international network, collaborating with other Fab Labs and taking part in some of its most important events. The second limitation that we have set ourselves regards territory. We have dealt predominantly, though not exclusively, with Fab Labs present in the EU, and in particular those located in the two countries where their proliferation has been greatest: France and Italy.

The article is organized as follows: in the next section (§ 2), we will explain in more detail what Fab Labs are and look at the features that make them interesting for those involved in development and innovation. In the section thereafter (§ 3), we will analyze their spread on different spatial scales, providing an explanation for their diverse degrees of penetration in various parts of the world, and especially in Europe. Finally, in the last section before the conclusion (§ 4), we will conduct more detailed analysis of digital laboratories in the two Mediterranean countries.

2. Between sharing economy and local development

As we have already mentioned, Fab Labs are small laboratories, open to the public, that provide a space with tools and equipment for digital manufacturing, making them available to individual users, small businesses and schools. As stated in the Fab Charter, they are a "community resource" with the aim of "enabling invention" and sharing "an evolving inventory of core capabilities to make (almost) anything".

For this purpose, they create local networks of digital practitioners connected to a global one, thus generating a relational architecture that closely resembles a "small world" network (Watts and Strogats 1998; Watts 2004; Ramella 2016). On the one hand, Fab Labs perceive themselves as *local places and communities*: they are both physical spaces where tutoring, making, and innovation take place and social spaces made of strong ties, where close-knit groups frequently interact (Fab Charter). On the other hand, they also consider themselves *global places and communities* because they guarantee access to distant individuals participating in the global Fab Lab phenomenon, with whom they share practices and attitudes. In this sense, they are also *loci* where weak ties emerge.

That said, fully to understand the contribution that Fab Labs can make to

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exploitation of the projects developed in the Fab Lab, but also the obligation to share some of the benefits that derive therefrom. It can be downloaded (in 12 different languages) from this site: http://www.fabfoundation.org/fab-labs/the-fab-charter/.

[6] All Fab Labs contain a number of machines and programs (open source and freeware) to create and realise physical objects. Some equipment, such as 3D printers, use so-called 'additive technologies' (printing layer on layer to build prototypes and objects of all kinds), while others employ 'subtractive technologies' (eliminating parts of material) such as CNC milling machines, laser cutters and cutting plotters. Then there are other tools for the input phase, such as 3D scanners and various softwares for 3D graphics. A detailed list of the equipment that should be found in each of the laboratories participating in the Fab Foundation can be found at this address: http://fab.cba.mit.edu/about/fab/inv.html.

local development, it is necessary to briefly introduce the technological and organisational changes taking place in the manufacturing sector, which have given rise to talk of a new – third or fourth – "industrial revolution" (Schwab 2016; The Economist 2012; Anderson 2012). In this new scenario – often referred to as Industry 4.0 – digitisation/automation of fabrication, product diversification, online trade and open innovation, all feature as relevant factors (Benkler 2003; Chesbrough 2006; Ramella 2016).

These changes deeply affect small and medium-sized companies. The new digital production technologies, in fact, can be very efficient for small series production: they make it possible to vary the goods without a significant change in unit costs based on the volume of production, therefore offering enormous potential for extreme product customisation. This is why several observers have noted that there is a potential for "*mass markets for niche products*", since new forms of artisanal entrepreneurship can develop by exploiting both new digital technologies and "long tail" economies (Anderson 2012; 2006). In other words, new possibilities are opening for small entrepreneurs, who are able to intercept demand from global markets for goods that would not find an adequate demand at a local level.

These changes may also represent an evolutionary phase of a model which has been widely acknowledged in the social sciences: the "flexible specialization" of the post-Fordist era (Piore and Sabel 1984; Bagnasco and Sabel 1995; Trigilia 2002). Adopting such a frame allows better interpretation of the impact of disruptive technological change (digital technologies and the spread of the Internet) on countries with strong artisanal and manufacturing traditions at the local and regional levels. The advent of new technologies, in other words, overlaps with transformative trends already ongoing in that industrial model (rather than radically altering them on its own). The 'digital breakthrough' operating in these stratified ecosystems leads us to conceptualize Fab Labs as potential *local collective goods* (LCGs) for development. LCGs are generally defined in the academic literature as generators of "external economies" that operate on a decentralised scale (Crouch *et al.* 2001; Crouch *et al.* 2004; Trigilia 2005).
They do so by (a) increasing innovative capacity, and (b) lowering the production costs for companies (especially SMEs) in a given territory. These 'external economies' can be both tangible and intangible. Examples of the tangible ones include infrastructure and services. Because Fab Labs are situated in a given territory, they can tailor their innovative solutions to what these territories specifically need (while no one on a larger scale would do that, leading to 'no production). Intangible external economies embrace instead cognitive and normative resources, such as tacit and contextualised knowledge, conventions, norms of reciprocity and social capital (Le Galès and Voelzkow 2001, p. 3).

Considering their multiple activities (training, promotion of digital fabrication, collaboration and open innovation), Fab Labs can therefore be classified as fully-fledged members of this category of collective goods playing a part in local development in terms of both social and economic innovation. They are in fact a *social platform for innovation* designed to stimulate learning, creativity and peer-to-peer collaboration, thus offering new solutions to the needs of local communities (European Commission 2013a); and they are also a *technical platform for innovation* aimed at strengthening the local community's capacity to use – for economic goals – their own "resources and abilities that are hidden, scattered, or badly utilized" (Hirschman 1958, p. 5).

Local enterprises, as well as citizens, can in fact benefit from both the supply of innovative solutions and education and training services provided by digital laboratories. Benefits are initially for artisans and entrepreneurs attempting to innovate, with these actors exploiting the reduced cost of access to capabilities and tools essential for prototyping (von Hippel 2017, 75). Fab Labs, moreover, tend to reduce the problems of 'non-development' and 'under-diffusion" related to user-innovations, therefore increasing the "social welfare" of the local society (Svensson and Hartmann 2017, 2). Thirdly, by making new knowledge stemming from the Fab Foundation's global network available to local actors, "versatile integration" between contextual knowledge (more tacit and rooted in local contexts) and codified knowledge (more formalized and coming from external contexts) is facilitated. This is considered an essential ingredient for the development and competitiveness of local production systems and industrial districts in particular (Becattini and Rullani 2000; Becattini, Bellandi and De Prosperis 2009; Ramella 2016).

Fab Labs can thus create educational and innovative opportunities in relatively less explored sectors, or foster inter-personal relations among "maker", strengthening the identity of the local society and its very ability to innovate (Alguezai and Filieri 2010). Fab Labs, in this sense, create social capital and knowledge spillovers across economic and social actors in a specific territory, and function as hubs for collaborative networks, which are regarded as key drivers of innovation (Asheim, Boschma and Cooke 2011, De Noni, Orsi, Belussi 2018).

All these features make Fab Labs real collective goods: bringing potential advantages to all local actors, even though only few have participated in their creation. We must add, however, that they have operational modalities and generative mechanisms which differ from traditional LCGs associated with the activities of public institutions (authorities) or interest organisations (associations). With reference to operational modalities, they rely on mechanisms of the 'sharing economy', since they create systems of horizontal relations based on 'temporary access' to production tools and services that are often private. Moreover, they are based on logics of action that are partly similar to those of open source communities, production networks and peer-to-peer exchange (Benkler 2004; Benkler and Nissembaum 2006; Botsman and Rogers 2011; European Commission 2013b; Schor 2014; Pais and Provasi 2015; Sundararajan 2016).[7]

[7] For a more detailed discussion of this point and the next, see Manzo and Ramella (2016).

With reference to the second aspect, several factors contribute to differentiating the generative mechanisms of Fab Labs from those of other traditional LCGs. As will be discussed later, the actors and the modalities of their foundation may differ markedly from one national context to another. In Europe, however, Fab Labs often result from the efforts of private citizens who use their time, their skills and, sometimes, their own money to set them up. This is consistent with the model described by the literature on innovation as a 'private-collective' generative mechanism, whereby individuals or small groups of people invest their resources and expertise to produce a public good (Von Hippel and Von Krogh 2003). This model differs from both the private investment one, which is market-oriented, and the public-intervention one, which is collectivity-oriented. All that said, agency factors and contextual factors do play a relevant role in explaining where Fab Labs emerged. Diversity in their geographical location clearly signals that teleological explanations based solely on the thesis that Fab Labs are the inevitable result of a 'technological revolution' are unable to explain an important part of why, and how, Fab Labs are generated. [8]

3. The geography of Fab Labs

Although widespread on a global scale, the Fab Lab phenomenon is a rather concentrated one from a territorial point of view (Table 1). While 84 countries have only one Fab Lab, in 15 countries there are more than 10 of them. The vast majority – about two-thirds – are located in two geo-political areas: the United States and the European Union.

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The geographical distribution of Fab Labs immediately highlights their relationship with levels of development. 80% are in high-income countries, where 20% of the world population lives. The remaining 20%, however, are located in middle- and low-income countries, where the other 80% of the world population lives. Furthermore, considering the density of the phenomenon – the number of Fab Labs per million inhabitants – there is a clear correlation with: a) the per capita GDP, b) the proportion of the population living in cities, c) the number of researchers, d) the expenditure on R&D, and e) the level of Internet use by the population. Even though correlation coefficients are not very high, all the results taken together highlight the link with levels of development. This is confirmed by a

[8] In this article, with the expression 'contextual factors' we refer to the socio-economic and institutional features of specific territories, which also include cultural and regulatory aspects. The expression 'agency factors' instead refers to the autonomous decision-making capacity of both individual and collective actors, albeit amid the opportunities and constraints structured by the context in which they operate. For the distinction between contextual and agency factors, see Burroni and Trigilia (2012).

binomial logistic regression which shows that the chance of a country having at least one Fab Lab can be predicted with good reliability by combining only two variables: volume of urban population, and amount of Internet use. [9] In short, what this first analysis tells us is that, on a global scale, Fab Labs are an urban phenomenon largely concentrated in the most advanced Western economies. It also suggests a relationship with a country's scientific-technological advancement: the more resources invested in research and in ICT infrastructure, the greater the Fab Lab presence. These statements, however, require two caveats.

The first regards the urban concentration of these laboratories. Obviously, it is predictable that an innovative phenomenon will originate and spread more easily in the Western world's most affluent cities. Since Weber's first reflections on the advent of modern capitalism, it has been clear that the Western city is the breeding ground not only of an entrepreneurial middle class but also of modern science and socio-economic innovation (Weber 2003). However, on considering the US and the EU – the two macro-regions with the most Fab Labs in the world – a number of differences emerge. In fact, with equal rates of urbanization, in Europe there is a larger number of cities located a short distance from each other, while in the US there is a higher level of suburbanisation and dispersion of population centres (Le Galès and Zagrodzki 2007). It is therefore easy to assume that a more fragmented and dispersed urban structure may have hindered the proliferation of Fab Labs in the United States. But this aspect only partially explains the differences with respect to Europe. Analysis of the urban locations of Fab Labs shows, in fact, that in the old continent their diffusion has been both *more extensive* (with a greater presence in smaller cities) and *more intense* (with a higher population density in any urban area class). The causes of the *differential diffusion* on both sides of the Atlantic must therefore be sought elsewhere: for example in the diverse 'generative' mechanisms.

In this regard, inspection of the information posted on the Fab Foundation website reveals a clear difference in how the labs are set up on each side of the Atlantic: an 'institutionalized' process in the United States and a 'grass-roots' one in Europe. The data collected show that three-quarters of the North American Fab Labs have their origin in secondary schools, universities or other educational institutions. In Europe, however, this percentage drops significantly (Fab Labs are virtually non-existent in secondary schools), while there is instead a larger amount of laboratories founded by groups of citizens, or by local public institutions, often in partnership with other civil society actors (Table 2).[10]

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[9] This simple model can correctly classify 78.5% of the 205 countries surveyed, as opposed to the 59.5% we are able to attribute without considering these two variables – that is, based on a model with just the intercept (see Appendix Table A1). Internet use by the population is closely correlated to per capita GDP (r 0.66 sig. 0.000) and thus summarises two items of information: one relating to a country's level of economic development, the other to the advancement of ICT infrastructure.

[10] Given the large number of 'missing-descriptions' present among the European Fab Labs compared to the American ones (67% vs 19%), probably due to the greater difficulty in providing a self-description in English, these figures should be interpreted with due caution. It is however likely

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The presence of so many digital laboratories in US educational institutions is clearly linked to the policies launched by the Obama administration to promote STEM disciplines (science, technology, engineering and mathematics) and the culture of innovation exemplified by the "Educate to Innovate" program.[11] These policies gave rise to a number of federal and state projects, and these leveraged the philanthropic activity of foundations and large private companies.[12] It is in the context of these initiatives that many of the "educational" type of American Fab Labs have found a special line of financing, to strengthen project-based learning methods.[13]

Besides institutional interventions, the 'profit-driven' activity of private actors should be mentioned. This second component – typical of the market-oriented American model of capitalism – has fostered the creation of commercial laboratories – like TechShop – which sell digital production services professionally and therefore do not take part in the Fab Foundation.[14] The dual action of public and private actors has thus left little room for a 'private-collective' generation of Fab Labs. In other words, it has reduced the incentives (and the necessity) for bottom-up mobilization, thus decreasing the number of laboratories – which, however, are (in general) more stable and better equipped. Citizen activity, on the other hand, has been more prevalent in Europe, although, as we shall see, with a number of differences there as well.

The second point we would like to make concerns the relationship between a country's scientific and technological progress and the proliferation of Fab Labs. This relationship is far from linear. On shifting attention to the European context, this aspect becomes very apparent. The data collected annually as part of the European Innovation Scoreboard (EIS) – to evaluate the quality of the National Innovation Systems (NIS) of the member states – makes it possible to assess this

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that these missing elements are classifiable amongst the less institutionalized and less resource-rich Fab Labs. This, therefore, adds strength to our hypothesis.

[11] To gain an idea of the financial commitment of these programs, consider that the 2017 budget envisaged the "investment of $3.0 billion across 14 Federal agencies for dedicated STEM education programs". For more details on this initiative, see the information reported on the White House website at the following address: https://www.whitehouse.gov/blog/2016/02/11/stem-all.

[12] In 2014, for example, the American oil company Chevron funded a $10-million project in collaboration with the Fab Foundation for the opening of 10 laboratories.

[13] Note also that in 2014 Obama launched the first "White House Maker Faire" in order to "support opportunities for students to learn about STEM through making, expand the resources available for maker entrepreneurs, and foster the development of advanced manufacturing in the U.S." (cfr. https://www.whitehouse.gov/nation-of-makers).

[14] TechShop is a commercial chain of laboratories, widespread throughout the United States, which provides its subscribers with digital manufacturing tools and courses and a specialized staff that assists them in the design and prototyping of their projects. The price for the subscription varies depending on the location, but in monthly terms can work out at around $140-200, while an annual subscription can cost around $1400/1600 (costs consulted on 22/08/2016). For a presentation of the services offered by this chain, see TechShop http://www.techshop.ws.

relationship in detail, in an area which encompasses almost half of the world's Fab Labs.[15] In addition to rate of urban population (r 0.56 $p < 0.01$) and per capita GDP (r 0.47 $p < 0.01$), the analysis conducted using the density of Fab Labs in UE countries confirmed the existence of statistically significant relationships with: a) the quality of ICT infrastructure and diffusion of digitisation in the economy and society; [16] b) many of the EIS indicators concerning advanced training, quality of research, and innovation. Surprisingly, however, no correlation emerges with the Summary Innovation Index, the composite indicator that assesses the overall performance of each country's national system.[17]

To explore this issue with multivariate analysis techniques, we therefore decided to expand the number of available cases, switching to analysis at the regional levels, with data on independent variables drawn from the Regional Innovation Scoreboard (RIS 2016).[18] The decision to shift to regional analysis (NUTS 1 and 2), apart from data availability, was also motivated by theoretical reasons. The phenomena of innovation, in fact, tend to be highly localized from a geographical point of view, so that understanding them requires an analysis of regional innovation systems.[19]

Including Norway, we were thus able to analyze Fab Lab diffusion – in relation to population – in 215 European regions. A first look at the most

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[15] What are NISs? This concept refers to "all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovation" (Edquist 1997, 14). This concept was introduced into the Innovation Studies field in the mid-1980s. Despite substantial differences, certain basic elements are common to scholars using this concept. First, the idea that knowledge and learning processes are key drivers of development. Second, the definitive abandonment of a strictly economistic view of innovation, with the realisation that: (a) innovation requires the contribution of a heterogeneous plurality of actors, both economic and otherwise (companies, universities, governments, etc.); and (b) *institutions* play an important role in shaping the context in which these actors operate. Third, the recognition that these processes are embedded in networks of relationships between people and between organisations. For all these reasons, scholars who follow this particular line take a systemic approach and focus on the social and political, as well as economic aspects, looking carefully at the origins and transformations of the institutional context in which innovation occurs (Edquist 2005). For a more detailed overview of the studies on NIS – as well as of the literature on regional and local innovation systems – see Ramella (2016).

[16] To measure this particular aspect, we made use of the "Digital Economy and Society Index" developed by the European Commission. This is a composite index that measures the digital performance and competitiveness of member states. It is based on five dimensions: 1) Connectivity (broadband infrastructure); 2) Human capital (basic and advanced skills to interact online and to take advantage of digital technologies); 3) Use of internet (variety of activities performed by citizens online); 4) Integration of Digital Technology (digitisation of businesses and diffusion of the online sales channel); 5) Digital Public Services (digitisation of public services and eGovernment). For more details, see: https://ec.europa.eu/digital-agenda/en/desi#_ftn1..

[17] The Summary Innovation Index sums up the score from 25 indicators relating to three different aspects: relevant inputs for the innovation process (Enablers); innovative strategies at a company level (Firm activities); innovation outputs (Outputs) (European Commission 2015).

[18] For having readily made the RIS database accessible to us, with all the indicators available at regional level, we would like to thank Daniel Wolf Bloemers, Policy Officer of the European Commission, DG for Internal Market, Industry, Entrepreneurship and SMEs, Unit F1 – Innovation Policy and Investment for Growth.

[19] This obviously does not mean that networks and crucial resources always and exclusively derive from the local context.

significant matrix of correlations, in addition to confirming the importance of the levels of regional development (also in terms of education levels), highlights other 'contextual factors' that appear to have facilitated/hindered the spread of the Fab Lab. First, there emerges the importance of the regional production structure and in particular a *positive* link with the innovative capacity of small and medium-sized companies. Secondly, a *negative* relationship is visible with the overall performance of the regional system of innovation – that is, with the ranking of regions carried out through the Regional Innovation Index. Third, a fairly significant *positive* correlation can be noted with the increase in unemployment between 2007 and 2015. This latter datum would seem, therefore, to confirm the connection – mentioned as an hypothesis at the beginning of our article – between the spread of Fablabs and the economic crisis.

However, multivariate analysis and qualitative research carried out on the Italian case – which we will discuss shortly – do not confirm a direct link between the rise in unemployment and Fab Lab diffusion in Europe. To explore the significance of the various factors of influence, we conducted a binomial logistic analysis, testing a model with 5 variables, with the aim of explaining the presence or absence of at least one Fab Lab in each of the 215 European regions for which data are available (Table A2 in the appendices).[20] This explanatory model suggests that in Europe Fab Lab diffusion has been influenced by: a) the population size of the regions, in terms of resident population; b) by their level of development, in terms of per capita income; c) and finally by their competitiveness and dynamism in terms of the innovation capacity of small and medium-sized companies. Statistical analysis, however, leaves other potential drivers out of the picture: as we show in the case studies, for instance, specific policies at the local and regional level can certainly be associated with the spread of Fablabs.

It is no accident that the list of the top 20 in terms of Fab Lab numbers includes some of the European regions with high levels of employment in manufacturing: the French region of Île de France, the Spanish region of Catalonia and the Italian regions of Lombardy, Veneto and Emilia Romagna. Yet this relationship with manufacturing should not be taken too far, given that all the most industrialized regions of Germany are missing from the list. However, our analysis does unequivocally show a) the absence of a positive relationship with the quality of innovation systems, both at national and regional levels, and b) the strong over-representation of French and Italian regions.

In fact, on subdividing European countries/regions based on EIS/RIS ranking, one notes that the peak of Fab Lab diffusion (both in absolute and relative terms) is located in the group of countries/regions known as *Strong Innovators* rather than in that of *Innovation Leaders* (Table 3).[21] This result, in part surprising,

[20] The model makes it possible to correctly classify 76.5% of the European regions, as opposed to the 53.1% that we are able to assign by default (with just the intercept model).
[21] The countries belonging to the group of 'Innovation Leaders' are, in order of ranking: Sweden, Denmark, Finland, Germany and the Netherlands.

immediately raises a question: why is the number of Fab Labs lower in the most innovative and qualified European regions? Our supposition is that in these territories – as has occurred in the USA – public and private actors offer many of the goods and services provided by Fab Labs, thus rendering the grassroots creation of the latter less necessary. This hypothesis is confirmed by the different generative mechanisms of the Fab Labs in the various territorial contexts (Table 2). As already noted for the US, even amongst Innovation Leaders the 'institutional model' tends to prevail. The educational Fab Labs – those originating at universities – are far more common, while laboratories founded by citizens and civil society non-profit organizations are relatively rare. The 'grass-roots model' on the other hand, tends to prevail decisively in countries that have less efficient and less qualified national innovation systems.

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4. Comparing two Mediterranean countries: Italy and France

As we have said, of the major European countries, France and Italy in particular stand out (Fig. 1). First, because they have a large number of laboratories: in absolute terms, they rank second and third in the world. Second, because they have a much higher density than might be expected on considering their position in the European NIS ranking. Not by chance – in confirmation of the above – both in France and in Italy (which are not listed amongst the innovation leader countries[22]) grassroots-laboratories represent 52% of the total, while in Germany the figure is just 12%.

There are, however, significant differences to be noted even between these two Mediterranean countries. In France, the spontaneous, grass-roots mobilization by citizens was promptly perceived and supported by the public authorities, and this has encouraged the further proliferation and consolidation of Fab Labs. Proof of this attention is the fact-finding survey promoted in 2014 by the *Direction générale des entreprises* (DGE) of the French Ministry of Economy and Finance, from which it can be inferred that the digital labs have become one of the priorities of the government's digital road map, and that more than half of those interviewed had received public, and in some cases very substantial, subsidies (Bottollier-Depois et al. 2014, p. 44). The DGE report also points out that there is at present a strong movement in the direction of institutionalization: on the one hand, digital labs operating in France are often "far from the market"; on the other, they tend to look for support from public and semi-public institutions, in search of funding and espousing a philosophy of "public service" and openness towards citizens, in keeping with the French tradition of "popular education" (ibid., pp. 54-55 and 81-82).

[22] France belongs to the group of 'Strong Innovators' and Italy to that of 'Moderate Innovators'.

The Italian situation, however, is rather different, given the lack of public support so far. However widespread the Fab Lab phenomenon may be in Italy, it is characterized by a higher level of 'voluntarism' and a certain sense of fragility. That said, Italy is, however, an interesting case: this country especially, given its rather low position in the European NIS ranking, is the real 'outlier' here.[23]

------------------------------ *Fig. 1* -----------------------------------

Why are FabLabs so widespread in Italy? The generational connotation and artisanal vocation of this phenomenon suggest two hypotheses that can be tested as possible answers: 1) the link with the high level of youth unemployment, and 2) the strength of manufacturing traditions in Italy.[24] The first hypothesis, however, does not seem to be supported by the geographical distribution of Fab Labs, given that these are highly concentrated in Centre-North Italy (where unemployment is lower) and that – at a provincial level– no correlation appears with unemployment rates (whether total, youth or intellectual). Moreover, the qualitative interviews that we carried out showed no overwhelming presence of job-seekers amongst the founders.[25] The second hypothesis, conversely, is supported by the geography of the phenomenon: Fab Labs are highly present in regions of the so called Third Italy (the central and north-eastern regions), where the model of flexible specialisation based on industrial districts is historically most widespread (Pyke, Becattini and Sengenberger 1990). The geographical location of Fab Labs, in fact, seems to be more in line with the percentage distribution of manufacturing firms than with that of the population.

Overall, even in the Italian case, where we conducted a more disaggregated territorial analysis (NUTS 3), ecological data confirm the results seen above: Fab Labs are a phenomenon linked to economic development and urban population. In addition, however, other territorial factors emerge: a) the importance of high levels of education; b) a fragmented production system, with a strong presence of manufacturing micro-enterprises; c) the endowments of social capital, and d) the degree of mobilisation in civil society on issues of civil rights and the environment (Manzo and Ramella 2015, pp. 393-4).

These results suggest that both 'human capital surplus' and 'deficit of collective goods' are relevant explanations for the growth of Fab Labs in Italy. In

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[23] It ranks 17th amongst European countries in terms of the quality of the national innovation system.

[24] Italy, in fact, has a youth unemployment rate (15-24 years) that is almost twice the European average. It is also the second manufacturing economy in Europe behind Germany. Compared to the latter, however, it has a much higher proportion of people employed in small firms (up to 50 employees): 55% vs 22.5%.

[25] In 2015 we conducted twenty semi-structured interviews with some of the founders/coordinators of the Italian Fab Labs. For more details, see the following note 29 and Manzo and Ramella (2015). Also the provisional data from a survey currently being carried out on all European Fab Labs seems at the moment to confirm this: the presence of unemployed persons amongst founders is less than 10%.

the Italian context in fact, the endowment of infrastructure and services related to new digital technology is very weak[26] and this 'supply vacuum' has thus created a structure of opportunity favourable to the mobilisation of civil society for the provision of collective goods. But the Fab Labs, as we will show below, were not created wherever they were needed but in specific places where 'contextual factors' and 'agency factors' came together.

To better understand the physiognomy of Fab Labs and the mechanisms in these two European countries that led to their creation, for Italy we will make use of the information collected by the authors of this article during a survey carried out in 2015[27] and, for France, the information in the above-mentioned survey promoted by the government in 2014.[28]

In Italy, the short history of the Fab Lab began in 2012, with the opening of the first laboratory in Turin. The diffusion process was very fast over the following years, leading to the current number of 69 Fab Labs.[29] After the initial phase, which, as we have said, featured a high level of spontaneity, Italy too appears today to have entered a *consolidation phase:* this sees the original laboratories going through a 'settling down' stage, as well as a proliferation of new laboratories – in this case, however, the phenomenon is less spontaneous and more driven by active policies.[30] In France, active policies in support of Fab Labs started rather early, in June 2013, when the government allocated funds in order to finance projects for the realization of digital laboratories. The establishment of these laboratories is still an ongoing process, but the effects of state contribution are evident from the data on the number of Fab Labs created in recent years: since December 2014 Fab Labs in France have increased from 52 to 84, so that it is now the European country with the highest presence of these laboratories.[31]

Let us now turn to the characteristics of these structures. Who 'inhabits' the digital fabrication labs in the two Mediterranean countries? First of all, those who

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[26] To provide just one proxy-indicator of this deficit, it is worth remembering that Italy is fourth last in the ranking of European countries according to the values of the "Digital Economy and Society Index".

[27] The data presented refer to all the laboratories recognised by the Fab Foundation, listed in the Italian section of the website (www.fablab.io/labs). The analysis is based on: 1) data and information gathered through their websites and specialist blogs and aims to reconstruct some of the Fab Labs' distinctive features; 2) semi-structured interviews with a representative sample of the founders-coordinators of laboratories (20 in total) distributed throughout the country.

[28] The research, conducted at the end of 2013 through an online survey answered by 86 French Fab Labs, investigated the state of the art and the economic model of French Fab Labs and tech shops. The study was published in 2014 by Bottollier-Depois *et al.*

[29] The cumulative distribution of the foundation's dates assumes the classic S shape: the typical logistic curve of the phenomena of innovation diffusion (Rogers 2003; Ramella 2016, p. 54).

[30] Over the past year, in fact, the first steps have been taken in promoting Fab Labs and supporting maker activity both at a national level (in March, 2016, the Ministry of Education, Universities and Research allocated 28 million euros to equip primary, and the first years of secondary, schools with new learning spaces where students can be trained in technological skills) and through regional and local authorities (Veneto Region, the City of Milan, Sardinia Region) and some private foundations (Fondazione Nord-Est, Fondazione Innovazione Digitale, Fondazione Adriano Olivetti and Fondazione Mike Bongiorno).

[31] Italy, which is second, increased in the same period from 52 to 69.

have created them: the founders. In Italy, these are predominantly men (11% are women), between 30 and 40 years of age and with fairly high educational profiles: 91% have a university degree (in most cases in engineering or architecture). After graduation, it is not uncommon for founders to have had professional experience abroad which gave them their first opportunity to experiment with the tools of digital fabrication. The stories of the Italian founders are united by an awareness of knowing how to do 'more' than required by their main professions: an over-capacity of labour resources and technical and professional skills not fully utilized in the formal economy, especially in times of crisis, and which are able to find expression in the Fab Lab.

The managers covered by the survey by Bottollier-Depois *et al* (2014) had features very similar to those of their Italian colleagues. The founders of the French Fab Labs have a high level of education: 78% have a degree, and, of these, 14% have a doctorate.[32] Inside the lab, each manager is a 'jack of all trades', taking care of every aspect of management, such as: the maintenance of, and access to, equipment; helping members; the organization of training courses; and opening and closing the laboratory. Finally, they perform the role, perhaps the most important one, of facilitators and stimulators of the community. As we shall see in what follows, the makers who frequent the Fab Labs most assiduously are one of its most significant aspects, not only because they keep the structure active, but also because they provide strong support for the laboratory management. This group of makers is closely integrated at a local level; it is characterized by the stability and frequency of relationships and tends to develop common interests and projects. In other words, it often takes on the features of a real community.

That said, a recent trend visible in France is the attempt of the 'jack of all trades' manager to bring differentiation and specialization to the different roles required for the operation of the facilities, in order to engage specific figures for the various functions, thus providing the Fab Lab with a more structured configuration.

With regard to the predominant profile of the users, Italian Fab Labs are frequented by students, first job-seekers and hobbyists; while at the same time offering their services to private companies, institutions and professional associations. The interviews do not seem to indicate either a 'typical user' or a strategy on the part of the Fab Labs to attract specific targets, although it is evidently important for the founders to cultivate partnerships with companies in order to produce prototypes of new products in the laboratory and strengthen the Fab Lab's design skills.

The French case exhibits similar features in this respect. 65% of the main users of the laboratories belong to what Bottollier-Depois *et al.* (2014) call the 'general public'. This description expresses, on the one hand, the heterogeneity of

[32] In this case, too, the provisional data of the survey conducted on all the European Fab Labs confirm the high prevalence of levels of tertiary education: almost all the founders have at least a degree.

users and, on the other, the openness of the labs to diverse types of user: citizens, employees, business people, students, researchers, children, artists, artisans, designers and start-uppers. Managers also say that they intend to attract economic actors into the structures, the purpose being to increase the number of relationships with companies and start-ups. The laboratories also perform a social role by bringing together different kinds of skills, especially for persons outside the labour market, such as young people, pensioners and the unemployed.

In both countries, therefore, the three principles that inspire the Fab Lab philosophy seem well-expressed: a) provide a shared space to work with tools difficult to purchase individually; b) provide the services of a research and development laboratory for product prototyping; c) propose events and educational opportunities through informal exchanges among members or, for a fee, through thematic courses and workshops. Assistance with access to the machines is an informal kind of education that takes place free of charge amongst members in both countries, and payment is limited solely to use of the machine. Moreover, as we shall see below, it is often those who stimulate and drive the lab environment that give it a more or less pro-market identity.

With regard to premises, Italian Fab Labs are: a) inside industrial buildings or warehouses (a phenomenon that connects to the reuse of disused spaces); b) in private areas contiguous to other activities (architectural firms, companies, associations); c) in incubators; d) or in a completely independent space (public or private property). Almost all of them use these spaces free of charge: 74% have their headquarters in a private space, 26% in a public space, and only 10% of those using private spaces pay rent; the rest of the laboratories have loan-for-use contracts. It is not uncommon for the headquarters of a Fab Lab to be incorporated in, or adjacent to, other activities related to the design world or social innovation, such as: co-working (9%), graphic design firms (9%), technology parks or incubators (20%) and small companies (6%). The 3D printer is the symbol instrument of such places, but it is only one of the many types of tools that can be found there. Each workshop combines different machines and programs (open source and freeware) for the design and creation of physical objects; and access and opening hours vary widely. The average number of days open is 4.3 per week. In addition, as part of their activities, several laboratories include Open Days dedicated to people curious about the world of digital fabrication, the ultimate goal of these being to raise awareness of the laboratory in the area. The sustainability of Italian Fab Labs is partly (and in some cases totally) guaranteed by enrolments for courses and/or membership. The management activities are carried out by the group of founders and the 'most active' members of the structure voluntarily (not formalized). Only a few Fab Labs have paid staff (one or two people at most) through contractual arrangements involving collaborations in projects (in many cases these are self-employed people with VAT numbers). The data collected by the *Fondazione Make in Italy* [33] in 2014 show that on average about 10,000 euros was spent to open a Fab Lab, a figure much lower than those proposed by MIT.[34] The initial investment is mainly based on personal capital, and it is not uncommon for the founders to have purchased (or, in the case of 3D printers, built by themselves) several machines before deciding to open the Fab Lab.

The situation in France is different, with half of the surveyed laboratories receiving public subsidies.[35] Most laboratories were launched by one or more combinations of: the founders' resources (53%), donations (47%), crowdfunding campaigns (22%), partnerships with private companies (18%) or by means of investment funds (16%).[36] In this case, sustainability is guaranteed by membership subscriptions (which include the cost of using machines) especially in the smaller Fab Labs. Training is the second source of income for 61% of French laboratories, but it is never the main one. However, it seems that the mere presence of one of these two financing methods is not sufficient to ensure economic stability. 40% of the laboratories say they do not pay rent, and of these 85% are based in premises provided by public institutions. In France, too, the 3D printer is the 'star' of the laboratories. 92% of the labs have one, albeit with certain differences: 87% have a low-cost 3D printer such as RepRap, MakerBot or Solidoodle, with a price of between 500 and 2,000 euros.[37] The second most popular piece of equipment is the digital milling machine, also in this case a machine with reasonably low costs. 68% of French laboratories devote at least half a day a week to Open Days. As in Italy, people who are curious and interested in digital manufacturing can go into the labs free of charge to see what happens in them. These are usually information days, where members are available to show visitors the equipment and services that the lab provides. Management tends to be 'voluntary' in nature, as in Italy, but in a far less accentuated manner. 42% of the laboratories have no employees [38], while the rest have 1.3 employees on average. According to an estimate made in the study by Bottollier-Depois *et al* (2014), 54% of laboratories use at least 10 hours of voluntary labour a week.

We therefore find, in the laboratories of both countries, small groups of people who have developed a strong sense of identification with the 'mission' of spreading the maker culture. This results in a sort of civic volunteerism whose purpose is to teach, disseminate or develop digital manufacturing. While, on the

[33] The Italian FabLab and Makers Foundation Make in Italy was created in 2014 by Massimo Banzi, Carlo De Benedetti, and Riccardo Luna. In 2015 the foundation carried out a survey of digital fabrication labs in Italy (*Censimento dei laboratori di fabbricazione digitale in Italia*): these data are open source and can be downloaded from the site http://www.makeinitaly.foundation.it.

[34] According to the list of instruments given by MIT, it has been calculated that to create a 'state of the art' Fab Lab the cost is about 227,000 US dollars (list costs updated August 21, 2015) to which management expenses must then be added.

[35] A significant number of these laboratories (20%) state they have received more than 70,000 Euros in subsidies (Bottollier-Depois *et al* 2014).

[36] It was possible to give multiple answers.

[37] Professional or industrial-style 3D printers can cost upwards of 50,000 euros.

[38] The corresponding figure in Italy is around 90%.

one hand, the scarcity of paid staff emphasizes the 'passion' of the members, it also, on the other, highlights the fragility of the phenomenon – to a greater extent in the Italian case. This feature is also indicated by the relatively low costs required in order to create a laboratory. The Fab Labs of the two Mediterranean countries, moreover, are at quite a distance from the market: at present, they seem more oriented to training and coaching than to designing and prototyping with companies and institutions.

A final consideration concerns the 'types of laboratories'. Fab Labs are not all the same, and not all of them perform the same functions: on the contrary, they are very different from one another, according to certain specific characteristics. In Italy this distinction is based on context, while in France it is more related to management and economic model.

In Italy, the labs can be distinguished on the basis of two main features. On the one hand, the *ability to create a local community*: that is, to become a reference point and gathering place for people who share the same interests; on the other, the *link with the territory* – in other words, the relationships established with local bodies (such as schools, public entities and private companies). In general, the laboratories have been able to adapt themselves to the needs of the areas in which they operate, developing partnerships and activities tailored to local needs. But regional differences also exist. The largest number of Fab Labs which have a dense network of relationships with local actors are located in the regions of Central Italy and the North East, where development is based on flexible specialisation. In the North West, on the other hand, the laboratories show – relatively speaking – a more pro-market orientation, with a strong propensity to develop projects and commercial prototypes, often in collaboration with industry. Finally, in the Southern regions (the least developed part of the country), Fab Labs, given the local production system's lack of responsiveness, tend to be very active in the field of direct training activities with schools.

French Fab Labs, however, stand out mainly because of several general objectives and of the principles that inspire the participation of the makers and the provision of services to the outside. In the typology developed by Bottollier-Depois *et al* (2014), Fab Labs are divided into three groups. The first type, the *community lab*, is mainly populated by open source, DIY and DIWO – (Do It Yourself – Do It With Others) – 'activists'; access is free of charge, the machines are often second-hand and/or self-produced by the members themselves, or even purchased cheaply. The function of this type of lab is almost a social one and the main objective is to create relationships between the users that animate the structure. The second type is more geared to *design* and has a specific professional target user; access costs to the lab are higher and the equipment is more sophisticated and expensive. The third kind, finally, lies somewhere between these two types, its inspiration being closer to the MIT model of Fab Lab, with a high level of equipment and a strong focus on design collaboration and contamination of knowledge.

In both countries, however, digital labs tend to produce economic and social externalities, both tangible and intangible, which do not always pass through the market and are often difficult to measure in terms of economic parameters, especially in the case of Fab Labs that address themselves mainly to the community. Ideally, in Neil Gershenfeld's definition, Fab Labs are places where it is possible "to make (almost) anything" – places, in other words, that are primarily designed for innovation and collaborative design. In both Mediterranean countries, however, these laboratories also function as a 'local collective good', often offering services free of charge and providing the general public, craftspersons and small businesses with equipment and training opportunities for the creation of new objects and skills. For this reason, they should be considered, and also treated, as public goods created by private citizens and destined for local communities.

5. Conclusion

As we have seen, Fab Labs are the result of development rather than the economic crisis. They are in fact more common in high-income Western countries and, surprisingly, there has been a greater proliferation of them in Europe than in the US. The reasons for this are to be found, in part, in the different models of urbanization present on the two sides of the Atlantic and, above all, in the different foundational mechanisms. In the United States, the generative model has been a more 'institutionalized' one, based around educational policies and institutions, while in Europe the model has been 'grass-roots' in nature, founded on the private-collective initiative of non-profit organizations and groups of citizens. Even in Europe, however, the regional diffusion of the Fab Lab has been quite variable, being influenced by: a) population size in the regions; b) their level and pattern of development; c) and, finally, their competitiveness and dynamism. That said, these labs have proliferated more in certain countries – such as France and Italy – characterized by less efficient national/regional innovation systems, rather than in countries that are European innovation leaders.

It is the Italian case, in fact, that seems to suggest that the link between the diffusion of Fab Labs and the economic crisis is an indirect one. As we have said, these phenomena are the 'fruits of development'. Their explosion in the crisis years cannot be interpreted in directly causal terms. Their propagation seems rather to follow an S-shaped pattern that is typical of the diffusion processes of innovation: initially, innovation is adopted only by a handful of pioneers, but after a while – thanks to process of imitation – the rate increases more rapidly (Rogers 2003).

On the other hand, however, the economic crisis in Europe has played a role, albeit a background one. It has stimulated certain 'specific' individuals to explore other professional and socio-relational possibilities, and these have resulted in community-based collective goods. As emerges from the interviews with the Italian Fab Lab founders/coordinators, the proliferation of this phenomenon in the most difficult period of the economic crisis was partly intensified by the hope – through the creation of a laboratory or by participating in its training courses – of finding a way out from states of partial/unsatisfactory employment. Even though they often do not represent a self-sufficient, employment alternative, these laboratories make it possible to develop skills, collaborative networks and reputational resources that can be synergistic and functional to other professional and entrepreneurial activities.

In other words, the rapid diffusion of Fab Labs in Italy as well as in other European regions seems to be a phenomenon linked to the *surplus of human capital* rather than to unemployment in the strict sense, and with a double connotation.[39] First, in the sense of an over-capacity of labour resources and technical and professional skills that are not fully utilised in the formal economy (especially in a time of crisis).[40] Second in the sense of overcoming conventional boundaries, in the exploration of new forms of innovation and of the creation of social and economic value.

It is not just professional, or more broadly material, benefits that drive individuals' decisions to set-up a Fab Lab. Personal gratification through attribution of meaning – what social psychologists term 'intrinsic motivation' – is clearly relevant. Similarly, individuals look for recognition from reference communities with which they identify (the "identifying activity" defined by Pizzorno, 1992, p.175). In the case of Fab Labs, sharing the values of a technical community is a key driver of individuals: learning, development and dissemination of the knowledge and values of digital and collaborative fabrication become primary, non-instrumental, objectives of their social action. Accordingly, interaction at the level of single Fab Labs is often among small groups that meet frequently: such interaction is based on shared interests and the sense of being part of a global community of makers.[41]

In conclusion, the macro analysis based on ecological data suggests an interpretative path to explaining the Fab Labs' 'differential diffusion' that – as we have seen in the previous sections – also appears to be compatible with the micro analysis. We may summarise our findings as follows: the levels of development and urbanization of the various countries represent a threshold effect, above and beyond which certain 'regulation factors' come into play to explain the greater or lesser presence of Fab Labs in the different countries/regions. In certain contexts, market action and government intervention (the USA and European innovation

[39] Both in Italy (Manzo and Ramella 2015, p. 401) and in France (Bottollier-Depois *et al*. 2014, p. 38-39), the founders and managers of these laboratories have very high levels of education.

[40] This concerns the availability of technical and professional skills and time that are in excess in relation to the use made of them by the official labour market and in the main jobs of these figures. There are various reasons for this: because employed work does not allow them fully to exploit their technological vocation and their entrepreneurial spirit; because forms of precarious, part-time or freelance professional work leave time available for other activities.

[41] These small groups recall some features highlighted by the literature on 'communities of practice' in organisations, which emphasises how group activities and the development of shared identity – based on common working practices – facilitate innovation (Lave and Wenger 1991; Wenger 1998; Brown and Duguid 1991; 2001).

leader countries) have produced an institutionalized model of the creation of Fab Labs, and this has reduced the space for grass-roots mobilization by groups of citizens. While this has inevitably restricted the proliferation of their numbers, it has also created more solid labs.

In other contexts, however, the weaker quality of the NIS and the presence of favourable urban and productive contexts (manufacturing and artisanal traditions) have generated a grass-roots model. This has given rise to a structure of opportunities facilitating the mobilization of educated citizens fond about new technologies and willing to experiment with innovative methods of cooperation in order to produce innovation. In some cases, as in France, this spontaneous mobilization was promptly supported by the public authorities, which recognized the potential for local development. In other cases, as in Italy, it created a model that was markedly more voluntarist in character.

The more disaggregated analysis carried out on the Italian case, however, shows that Fab Labs have not come into being automatically and everywhere with the same intensity. Their geographical diffusion has been fostered by specific 1) contextual factors (the most highly developed regions, metropolitan cities and provinces with a strong presence of SMEs) and 2) agency factors (people with high levels of education and a passion for technology, with civic inclinations and a surplus of time and expertise).

Appendix

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------------------------------ TABLE A2-----------------------------------

Reference

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Table 1 *The diffusion of Fab Labs (FLs) according to World Bank's Geographic Regions. 2015*

Regions	No. of countries	No. of FLs	% countries with at least 1 FL	% world population	% FLs worldwide
East Asia & Pacific	37	52	32.4	31.8	7.6
Europe & Central Asia	57	385	57.9	13.0	56.1
Latin America & Caribbean	41	56	31.7	8.7	8.2
Middle East & North Africa	21	24	52.4	5.5	3.5
North America	3	132	66.7	5.0	19.2
South Asia	8	18	37.5	23.4	2.6
Sub-Saharan Africa	48	19	20.8	12.6	2.8
All countries	215	686	39.1	100.0	100.0

Source: Elaboration of World Bank and FabLab.io data
Note: For the list of Countries included in each Geographic Region see https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

Table 2 Distribution of Fab Labs according to the type of origin/affiliation

	Educational Institutions	Public institutions	Non-profit groups	Total	N.
USA	74.2	14.0	11.8	100	93
UE Countries	40.0	21.8	38.2	100	110
Innovation Leaders	68.7	12.5	18.8	100	16
Strong Innovators	36.1	19.1	44.8	100	47
Moderate and Modest Innovators	34.0	27.7	38.3	100	47

Source: Elaboration of FabLab.io data.

Table 3 Fab Labs in EU countries and regions according to innovative performance class. 2015

Classes	Number of countries	Average number of Fab Labs	Fab Labs per 10 mil. inhabitants
Innovation Leaders	5	13.8	7.5
Strong Innovators	7	19.6	9.3
Moderate Innovators	14	8.6	5.4
Modest Innovators	2	0.5	0.7
All EU Countries	28	11.7	6.4
Classes	**Number of Regions**	**Average number of Fab Labs**	**Fab Labs per 10 mil. inhabitants**
Innovation Leaders	38	1.6	6.6
Strong Innovators	66	2.2	8.5
Moderate Innovators	81	1.4	6.2
Modest Innovators	29	0,2	0.6
All European Regions*	214	1.5	6.2

Source: Elaboration of Innovation Union Scoreboard 2016 (IUS), Regional Innovation Scoreboard 2016 (RIS) and Eurostat data. *Norwegian regions are included.

Fig.1 Fab Lab density based on EIS Summary Innovation Index. 2015

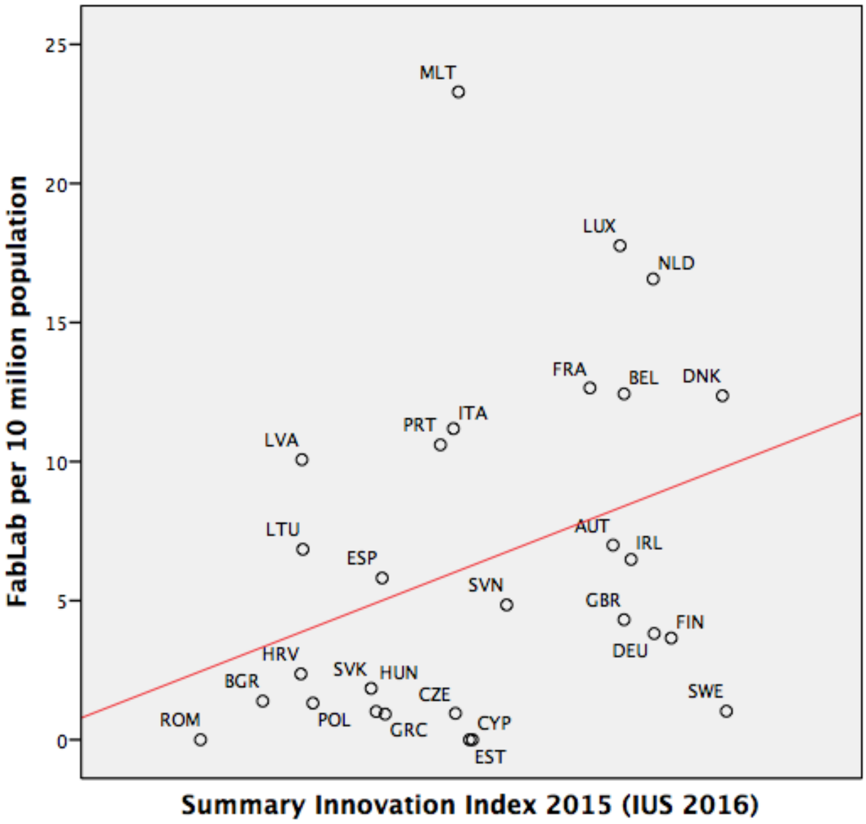

Table A1 Fab Labs in the World. *Logistic regression that predicts if a country has a Fab Lab*

Model summary	**Nagelkerke's R^2**	**χ^2**	**df**	**Sig.**	**No. cases included**
	.382	68.241	2	.000	205
Variables in the equation	**B**	**E.S.**	**df**	**Sig.**	**Exp (B)**
Urban Population 2010 (millions)	.000	.000	1	.000	1.00
Internet-users per 100 people 2010	.032	.006	1	.000	1.03
Constant	-2.568	0.4	1	.000	.077

Source of data: World Bank

Table A2 Fab Labs in Europe. *Logistic regression that predicts if a UE Region has a Fab Lab*

Model summary	**Nagelkerke's R^2**	**χ^2**	**df**	**Sig.**	**No. cases included**
	.477	94.211	5	.000	215
Variables in the equation	**B**	**E.S.**	**df**	**Sig.**	**Exp (B)**
% of SMEs innovating in-house 2012	14.342	5.79	1	.013	1693530.72
% of SMEs introducing product or process innovations 2012	-14.077	5.976	1	.018	0.00
Sales of new-to-market and new-to-firm innovations in SMEs as percentage of turnover 2012	5.885	1.943	1	.002	359.68
GDP per capita 2014	.000	.000	1	.003	1.00
Residents 2011 (in thousands)	.000	.000	1	.000	1.00
Constant	-4.383	0.697	1	.000	.012

Source of data: Eurostat and RIS 2016