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INDUSTRIAL DISTRICTS AND THE FOURTH INDUSTRIAL REVOLUTION, RECENT CHANGES AND THE INDUSTRY 4.0 CHALLENGE

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INTRODUCTION

Research studies that focus on how industrial districts are changing in order to adapt their local systems to new economic and technological challenges are today of particular importance. This is especially true in the case of Italy, a country characterised by long economic stagnation, weak innovation performance and where the local economy based on SMEs plays a major role in productive landscape. It is important to note several factors that make the current period a particularly favourable time to carry out this kind of research. First, globalised competitive forces have not diminished; on the contrary, they are exercising a continuing pressure to change. Second, the great economic crisis of 2008 in Italy, as in other Southern European countries, seems to have unfolded creative destruction and creative accumulation processes, forcing the exit and replacement of underperforming companies alongside the intensification of competitive efforts by healthier ones (Donatiello & Ramella, 2017). Finally, we are currently seeing the emergence of a new prevailing technological paradigm involving manufacturing, namely Industry 4.0.

The term Industry 4.0 refers to a new manufacturing production system. Following an approach oriented to innovation in both the process and the product, Industry 4.0 is based on advances in digital technology and the integration of different productive components. The diffusion of this new productive paradigm appears destined to have a substantial impact on manufacturing firms' activities and organisation. Given the novelty of this phenomenon, it is hard to find an endorsed and precise definition for Industry 4.0. A good starting point is to consider the enabling technologies, which form the technological core at the basis of Industry 4.0's implementation. These technologies can be classified as 1) those with an in-house application, such as collaborative robots and 3D printers (additive manufacturing) and augmented reality for productive processes, and 2) those that can operate on both an intra- and inter-company basis. They include process optimisation between interconnected machines (digital manufacturing),

communication between production and products (Internet of Things) and data management technologies such as cloud computing and cybersecurity (Bonomi, 2018).

Identifying the selected technology cluster involves focusing on rewording the problems or tasks to which the technological core is applied. Indeed, following Dosi (1982), technology selection and task determination comprise the two main dimensions of a technological paradigm, since these are the two components that shape the trajectory of technical development. In other words, technology selection and task determination are the two factors that define the normal activity of problem solving that extends the application field and improves the economic outcomes of any technological paradigm.

In order to understand the problems to which technology is applied, it is important to consider the interests of the actors involved, namely companies and institutions. For enterprises, Industry 4.0 provides answers to two different needs: on the one hand, it facilitates a reduction of both productive and transaction costs, thereby raising profits; on the other, it enables the conversion of replicative manufacturing to innovative manufacturing, thus embodying features of the service sector (Rullani, 2015). The capacity to operate this transition is increasingly important in the context of global competition. A manufacturing model based on innovation allows for the provision of more added value from global production chains, avoiding the productivity attraction of low labour costs countries. It is exactly on this ground of competitive capacity that institutions and firms see their interests converge. This common concern for a 'highway' of development also crosses different governance levels. At the supranational level, Industry 4.0 can function as a response to the European problem of creating an inclusive development model, a problem that has become ever more salient with the largely failed Lisbon strategy (Ramella, 2016). At the national level, meanwhile, the principal European countries focus their industrial policies on Industry 4.0 as a strategy to maintain manufacturing production within their borders. The relationships between, and the interests of, enterprises and local institutions are even more intertwined. Thus, local governance not only plays an important role in the diffusion of these new

technologies; at the same time, this technological change can also lead to an adjustment of local institutional settings, changing the collective goods provided and their relative importance.
These elements are at the basis of my research question:

What is the industrial districts role in the new days Italian economy, and how did they are changed in the post-2008 crisis periods?

What are territorial economies more able to absorb 4.0 technological innovations? In what ways is the diffusion of these technologies linked to the evolution of districts that is already underway?

What are the effects of the industry 4.0 diffusion over industrial districts?

The focus of the research

This study will focus mainly on the contribution of local governance and informal institutions in the integration of 4.0 technological paradigms in the context of industrial districts. This decision has been taken for three main reasons. First, the understanding of the role played by local institutions and the dynamics of their changes is one of the aspects where the contribution of economic sociology is particularly relevant, including for other fields and disciplines. Second, a great body of recent studies already addresses the role of network dimensions, both local and non-local, in innovation processes. Finally, and probably because of the previous reason, many scholars have called for a greater research effort to enquire into the coevolution of local economies and institutions (Crouch, 2005; Dei Ottati, 2017; Martin & Sunley). These decisions have theoretical, empirical and methodological implications.
From the theoretical point of view, the work relies heavily on the governance approach, particularly as it has recently been defined by Crouch (2005). This theoretical framework presents several advantages. Above all, it already incorporates notions and perspectives relating to agglomeration economies, neo-

institutionalism and comparative political economy, which are precisely the three main branches of studies indicated by Martin and Sunley as being particularly promising for economic evolutionary geography developmental turn (2015). Moreover, the authors' stress on exit, voice and loyalty dynamics provides a useful instrument for conceptualising local institutional frameworks' evolutionary dynamics. Indeed the capacity of local actors to exercise voice toward local governances can be a powerful driver of local institutions transformation and for the provision of new public good for competitiveness. At the same time, excessive loyalty to the status quo can lead to a "look-in" problem, an exit strategy by leader firms from local governance regulation initiating a process of local de-embeddedness.

Empirically, the research focuses on the metalworking sector. This includes the industries most involved in the 4.0 technological transformation regarding both the production process and the goods market. As we will see, this sector's relative importance in the landscape of industrial districts is growing over time, and metalworking districts represent specific local systems of innovation. Thus, specialized local economies in metalworking are a particularly interesting unit of analysis for this research's aims, especially considering that they are usually characterised by high union and business association density.

Regarding the methodology, the research is based on a mixed-method approach, combining variable- and case-oriented approaches (Ragin, 2014). The latter approach is based on a reasoned selection of cases, the study of which can both generate new hypotheses and falsify existing ones, while at the same time deepening the analysis of the causal connections that underlie the investigated phenomena. In the case of the variable-oriented approach, the research focuses on the ex-ante definition of causal links and the attempt to analytically reconstruct the relationships between different independent variables and a dependent variable. Because of the newness of Industry 4.0, a mix of these two approaches appears to be a good strategy for exploring the field and obtaining generalisable results.

The variable-oriented approach

Two different empirical steps compose the quantitative part of my works. One addresses the issue of the recent changes in metalworking industrial districts through contextual analysis, while the second explores the propensity of industrial districts to take advantage of Italian industry 4.0 policy. The principal aims of this first empirical step are to address the mechanisms related to the ecological level of analysis and compare specialised local economies and other local systems. More precisely, I rely on a multilevel regression model. This is a statistical procedure that can be used when the data are organised at more than one level (i.e. nested data), where individual units of analysis (at a lower level) are nested within contextual/aggregate units (at a higher level). This model is particularly useful in research with the following characteristics:

• The observations that are being analysed are clustered along spatial and geographic/political dimensions;

• Causal processes are thought to operate simultaneously at more than one level;

• There is an intrinsic interest in describing the variability and heterogeneity of the population in different contexts, over and above the focus on average relationships (Subramanian, 2004).

What make this model so important for research such as this, which matches these characteristics, is the possibility of testing the relation between individual variables and the context in which these are embedded. In my study, the first-level unit of analysis is represented by firms, while at the second level are the local economies in which they operate.

The second empirical step is based on a dataset of my own creation that, thanks to a sematic digital study on Italian firms forms balance, has allowed me to identify enterprises that are early adopters of 4.0 policy in 2017. The principal goals are to determine the territorial articulation of today's main Italian industrial policy and whether industrial district firms have a higher propensity to take part in it. Finding an answer to these interrogatives provides valuable insights on policy implementation and is an important indirect indicator of industrial districts' capacity to absorb 4.0 technologies.

The case-oriented approach

The last empirical step is based on a qualitative comparative case study of two metalworking districts, Lecco and Borgomanero. The first is an important and well-known industrial region located in the north of Lombardy. The second, despite being less known, represents a relevant local productive reality. This territory, highly specialized in the production of taps and valves, contains an "industrial monoculture" that, in 2019, employed more than 15000 workers and produced a combined turnover of 7.5 billion euros, most of which was derived from exports (64.9%). Moreover, Borgomanero represents one of the few local realities that demonstrate high levels of industrial resilience in the Italian Piedmont region. The analysis of these two cases provides a valuable instrument to respond to the hypotheses and address unsolved problems or generated by the previous empirical step. However, this final empirical part's principal aim is to establish more clearly the role of local governance in underpinning local economies after the 2008 great economic crisis, particularly concerning the fourth industrial revolution technological change. The comparative case study's qualitative analysis is primarily based on semi-structured interviews of district firms' entrepreneurs and local business association members

1 BUILDING A THEORETICAL TOOLKIT

1.1 THE CONCEPT OF EMBEDDEDNESS IN LOCAL ECONOMIES STUDIES

From a general point of view, local social systems of production have the capability of competing in a continuously globalizing economy, thanks to their embeddedness in a territorial, socio-political and relational context. Regrettably, the spreading of this concept has led to a proliferation of notions and meanings and consequently to an expansion and relaxation of the concept's boundaries. This is particularly true in the study of the evolution and economic success of regions characterized by locally clustered networks of firms. The "fuzzy notion" of embeddedness leads not only to a necessity for more clarity but also to the question of 'who is embedded in what'. Identifying the answer provided by different scholars to this question can be useful not only to clarify what meaning of embeddedness is more appropriate to my study but also to understand what is the possible relevant dimensions that I must investigate in this research.

Polanyian embeddedness:

The central issue is the 'institutionalization' of economic processes. Embeddedness is the integration of exchanges in a functionally differentiated institutional regime. The basic idea is that the market is socially constructed and governed and does not have a "natural", given, or inevitable form (Polanyi & MacIver, 1957). Thus, it makes perfect sense that firms in market economies should also be constrained and governed to some extent by their social-institutional environment. The varieties of capitalism theory may be seen as an attempt to apply this principle. However, Polanyi's work provides one other important insight: the notion of double movement. In a time of economic change, actors try to rearrange institutions in order to avoid the market's undesirable effects. In other words, society tries to

reintegrate the economic reproduction into the societal one (Polanyi & MacIver, 1957).

New economic sociology embeddedness:

The understanding of embeddedness advocated by Mark Granovetter (1973), which led to the widespread use of the term in the new economic sociology, fundamentally differs from the meaning of the concept in Karl Polanyi's work. According to Granovetter, economic action is "embedded in concrete, ongoing systems of social relations" (1985 pag.497), in other words, in actors' social networks.

The two different conceptualizations of embeddedness focus on two different aspects: Polanyian understanding points to how institutions integrate exchange and economic activities in a social system, ensuring its reproduction. New economic sociology points to social explanations of market outcomes. The issue is not how social relations build constraints around the market forces, but on the contrary, how social relations are important to explain the market's outcomes.

The embeddedness of local economies:

In the study of local economies, the concept of embeddedness emphasises the social and cultural factors underpinning the economic success of regions (Bagnasco, 1988). Factors contributing to this local rootedness are: a strong institutional presence; high levels of interaction; defined structures of power or patterns of coalition; and a mutual awareness of being involved in a common local enterprise. It is possible to identify three main relevant aspects of local anchorage:

The role of spatial proximity in creating trust among business partners (Becattini, 2000). Regional cultures and local institutional fabrics. (Bellandi & De Propris, 2015) positive social externality, the presence of dedicated services and public goods for competitiveness (Crouch et al., 2001).

What distinguishes this last understanding of embeddedness is its territorial dimension. Actor's, manly firms, operate in an environment in which they absorb, and in some cases become constrained by, the economic activities and social

dynamics that already exist in those places. This kind of perspective is particularly evident in Porter's study on firm clustering (Porter, 2000). In addition, the territory's dimension is related to some specific competitive factors, such as the presence of a skilled labour force.

It is now possible to provide an answer to my initial question: who is embedded in what?

Table 1 Different embeddedness conception aspects

	Who	**In what**	**focus**	**Dimension**
Polanyi	The economy (system of exchange)	Institutional and cultural structure	Negative economic externalities on the social sphere	Institutional and communitarian boundaries
New economic sociology	Individual behaviours actors/ firms	Network of ongoing social relation	Effects of social links on market outcome	No particular scale
Local social system of production	Firms, interest organization	Network/institutional setting	Social positive externalities on economic dynamism	Regional/local

This different concept of embeddedness (Table1) underlines three dimensions useful for understanding local economies. The first, the Polanyian one, underlines the presence of institutions that constrain economic actors' behaviours in order to preserve local actors from undesirable market outcomes. The second is the network dimension. This is a characteristic of single firms and not of the territory, and so it is possible that the networks in which they are embedded extend beyond the local reality. This second dimension is particularly relevant since recent studies show the importance of extra-territorial linking (De Marchi, Gareffi, & Grandinetti, 2017; Pegoraro, De Propris, & Agnieska, 2020; Tattara, 2009). First of all, they provide the principal way to link territories with foreign markets, and second, the presence of more open and differentiated networks make local look-ins less frequent. The last dimension is the territorial one. This refers to the territorial network and local

institutions, but its understanding of both networks and institutions is different from the previous one. Actors are embedded in the sense that they are attracted or anchored and therefore absorb the economic activities and social dynamics that already exist in those places. From this point of view, networks are no longer an individual characteristic but a systemic one. The presence of a community of enterprises and continuing and dense social relations is important to determine economic performance and attractiveness. Considering local institutional settings, both formal and informal, their principal role is to display resources for production systems through two main mechanisms: first, providing public goods for competitiveness, for example, the formation of skilled labour; second, the creation of institutional comparative advantages. Following this perspective, institutions provide stable behaviour patterns that make economic relations less problematic. These three dimensions are highly interconnected; an example could be the requalification of work during a period of economic transformation. In this case, the institutions are simultaneously providing a public good for competitiveness (creation of skilled labour force) and the redistribution of resources in order to avoid unwonted market outcomes, which is the social "dislocation" that follows major economic changes.

The distinction between individual and collective embeddedness is often mainly analytical and not empirical. Take for example firms that connect local networks with external markets. Their position in the network is highly valued for individual firms but also for the whole local economy. Indeed, recent studies show that the number of external links is a key competitive factor of industrial districts (Crouch, Schröder, & Voelzkow, 2009; Rullani, 2015).

1.1.2 Social capital and Local communities' culture

Since the rediscovery of the concept of industrial districts by Becattini (1979), scholars have emphasized the presence of a specific culture as a main feature of these socioeconomic entities (Bagnasco, 1988). Many researchers have identified in communities' features like high levels of in-group trust, cooperative attitudes, and

shared understandings of economic risks and fairness, one of the most important factors for the economic success of local economies. In other words, it is a distinctive culture that operates as a pillar of districts' social capital. However, a major theoretical issue remains, answering the question, "How can district culture spread so quickly and persist over time in a continually changing environment?" Unfortunately, the large production of literature on local economies provides largely unsatisfactory answers ((Bagnasco, 1988; Becattini, 2000; Bellandi & Dei Ottati, 2001). The fundamental problem lies in the inefficacy of statics theory to explain emergent phenomena. More precisely, a macro-cultural explanation has difficulties in grasping changes resulting from complex strategic interactions between social actors.

This point is made extremely clear in Coleman's claim about the importance of internal explanations of systemic behaviour, which implies that to provide a relevant macro-explanation, it is necessary to investigate the relations of the micro/meso levels that give birth to it (1994). Coleman thus identifies a schema with three components: the elements of a social structure that produce incentives for the action of the individual (macro-micro transition); the actors who, on the basis of their own principles of action and the incentives produced at the macro-level, decide which actions to carry out (micro-level); and, finally, the combination, according to various models, of the particular actors' actions that produce the consequences on the social structure (micro-macro transition). In the case of local economies, the macro phenomena are the relations between community culture and social capital. Indeed, this last explains the economic outcomes of districts. However, this kind of approach has many problems. First, it is difficult to distinguish between social capital, culture and institutions (Pizzorno, 1999). Second, the same elements can lead to very different outcomes, such as successful change or the problem of local look-in (Grabher, 1993; Porter & Landolt, 1996).

1.1.3 From cultural social capital to local governance

From the 90s, social factors that have a positive economic impact have been included in the concept of social capital, which refers to the positive economic

externality of social behaviours. Although this concept is commonly accepted as a useful tool for sociological and economic analysis, its complexity and the multiple perspectives from which it has been used make it ambiguous at times and always difficult to control (Dasgupta & Serageldin, 1999; Ostrom & Ahn, 2001). This is in part the direct consequence of the theoretical impositions given in Coleman, where it is used to identify the functions of a number of different forms of social organization (1994). He brings together under the same heading heterogeneous phenomena, which have in common the fact that they are configurations of connections or relationships capable of increasing the efficiency of collective or individual actions (Bianco & Eve, 1999). Social capital is qualified by its function to create resources both for individual and collective action. In order to profit from this concept and have more control over it, Bravo and Bertolini propose to divide it into five different forms: (1) relational, (2) normative, (3) cognitive, (4) trustworthiness of social environment, and (5) institutional (2001). The five terms are described below:

Relational: the sum of connections of relations and exchanges—variable in stability, value and contents—which link different individuals in their context of reference.

Normative: the sum of the rules and norms of behaviour and the values internalized by the actors analysed. Developmental psychology suggests that human beings may have developed over their millions of years of evolution the capacities and cognitive means to recognize and learn social norms as instruments for facilitating problem-solving through social exchanges. This does not mean that human beings have inherited one or a series of particular norms but that what is transmitted is rather a heightened ability to recognize and elaborate norms in order to increase long-term benefits in the face of problems of collective action E. Ostrom (1998).

Cognitive: the sum of the knowledge shared and the information possessed regarding the problems that an actor or reference group find themselves facing. Included in this category are the heuristics of the individuals, which allow for the solution of new problems by using accumulated experience and the sharing of common meanings with respect to specific institutions and behaviours. This is what Donolo defines as standard setting; different from the cultural understanding of

norms, it is not a prescription for determinate behaviours but is a shared understanding of the good endings of interactions that permit, among other things, the reduction of the ambiguities intrinsic in every rule (Donolo, 1997).

Trustworthiness of social environment: this concerns the general confidence afforded to the behaviour of the individuals present in any given system. A high level of trustworthiness of social environment allows a reduction in uncertainty in the face of possible actions and the will to cooperate with other members of the group, diminishing in this way the costs of transactions and increasing the possibility of collaboration (Bertolini & Bravo, 2001).

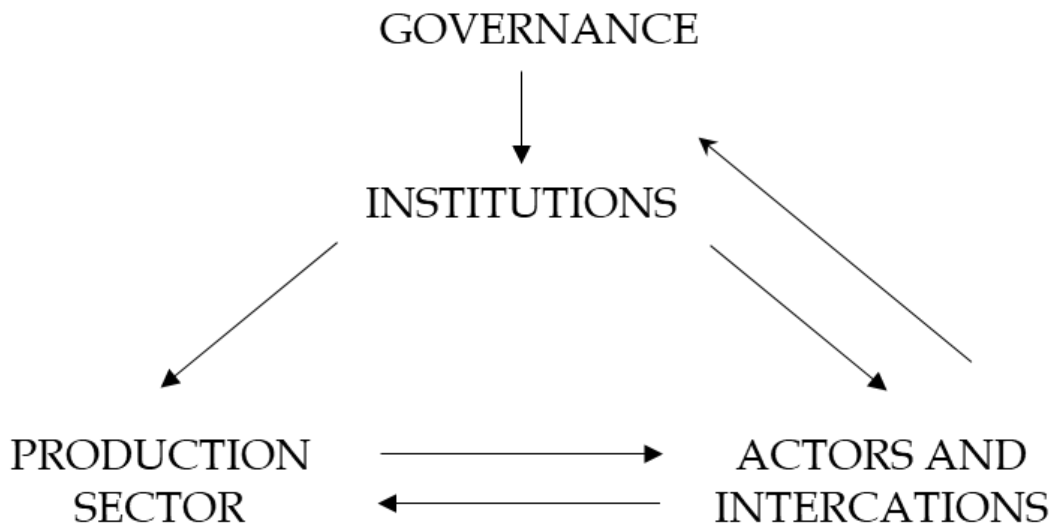
Institutional: this includes both informal and formal institutions. I use 'institution' according to the definition given by North: informal constructions of formal rules and mechanisms which are self-supporting and which constitute in such a way the rules of the game of society. Defined in this way, if they function efficiently, institutions can simultaneously reduce the uncertainty of the actors' behaviours and create an incentive towards greater levels of coordination and cooperation (North, 1990).

The different forms of social capital are related to different levels of analysis; if the first three are essential interactions at the micro-level, the last two are macro-characteristics of socioeconomic systems. In other words, the first three are related to actors' interactions and network dynamics, what Marshal defines as district atmosphere. The second two are related to the system's capability to create and sustain functional institutions and a cohesive community, and so are related to the capability of local governances. By governance, I mean systems composed of different actors that generate institutions and norms, allowing agents and social mechanism to liaise in view of their elaboration and activation for a collective end (Bagnasco, 1988). Governances are important also for districts' socio-economic reproduction because to do so, they need to be complementary for interests of production and social structure.

The seminal governance approach is by Hollingsworth and Boyer (1997), but more recently, Crouch (2005) restated the theory by increasing the dimension along which models of governances differ. Remarkably, the author takes into account the

problem of enforcement and the capability of economic actors to perform *exit* and *voice* on governances' systems. Crouch's work is of particular importance since governances are heavily connected with local institution frameworks. Moreover, as pointed out by Streeck and Thelen, to understand institutional change, it is crucial to focus on the feedback that results from *exit/voice* and the enforcement capability dynamics that occur among local actors (2005). The interactions between these different forms of social capital and the problems facing production systems generate both the mechanism of innovation and the social-economic reproduction of the industrial districts. The three elements of analysis and their interrelation can be outlined as follows:

Figure 1 Dynamic model according to the governance approach



The production sector creates different needs for economic actors and different coordination problems. In fact, if industrial districts and high-tech districts have great similarities, their primary forms of social capital and governances differ following the peculiar problems of each sector. The agents, thanks to the shared social capital that is involuntarily generated within their relationships, can solve only a part of their problems. Nevertheless, they are able to exercise *voice* towards governance actors to create voluntary forms of social capital, i.e. institutions. Therefore, local players can shape the institutions that create comparative institutional advantages for different sectors and production patterns, providing

specific public goods for competitiveness and solving complex interaction problems.

From the previous discussion, the importance of the agency of local actors, both individual and collective, clearly emerges in the dynamics of economic adjustment and innovation of local economies. Culture plays a pivotal role, but not as a set of rules or sedimented practices; on the contrary, it provides resources for intentional strategic actions. This point was made clear by Swidler. In her seminal work 'Culture in Action: Symbols and Strategies', she claims that culture or value usually does not determine the ends of action but instead provides a tool kit for constructing strategies of action (1986). The author suggests a division between the two different contexts of settled and unsettled actions. In the first case, culture has a direct powerful causal effect on individual behaviours; when we face familiar situations and routine problems as an individual or group, we perform actions in traditional ways. On the contrary, in the unsettled context, strategic actions prevail; when we face new problems or new contexts, the actions are not performed routinely but are chosen to select between expected outcomes. This does not imply that culture and values do not play any role in unsettled situations, but rather that in such situations people selectively use culture to inform or justify behaviour rather than merely being passively affected by it. In this sense, in an unsettled context human rely on a repertory of resources, selecting between different understandings and behaviours that enable them to choose strategically from different courses of action rather than constraining them to a single one (DiMaggio, 1997).

1.1.4 Institutions a non-institutionalized concept

Discussing institutions, the first dilemma is: what are they? However, it is far from simple to answer this question. From a general point of view, them structure society. Institutions frame actors' actions through the enforcement of prescribed behaviours. Thus, following North, institutions appear to be the "rules of the game . . . or . . . humanly devised constraints" (1991, p.97). To be precise though, according to North's own definition, constraints are not completely to be considered as

institutions. He provides a broader understanding of institutions that accommodates the informal basis of all structured and durable behaviour (North D, 1990). That is why he defines institutions as durable systems of established and embedded social rules that structure social interactions rather than rules as such. An alternative understanding of institutions as a coherent set of rules is provided by scholars who follow a more economic tradition. This contrary view sees institutions not as rules of the game but as game equilibria. For example, Schotter argues:

"[Institutions] are not rules of the game but rather the alternative equilibrium standards of behaviour or conventions of behaviour that evolve from a given game described by its rules. In other words, for us, institutions are properties of the equilibrium of games and not properties of the game's description. We care about what the agents do with the rules of the game, not what the rules are". (Schotter, 1981, p. 16)

The strong claim of this second point of view is to internalize enforcement's problems in the theory institutions' creation and reproduction over time. This literature on self-organization and spontaneous orders provides the essential insight that institutions and other social phenomena emerge and are stable over time thanks to their self-enforcing property. To understand this point, we can consider one of the pillars of institution studies: "The Logic of Collective Action" by Marcus Olsom (1965). The author was interested in the social dilemma at the basis of any collective action and he was able to identify two basic systems' elements of any kind of institution: the monitoring of group members' behaviour and the selective incentive aimed at creating a stable pattern of action. This does not imply that deviation from the prescribed behaviour is impossible, but the discrepancy between prescribed and performed behaviours does not exceed certain limits. In other words, in order to maintain a certain institution, constant pressure toward the prescribed action is necessary (Thelen, 2014). The approach of institutions as equilibria aims at internalising the cost of monitoring and enforcement in the explanatory theory. Although this kind of explanation provides important insight for understanding why some institutions are more stable than others, it is not well

equipped to take into account power relations and the preservation of social contracts (Castells, 2011). Streak claims that these two approaches to equilibria and rule, not only look at institutions in a different way but are interested in two different kinds of institution (Streeck & Thelen, 2005). The economic view focuses on voluntary institutions aimed at solving complications connected to intrinsic problems of exchange interactions. The sociological view looks at the institutions that are not designed to make exchange relations possible but to establish the limits in which these relations must be performed. They are in this sense normatively imposed.

The characteristics of the two ideal types are summarized in the following table:

Table 2 Institutional conception comparison

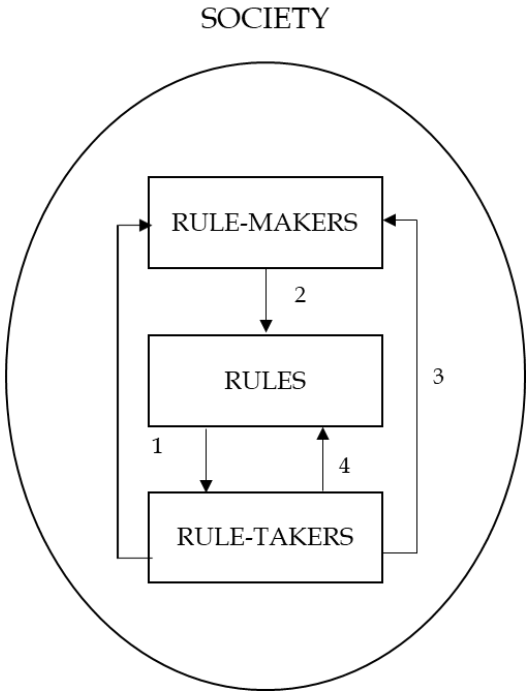
POLANIYAN	**WILLIAMSONIAN**
Authoritative organization	Voluntary coordination
Creation of obligations	Reduction of transaction costs
Public order	Private ordering
Government	Governance
Obligational	Voluntary
Exogenously imposed	Endogenously contracted
Third-party enforcement	Self-enforcement

Source *(Streeck & Thelen, 2005)*

One of the most important differences between the two institutions lies in the actors' possibility for *exit*. Indeed, Polanyian institutions are enforced exogenously, often by central actors. For this reason, it is more difficult to avoid them. This simple difference leads to a different understanding of institutional changing processes. The economic understanding allows for change because of exogenous factors that alter the stability of equilibria. On the contrary, the sociological point of view sees the institutions under constant tension for change. Indeed, following scholars such

as Streeck and Thelen, it is possible to conceptualize institutions as a regime. A stylized model of the theory is summarized in the following picture:

Figure 2 Visual represntation of institutions as regime theory



Source (Streeck & Thelen, 2005)

This model distinguishes between two categories of actors: rule-makers and rule followers[1]. The characteristics of this model are the legitimization of rule due to the role of the emanating actors and so the enforcement of a third party. At the same time, there are certain degrees of freedom in the application and interpretation of norms (4) that make it hard to anticipate what would be the possible outcome of an institution's implementation. Therefore a system of feedback is required (3). The discrepancy between the desired outcome and the actual one and the feedback process together with the space of freedom of application, allow for endogenous incremental institutional change. This approach, based on the declination of rules, presents several advantages in studying local economies, such as creating institutions following a process of trial and error. It also makes it easier to take into

[1] If it possible to analytically distinguish between the actors, it is also possible that they empirically concede.

account power relations and coalitions. However, the most significant merit is conceiving the possibility of incremental changes in institutions. It is possible, now, to provide a more exhaustive definition of institutions:

"Institutions are a set of rules for standard behaviours that take shape through the interaction of repeated actions. Institutions create shared expectations and the limits of implementable actions".

Following this definition Polaniyan and Willamosonian institutions are not two different typologies but two dimensions alongside institutions articulate. The first dimension accounts for the aspect of social integration and latency, while the second is related to the problem of effective coordination. For example, VoCs theory sees important welfare and industrial relation institutions as one of the most effective systems that underpin the equilibria in coordinate market economics (Hall & Soskice, 2001). Or even, in many studies on industrial districts, scholars underline the role of community rules to solve problems related to incomplete and incomplete contracts (Dei Ottati, 2003). Considering a more strictly economic perspective, Greif shows, in his work about Maghribi traders' coalition, how religious rules help to solve principal-agent problems in Muslim trade guilds (Greif, 1993). On the other hand, Willimsonian institutions can also be helpful to solve the enforcement problems of Polanyian institutions. As an example, we can consider the issue of "wage theft" in the USA. The rules about minimum wage and other aspects of job relation in the American system are particularly difficult to enforce. This happens because these institutions are dedicated to the labour market weaker segments, and the capability of institutions to regulate the employment relationship are heavily connected with the reporting of workers. However, since these workers have a really weak contractual position, they can hardly choose to act against employers. Therefore, this is only effective in sectors where workers' organizations are present to support the employee reporting to the central enforcement (Thelen, 2014). In this case, the presence of a governance logic (characteristic of Williamsonian institutions) makes government enforcement possible (Polanyian institutions). For this reason, in my opinion, a strict division of the two institutional models makes it more challenging to detect essential aspects of economic regulation. Following this

perspective, the more an institution is close to an equilibrium, the less costly the enforcement will be, and actors can use central enforcement as part of a coordination mechanism. In Industrial districts, this normative framework is not enforced by central law, but by local formal and informal institutions and social pressure to maintain a determinate relational standard.

1.2 THE CONCEPT OF INDUSTRIAL DISTRICTS

The concept of industrial districts refers to a specific production model rooted in a specific territory in which a high number of small-medium enterprises organise themselves in common values chains. The first to recognise the potential of these local systems of production was Marshall (2009), which, thanks to his study on the metalworking sector in Sheffield, recognised the following:

Passing away from this illustration of the action of modern forces on the geographical distribution of industries, we will resume our inquiry as to how far the full economies of division of labour can be obtained by the concentration of large numbers of small businesses of a similar kind in the same locality; and how far they are attainable only by the aggregation of a large part of the business of the country into the hands of a comparatively small number of rich and powerful firms, or, as is commonly said, by production on a large scale; or, in other words, how far the economies of production on a large scale must needs be internal, and how far they can be external. (p. 230)

Due to a process of productive specialisation and integration, small firms are able to compete with large and powerful enterprises. Marshall explained this assertion by introducing the concepts of district 'external economies' and 'industrial atmosphere'. From a simultaneous understanding of these two concepts clearly emerges the idea that the peculiar competitive capacity of industrial districts lies in exchanges between the simplicity of productive relations internal to single production units and the complexity of relations with the environment in which the

integrated process of production takes place. In other words, the local context became a source of significant positive economic externalities of social matrix, manifest in the skilled labour force, information flows and a high level of trust between economic agents (Trigilia, 1999). Taking into account the importance of context in shaping economic activities implies a substantive understanding of the economy. Consequently, it entails an investigation of the relation between the social and economic contexts.

Nevertheless, the richness of this approach was largely neglected for almost a century; Only in 1979, Giacomo Becattini, an Italian economist who researched Tuscany industrialisation, reintroduced the concept of the industrial district in the debate regarding economic development (Becattini, 1979). Neither the time nor the place of this rediscovery where a case. Indeed, the Fordism path of growth that had ensured economic and technological development for the twenty years following World War II declined starting in the mid-1970s. The model of development based on mass production and pursued by rigid, vertically-integrated companies as well as centralised modes of regulation based on central state intervention were less able to comply with prosperity. Meanwhile, the end of this golden age put pressure on the whole European socio-economic systems; few Italian regions, traditionally economically backward, were leaving unexpected economic developments. Several factors made the rapid growth of the productive capabilities of Third Italy surprising. First, it was based on small-medium firms and not on big companies; second, it was not fostered by the central policy of investment; finally, it took place not in big cities but in peripheral areas. This unusual industrial growth posed a significant challenge for the development theory of the time. Neither Williamsonian theory (1975) nor the modernisation approach started by Shonefild explain much about the economic dynamism of these regions in a scenario of general stagflation. In this context, Becattini (1979) proposed Marshall's industrial districts as a new unit of analysis and local development interpretative frame, redefining it as follows:

"Un' entità socio-territoriale caratterizzata, dalla compresenza attiva in un'area territoriale circoscritta, naturalisticamente e storicamente determinata di una comunità di persone e di una popolazione di imprese industriali" (p. 79).

Traslation:
"A socio-territorial entity characterized by the active coexistence in a circumscribed territorial area, both naturalistically and historically determined, of a community of people and a population of industrial companies"

Becattini's work represents the base of a flourishing field of study, a field that has seen the participation of many scholars from different traditions, such as economists, sociologists, political scientists and geographers. It is crucial to consider two aspects to understand why the concepts of industrial districts piqued the interest of so many different social scientists. First, Granovetter was concurrently revitalising another old concept—the embeddedness—and opened a propitious season for the economic sociology (Granovetter, 1973, 1985). Second, Becattini's works created the preconditions for a new interpretation of local economies as entities characterised by multiple facets of embeddedness (Storper, 1995). Moreover, Industrial districts theory does not reissue neoclassical concepts but creates an approach more in line with sociological analysis. Both agglomeration theory and transaction cost economics follow standard neoclassical logic and see local economies as collections of atomistic competitors, which coordinate through price/cost signals and contracts. In contrast, industrial district theory emphasises the contextual significance of communal non-economic institutions and the importance of relations of 'trust' in reproducing sustained collaboration among economic actors within the districts (Bennett, 1992). The prospective introduced by industrial districts theory, as the new economic sociology started by Granovetter, leads to a more substantial understanding of economic activity and forces the focus simultaneously on both social and economic reproductions.

1.2.1 Three Processes of Socioeconomic Reproduction

It is possible to identify three main socio-economic reproduction dynamics in industrial districts: the division of labour in an adaptive network, versatile integration, and local governances' deliberative capacity. These processes are highly intertwined, but for the sake of clarity, I will discuss each separately.

Division of Labour in Adaptive Networks

At the base of industrial districts' capabilities to compete is a population of small-medium firms specialized in different activities but which participate in similar, if not identical, value chains. A considerable number of businesses compete, while others cooperate closely. Operators in a district share a set of implicit rules that shape cooperation and competition, which Brusco has termed the districts' *behavioural codes* (1999). It follows that dense cooperative networks and competitive relations in local markets, both of which were embedded in informal institutions, achieve the integration of the division of labour among the district firms. In other words, industrial districts can be seen as a complex system based on the combination of different coordination mechanisms, related to both market dynamics (price signalling) and the community (a system of rules and conventions). Indeed, influential scholars such as Bagnasco (1985) and Dei Ottati (1986) respectively refer to this phenomenon as the social construction of market and the community market.

If industrial districts' competitive capacity in the short term relies upon the possibility of rapidly readjusting local production networks, then in the medium term, the context in which they operate provides the most valuable resources (Trigilia, 2005). The high level of trust among actors and the spin-off process, on the one hand, make it easier to establish new productive relations and, on the other hand, guarantee the flourishing of new enterprises that enrich the local context of productive capacity. For example, in many industrial districts, in addition to the primary production, it is present a number of enterprises manufacture machine tools for local core businesses' specific needs. In sum, what makes districts' economic reproduction possible is a constant process of specialization and

integration, which generates a context dense with economic and social relations. The resulting contextual complexity is handled thanks to a collaborative culture, information flow and social dynamics as reputation mechanisms, all of which guarantee coordination and lower transaction costs.

Process of Versatile Integration

The second reproduction dynamic concerns the local flow of information and the relation between contextual and codified external knowledge (Becattini & Rullani, 1993). These aspects regarding innovation were already present in Marshall's (2009) study:

Good work is rightly appreciated; inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; thus, it becomes the source of further new ideas. (p. 225)

Contextual knowledge is based on both the intimate knowledge of specific production phases and the density of social relations that enhance a general understanding of the whole district value chain (Lawson & Lorenz, 1999). In other words, this knowledge is the expertise of many agents who are specialised in different activities that complement each other; such agents typically engage in daily interaction and share technical and social codes that guarantee knowledge spill-over and rapid information flow. On the contrary, codified knowledge is produced in more formal ways through research and development programmes or by dedicated institutions, such as those found in universities, laboratories or scientific parks (Lawson & Lorenz, 1999). If industrial districts' social dynamics guarantee the rapid formation and circulation of tacit contextual knowledge, then the endogenous sources of formal codified knowledge are scarce. Indeed, a vital part of their reproduction is the ability to integrate them into the local system's external knowledge. What makes industrial districts able to compete on the external market is a process of double adaptation. On one side, external knowledge is adapted and integrated into the local expertise, while on the other side, local

dispersed ingenuity is aggregated and codified to be communicated externally (Becattini & Rullani, 1993).

Capacity of Local Governance

The concept of governance has been discussed in this chapter; for the ongoing discussion, it is sufficient to say that a district, as an entity, is a local socio-economic system that consequently has its own organisation. In other words, for a district to exist, systematic coordination of agents and resources with the aim of obtaining particular results is needed. In the local development field, the term *governance* refers to the institutional regulations based on more or less explicit rules that coordinate the actors' behaviours, the production of collective resources, the management of this last and the persecution of collective interest (Crouch et al., 2001). In the first wave of studies, the local community is the main element of governance. A local community is characterised by strong social relations based on familial relations or friendship as well as a strong local identity that enhances the trust between community members. In other words, each of the four forms of social capital are already discussed. Reputational systems, relational standards and the perception of being involved in a common fate are the main social dynamics that underpin this system of governance. It is important to note that the informal form of governance is based on both the local culture's 'longue durée' and rich information flows that cross all districts. Many scholars underline how circulating information about actors' behaviours is one of the main factors for the institutions' creation and advocacy. Information flow is important to sustain monitoring systems (Olsom, 1965), permit the framing and solving of problems related to public goods (Dietz, Ostrom, & Stern, 2003) and solve principal agents' problems not enforced by contracts or laws (Greif, 1993).

1.2.2 Studying Districts after Their Rediscovery, Decline, Dissolution and Adaptation

In the 1990s, a new phase of studies around industrial districts began. Indeed, these years saw several emerging phenomena leading to significant transformations in international, national and local contexts in which economic actors pursued

activities. Globalisation and the emergence of new information technologies considerably impacted industrial district theory (Bennett, 1994). Many observers questioned the ability of industrial districts to survive within the new, radically changed global economy. Globalisation's cold wind seemed to lead towards a progressive deterritorialisation of economic activities (Amin & Thrif, 1992), a process intertwined with the deindustrialisation of western economies and the rising of Asia as a new global industrial producer. Undoubtedly, the new economic landscape was characterised by greater global competitiveness, and Western economies experienced a loss of industrial sector centrality in favour of services. The same was not true for the deterritorialisation thesis. Apparently paradoxically, when global economies were becoming more interconnected, and value chains were increasingly international, the local dimension was also becoming more valuable (Scott & Storper, 2003). Indeed, the ability to anchor parts of global production networks in territories and extract value from them highly depends upon the quality of local resources and their management. This is particularly true for high tech productions, ICT and advanced services sectors, which present a high territorial concentration right because of their need for favourable context (Cooke, 2001).

The mutated economic context creates the space for a second wave of research regarding local economies. In the United States, influential scholars such as Krugman (1991) and Porter (2000) started a new branch of study regarding the concept of clusters. Cluster theory has many points in common with industrial districts tradition, but it is broader and considers a wider range of economic agglomeration phenomena. In particular, this approach places less emphasis on local society, it not focus on determinate dimensions of enterprises, and it is less related to specific economic sectors. At the same time, European academics were opening three connected lines of investigation. First, a systematic comparison was started between traditional industrial districts and emerging high-tech ones. Second, based on previous studies, an action research approach was initiated to investigate the possibility of using specific policy instruments to foster local development, which leads to the season of territorial pacts (patti territoriali per lo

sviluppo) in Italy and to cluster policy at European levels. The last line of inquires focuses on the capability of industrial districts to face the new technological challenges, a debate opened by Storper's Californian School.

Investigating the local economies' adjustment process implies taking into consideration not only successful paths of development but also local look-in (always connected to the economic downturn) and dissolution of district environment (with mixed effects on local economic dynamism) (Amin & Thrif, 1992; Burroni, Crouch, & Maarten, 2005). Before seeing how these changes recast the understanding of the district's socioeconomic reproduction, it is worth seeing more in-depth Italian context transformation. In Italy between 1991 and 2001, the employment in manufacturing decreased by 6.1%; in the districts, however, figures on average remained stable (–0, 8%), but with a shift from more traditional production to the mechanical sector (+17.7) (Dei Ottati & Grassini, 2008). Even if the manufacturing job loss continued during the Great Crisis, districts still accounted for roughly 40% of industrial employment (data from ISTAT 2015). Despite their capability to retain employment, it is important to focus on three other phenomena related to Italy deindustrialisation. First, despite the maintenance of manufacturing tradition, districts have followed off-shoring strategies in the last twenty-five years. Delocalisation is generally advantageous for firms that engage in this procedure, but the overall effects on the district can be positive or remarkably negative. This process is definitely damaging for weaker firms, but it can compensate for forcing an overall district reconversion toward more value-added activities. Moreover, offshoring can make it possible to obtain resources that can be reinvested locally, making the upgrading process easier. Nonetheless, if local firms do not maintain an adequate quantity and quality of high value-added functions within the district, then delocalisation accelerates the district's decline (Tattara, 2009). One other important aspect to consider is the changing of Italy from emigration to immigration. Especially in the North, the industrial districts' manual work demands were fulfilled by immigrant labour, a process still presents today (Lombardi & Magliocchi, 2016). However, immigration is not the only important change in the local community. Indeed, the transformation of parties' landscapes

ended the homogeneous political background, which characterised Italian districts. Christian Democratic Party (DC) in the northeast and the Communist Party (PCI) in central Italy both operated for the defence and development of local societies. However, both disappeared in the middle of the 1990s. Finally, the financial sector of the districts also faced major changes. Since the beginning of the 1990s, the process of liberalisation and the acquisition strategy led to a reduction of local banks. This banking system consolidation has transferred the decision-making centre away from the local context (Alessandrini & Zazzaro, 2000). The changing of economic and socio-political contexts has not only implied a diversification of industrial districts' evolutionary paths as look-ins, dissolution and adjustment, but also led to a modification of their reproduction processes.

New Division of Labour in Adaptive Networks

As we have seen, to face globalisation, districts must enter into relations with international value chains and reposition themselves in phases of productions with higher value-added. This leads to increasing the importance of managerial capability, greater R&D expenditure and a growing need for investments, both in entity and frequency. Consequently, district leader enterprises increase their size and produce a more formal and hierarchical organisation of local production networks to ensure stability in their value chain (De Marchi, Gareffi, & Grandinetti, 2007). The role of external gatekeepers and the disproportion of commercial power have undermined the relative symmetry in the relations of district firms. This process of hierarchisation can have different effects on districts' reproduction. In some cases, it leads to a substantial embeddedness of leading enterprises and a small number of selected subcontractors. In other cases, these processes may transform local realities from a network of firms to an enterprise structured as a network, as with the case of the Belluno eyewear district, where a single global player (Luxottica) rose as the main source of production coordination (Camuffo, 2003). However, even with the introduction of verticalization elements, typical integration of the division of labour proces was maintained in many local economies. These are cases where the leader enterprises began important resources

for the districts. They had the role of gatekeepers for other dynamic local firms, which, however, without the links offered by international players, struggled to reach international markets. On the other hand, leader firms rely on flexible local networks to maintain their competitiveness. This system requires the cooperation and commitment of the various actors, who cannot be easily achieved without distinctive forms of social capital. Some examples of this last dynamic are the Modena and Lecco mechanical engineering districts (Russo & Bigarelli, 2012).

Versatile Integration, New Actors and the need for Institutional Support

The pressure for technical innovation and the high global competitiveness make the integration of local contextual knowledge with codified external one more important than before. At the same time, the traditional, informal and decentralised circulation of knowledge, typical of industrial districts, was no longer able to ensure this integration alone. Indeed, the number of firms with sufficient financial and cognitive resources to access external knowledge is far lower than in previous times (Dei Ottati, 2017). These are usually final firms or subcontractors, which adopted functional upgrading strategies; these actors not only embody the effective endowment of both contextual and codified knowledge but also interact externally. Even if this kind of actor appears to integrate external knowledge into local systems efficiently, it is unlikely to occur without institutional support and the provision of public goods for competitiveness (Asheim, 1996). Most advanced firms may follow predatory strategies and restrict the extent to which smaller firms can access knowledge transfers, or the technical/cognitive distance between firms can become so great that it becomes extremely difficult to transmit knowledge. Regardless of the cause, in the long run, both of these dynamics undermine the district's reproduction and damage the most advanced enterprises, as their innovative capacities rely upon contextual resources. To foster collective learning and the integration of knowledge, districts must rely on both formal and informal institutions to maintain a cohesive community and provide specific support for small firms. Finally, the other type of actor that can foster the process of integration between the codified external and contextual knowledge is represented by

knowledge-intensive business services (KIBS) (Camuffo & Grandinetti, 2011). Due to the servitisation of manufacturing combined with the need for support for innovation and marketing functions, services connected to the industry are becoming more and more critical. Usually, these kinds of firms are located in medium-large cities, but to a minor extent, they are also present in districts that are adapting to globalisation, where they respond to the specific new needs of local manufacturing businesses (Camuffo & Grandinetti, 2011). It is important to note that only in the case of local KIBS do they participate in integrating local knowledge.

New Capacity of Local Governance, from Informal Community to Multi-Actor Systems

In the past, districts' governances were largely underpinned by cohesive communitarian factors, the cultural-political homogeneity and territorial identities, and common values provided the regulatory regime of the local market (Becattini, 2000). Also, public goods, such as those produced by the skilled labour force, were mainly generated using semi-automatic involuntary processes (Crouch, Galès, Trigilia, & Voelzkow, 2001). Nowadays, to face global competition and socio-cultural and economic heterogeneity, districts must rely on a more conscious and institutionalised form of governance (Crouch, 2005). In fact, a successful adaptation by a limited number of enterprises is not enough to ensure the district's social reproduction. What is needed is a path of development that involves a large number of small firms as well as the congruity of production and the social system. This means that in addition to measures designed to sustain the competitiveness of leaders' enterprises by helping small firms overcome adaptation difficulties, it is also necessary to introduce measures that will favour social cohesion (Dei Ottati, 2017). The current industrial districts' governances are multi-actor systems that involve different collective actors, such as business associations, trade unions and local governments. Following the definition of institutions as regimes, often in industrial districts, rule-makers and rule-followers coincide and can rely upon the efficient flow of information, which fosters the mechanism of feedback. It is extremely important to consider this since the actors mentioned before are only the

organisations that compose the local governance, not the governance itself. In actuality, local governances are the products of the iteration of these actors, which, through collective action, provide the districts' institutional environment and collective goods for competitiveness (Bagnasco, 2004). The capability of these actors to create cohesive systems, composing their respective interests around a shared view of local problems and elaborating a path of development, was what made local governances effective (Culpepper, 2003). If it is crucial to meet the immediate interests of most dynamic districts' firms, it cannot be done at the expense of more general medium-term interests (Dei Ottati, 2017). In other words, to avoid the problem of look-in, districts must adapt their production systems and the institutional context. However, this change follows a process of trial and error, which would not achieve the desired results. Local governances' actors may wont preserve the status quo withstanding the change, or, on the contrary, forcing a transformation that serves only a part of the district's firms, if any.

Following Bathelt and Conserva, these double-adaptive dynamics, where industrial change can influence or trigger institutional adjustments and vice versa, have six possible outcomes, synthesised in the following figure:

Table 3 Regional adjustment paths

Regional restructuring scenarios	Adjustments in the regional institutional context			
		Persistence	Hybrid change	Fundamental change
Adjustments in the regional industry and corporate structure	Persistence	- Loss of corporate competitiveness - No effects of regional learning - Regional decline	-Institutional stimulus unsuccessful -Stagnation of regional learning base	New institutions do not match Loss of regional learning base Regional crisis
	Change	-Limited new learning patterns develop -Hollowing out of regional learning platform -Slow regional change	-New and old industries integrated in new and established learning cycles -Growth in global economy consistent with localized learning	-New industries supported by new institutions -Established industries left behind -Bifurcated regional structure

Source (Bathelt & Conserva, Globalization and institutional change in Italian industrial districts, 2018)

The importance of a more institutionalised and formal form of governance does not mean that the involuntary and informal social capital no longer plays any role. On the contrary, it is still one of the main resources in districts. Moreover, a culture of cooperation, a common sense of belonging, and a reputational system play significant roles in the relations between the actors responsible for the implementation of formal governance. As mentioned, local culture provides important resources for strategic interactions of scope in addition to routinised traditional behaviours. Unfortunately, the academic discussion about industrial districts at present neglects the study of local institutions and cultural changes and how they interact.

1.2.3 Critiques to Industrial districts theory

Over the last three decades agglomeration theories, literature on industrial districts, innovative milieus and industrial clusters have enriched the knowledge surrounding the endogenous factor of local development. Even these approaches present some differences. They have many points in common with a significant amount of overlap. Given their similarity, they suffer the same shortcomings and face the same critics, which involve the following aspects:

Fragmented Theory Updates

If, in the beginning, the field was based on seminal works of great theoretical orientation, its evolution relies upon research that has strong empirical vocations. Thus, theoretical updates are scarce and there have been few attempts to merge them as integrated theoretical frameworks. This fragmentation is connected to the two main characteristics of the fields. First, the typical method used to investigate local economies is the implementation of case studies. Second, the field sees the contribution of many different disciplines, such as economy, geography, sociology, and organisation and business studies. If these features can be seen as great strengths for the evolution of the debate, then they negatively affect convergences towards a widespread and homogenous paradigm. Even if the various traditions

contribute to one other, wards and boundaries still exist, and case studies make it difficult to reach high levels of generalisability.

Even if the field presents a fragmentation, which largely follows disciplines bounders, it is also true that contamination still flourishes. Moreover, as shown in previous pages, the accumulation of empirical works leads to systematic recognition of the elements of change common in industrial districts.

Optimistic Views

For a long time, industrial districts have represented an interesting economic organisation to face the post-Fordism economy and a path of development more inclusive and, in some ways, more 'human'. The emphasis on cooperation, shared values and fairness makes districts as examples of industrial growth more congruent and harmonic with local communities. Some authors point out that it is only partially true, and they complain of an underestimation of power dynamics and competitive mechanisms.

In actuality, it is true that the district theory relies upon local embeddedness, social capital and cooperation as primary explanatory keys; nonetheless, influential scholars in the field have addressed both the problems of power and competition (Bagnasco, 2004; Dei Ottati, 2003). The problem of maintaining economic and social reproduction congruency does not imply the overcoming of market and political powers; per se, social capital is neither positive nor negative, so it can be used to foster collective actions or to pursue private ends (Bagnasco, Piselli, & Trigilia, 2001). As shown in previous pages by the risks associated with the verticalisation of the economic relations resulting from the increased sizes of firms.

A Model of Production Doomed to Fail

One other critic regards how these theories can be used to understand contexts differently compared to when they emerged. This is particularly true for industrial districts, which would have seen a phenomenon related to specific European regions. Moreover, globalisation processes lead to stronger interregional inequalities, which nowadays follow not only the boundaries of vast macro areas,

such as the Italian north-south divide but also centre-periphery dynamics. Thus, the new locus of global economies is, more than ever, metropolitan cities. Under these conditions, a more peripheral context can strive only to show resilience to decline and not exemplify local development.

Despite these critiques, empirically, it is possible to detect industrial districts in South America, Cina and India (Becattini, 2014). Furthermore, the industrial districts of European countries, particularly Italy and Spain, represent one of the few economic dynamic realities, both in terms of occupation and export (Hervas Oliver, 2018).

A Static and Close Explanation

In particular, the literature on industrial districts has been criticised sharply for relying too heavily upon static analysis and saying little about the development of regional collections of firms and industries over extended times. Moreover, the theory focuses overwhelmingly on internal relations with a consequent underestimation of the importance of external links.

These final critics are the most radical and the most crucial, questioning the effective capability of the industrial districts' approach of providing a deep understanding of the dynamics of territorial embeddedness. For these reasons, different approaches to exploring local development and agglomeration have emerged in recent years. First, there was a shift of focus from local ties to global links and networks, such as the global pipeline perspective from Bathelt (2004). Second, the diffusion of evolutionary economic geography and the connected theory of proximity. Before reviewing these theories in greater detail, it is essential to make a point clear. The Italian school of industrial districts provides a solid theoretical base and a flexible framework that makes possible the integration of different approaches. Remarkably, while generally used as the ideal type, following Becattini formulation, industrial districts represent a specific unit of study, which can be understood through three different analytical levels (Becattini, 1979). First, the productive system; second, the social relations connected to production; and third, local institutions. An example of the flexibility of this theory is its application to

high-tech sectors. While high-tech local economies present some significant differences from industrial districts, it was possible to study them by maintaining the same approach. The result of this process was not only a deep understanding of high-tech production agglomerations, but also a revision and expansion of districts theory and a greater understanding of sectorial differences.

1.3 EVOLUTIONARY ECONOMIC GEOGRAPHY

Evolutionary economic geography (EEG) is an emerging approach that has moved away from traditional economics and economic geography in general in favour of heterodox economics and other social sciences (Martin, 2000). The 'institutional' or 'cultural turn' undertaken by the field was motivated by a rising interest in the institutional, cultural and social foundations of regional and urban development and by the impossibility of understanding firms clustering considering only local embeddedness. However, Boschma and Frenken (2006) lament two opposing shortcomings in different theoretical developments. On one side, part of the debate neglects the importance of history in shaping the economic landscape. On the other side, the line of studies that account for path dependency does not provide explanations for how the landscape evolves over time. For these authors, an evolutionary perspective is essential for a proper understanding of technological progress, dynamic competitive advantage, economic restructuring and economic growth. Thus, a research agenda was started to extend the ideas and concepts of evolutionary economics to regional and urban development analysis.

1.3.1 Three Points of Theoretical Departure

Evolutionary economic geography is based on three theoretical pillars: Economics complexity theory (Frenken, 2006), path-dependence (Martin & Sunley, 2006) and generalised Darwinism (Essletzbichler & Rigby, 2007). Each of these approaches emphasises different moments of the evolutionary process. Complexity theory focuses on the creation of variety; path-dependence stresses the retention of existing information and knowledge; and generalised Darwinism examines how a

population of heterogeneous entities evolves through interaction among themselves and with the environment they help to shape (Boschma & Martin, 2010). Starting from the latter, generalised Darwinism is an analogy between the biological evolution of organisms and human society and organisational changes. This metaphor points out the Darwinian notions of variation, selection and retention (VSR), which are the core principles of any evolution dynamics. It provides a general theoretical framework for change in complex population systems. However, the meaning of those principles and the ways in which they operate are different for different domains (Essletzbichler & Rigby, 2007). The theoretical departure of evolutionary economic geography, what is the meaning of VSR in the economy. In a capitalist mode of production, firms differ from one another across a series of dimensions, such as product type, technology, organisational form, location, routines and so on. This heterogeneity is an inevitable by-product of a competitive environment where firms are compelled to innovate, search for new products, develop new markets, experiment with new sources of inputs, create new processes of production and organisational routine and can be sure only in the knowledge that others are doing the same (Schumpeter, 1942). It is this constant imperative to innovate that sustains economic reproduction and capitalist competition, fostering evolutionary change rather than the tendency towards an abstract equilibrium. Market selection sets out the rewards of these innovation attempts to alter the economic environment; it pushes some firms out of the market, encourages others to enter and constantly recasts relative efficiency (Essletzbichler & Rigby, 2010). It is important to note also that the selection process is far from perfect; it does not result in the survival of the fittest, most adaptive or most efficient in an absolute way. In this framework, fitness or efficiency is always a contextual, dependent and relative feature to a locally given environment, not according to a global maximum. Every selection dynamic needs a certain level of stability in order to exist. Indeed, in a world of instant and perfect adaptability, variety cannot exist, leaving anything to select. Technological switching costs, organisational inertia, cultural heritage and institutional resilience to change create path dependence that

allows this selection process to operate at different velocities (Hodgson & Knudsen, 2004).

How showed the unit of analysis of EEG are firms and not regions but location influences the behaviour and fitness of individual actors within a region. From local to global, different territorial levels can be conceptualised as different selection environments within which and across which evolutionary processes operate (Essletzbichler & Rigby, 2010). The different selection environments provide different pressures for change, and individual firms have different levels of capability to modify those environments, both directly and indirectly. Local features evolve over time, shaped by local histories and paths of development, generating contextual variety. If different contexts present to different characteristics the same competitive forces which underlie the birth and death of individual business units, they also select different socio-institutional environments (Essletzbichler & Rigby, 2007). Regions are more than a simple delimited holder of an agent's population; they represent complex systems technological, organisational and institutional embedded on constant pressure for changes and innovations. For this reason, EEG focuses on evolution both in regions and of regions.

1.3.2 Evolution of Regions

To understand the evolution of regions, the starting points focus on firms' populations for a common environment of selections. To explain this change, we can consider times *t* and *t+*, with the firms' population at time *t* defined as incumbent plants. The different units of production for the effects of environmental pressure apply changes in their organisation, production, technologies and so on, to generate local varieties. However, only a part of these attempts will be selected by the environment, forcing part of the plant to exit. At the same time, new firms entering the local systems of production enrich the local economies. Thus, the population at time *t+1* is composed of incumbent plants minus exists plus enters. The overall characteristics of regional production systems in the second time can be seen as the average features of these two populations (Rigby & Essletzbichler, 2005). The changes in the composition of the local economy and the relative importance of

different firms create a shift in aggregate regional technologies, specialisation, and organisational forms.

In the short term, the evolution of regional economies is the result of the following processes (Rigby & Essletzbichler, 2005):

1. Technological change in incumbent plants.
2. Differential growth (selection) of incumbent plants.
3. Plant exit.
4. Plant entry.

However, in the longer term, major changes to the overall organisational forms and institutional relationships may shift and alter the structure of local systems to generate more profound shifts in the regional path of development. It is increasingly clear that industries do not evolve in a vacuum but coevolve with other local agents and alongside the broader institutional settings of the regions (Essletzbichler & Rigby, 2010).

In this case, the focus shifted from the selection process of firms in delimited spaces to the competitiveness of enterprises settled in different regions. These changes, in retrospect, significantly impact the characteristics of places where plants are embedded. Individual agents coevolve with local systems, and over time, technology, institutional settings and other place-bound resources develop in specific ways fostering regional differences (Boschma & Frenken, 2009). Consequently, the production of variety gives room for the process of selection driven by market forces. Thus, if the evolution of local systems is extremely path-dependent, at the same time, it is subject to a double source of pressure for changes both internal and external. It is important to notice that the selection process between contexts impacts the selection in context (Essletzbichler & Rigby, 2010). These make it extremely hard, if not impossible, to predict changes to the local economies. They clearly can evolve slowly, incrementally and gradually, making possible some form of forecasting possible. Nonetheless, local economies can experience rapid changes arising from technological changes, policy implementations or major economic changes. Alternatively, they can experience a

decline due to a territorial look-in, which prevents any attempted local context adjustment to respond to external competitive forces.

1.3.3 Developmental Turn

If the EEG provides a valid theoretical framework with which to understand local economies' evolution over time, however, it is a recent development in the field and is not exempted from shortcomings. Martin and Sunley (2015) invoked a developmental turn to better address the role of local institutions and their evolution. The authors point to the importance of the path of adjustment based not only on substitution in local firms population but also on the dynamic of adjustment less radical and which involves a more voluntary form of institutional intervention. This extension of the theory is based on the integration of generalised Darwinism into another biological metaphor: generalised epigenetics. The basic idea is the possibility of adaptation to sectorial and firm substitution. This process is based on plasticity, canalisation and exaltation in a niche. These dynamics make it possible to react to environmental change with minor adjustments (plasticity), which, thanks to a process of coordination, leads to the exaltation of previous characteristics that make it possible to fit into specific niches. According to Martin, it is important to focus on the capacity of a system such as a local economy to maintain core functionality and performance (say, for example, economic growth, full employment and raising real incomes for its residents) under conditions of a constantly changing (competitive and technological) environment (Martin & Sunley, 2015). With this aim in mind, Martin proposed a research agenda that integrates the EEG element of comparative political economies and the study of local institutions instead of considering it an alternative model of explanation.

1.3.4 Evolutionary Economic Geography and Proximity

In general, a key issue for any theory that attempts to cast light on firms' agglomeration phenomena is the role of proximity in the process of learning, the role of the integration of new knowledge in local context and the coordination between actors. Boschma provides a framework to explain both the emergence of

changes and the problem of lock-in, focusing on the well-known trade-off between the ease of transfer and absorption and the relative value of the knowledge gained (Boschma, 2005). While a high degree of proximity, however defined, as well as network embeddedness are the main drivers of network formation and knowledge diffusion, the impact on innovative performance is rather ambiguous, since proximity between actors does not necessarily translate into a more innovative performance. The so-called proximity paradox can be used to argue that the drivers of network formation should be distinguished from the determinants of innovative performance. If proximity and network embeddedness clearly explain the formation of network relationships (Cassi & Plunket, 2014), interactive learning and knowledge flow (Breschi & Lissoni, 2009), they may not necessarily benefit innovative performance and they may even be harmful for interactive learning. Following Uzzi's (1997) theory, the network's density and proximity have a reverse U-shaped relationship in terms of the introduction of novelty. If some degree of proximity is necessary to establish stable relations and to facilitate knowledge transfer at some points, it starts to have a negative effect on innovative behaviours. Indeed, recursive practices, redundant information and normative values' homogeneity may create a cage that makes it difficult to acquire and exploit new knowledge.

Moreover, proximity between economic actors is more than the mere co-location; it refers to the process and relations, which links them on different territorial levels. Thus, according to Boschma, it is possible to decompose proximity in different dimensions (2005), each connected to different processes of the evolution of relational networks (Balland, Boschma, & Frenken, 2015). Before seeing these five dimensions in detail, it is important to notice that if heavily connected, they allow variations among them. Because of this excessive proximity or distance, on one dimension can be mitigated by the levels of others.

Cognitive Proximity

The claim is that there is a minimum level of knowledge required to exploit each new technology. In other words, to close knowledge gaps requires some degree of

cognitive proximity, since the agents involved need a common knowledge base and expertise to understand and learn from each other. However, cognitive proximity can have negative effects on innovation for at least two reasons. First, innovation and new knowledge building often require a dissimilar yet complementary body of knowledge; thus, cognitive distance tends to increase the innovation potential. Second, too much proximity can lead to cognitive lock-ins, since routines and best practices can obscure new possibilities; this phenomenon is called the 'competency trap'. To sum up, too little proximity leads to problems with communication, while too much leads to a lack of novel sources. The connected dynamic of change is learning and, more precisely, interactive learning (Lundvall & Johnson, 1994). Through interactive learning, actors reduce their cognitive distance and the configuration of knowledge complementarities between them.

Organisational Proximity

Analytically, organisation proximity is separate from cognitive proximity and refers to the extent to which the relations are shared in an organisational arrangement, as either inter- or intra-firm arrangements. More precisely, it refers to the grade of autonomy that enterprises can express. This dimension is articulated on a continuum that goes from short-term interaction in the market to hierarchically organised firms, passing through the firms' network, ordinated by their formality and structure. This kind of proximity provides control and coordination capability, which makes knowledge transfer easier, yet it can also be unfavourable for innovation. The common issue is the problem of lock-ins in specific exchange relations. Second, the implementation of innovation requires organisational flexibility. The tighter and more dependent the relations are, the more a single firm will face problems when adjusting and changing. The change dynamic of organisational proximity is the process of integration. Indeed, continued collaboration between different production units forces the development of co-specific assets to integrate a dispersed production process. An example is the specialisation of machine tolls producers for serving the main production activity in industrial districts.

Social Proximity

The notion of social proximity derives from the embeddedness literature, in particular following the understanding provided by Granovetter (1985). In essence, it indicates that economic relations are always embedded in social contexts. Thus, social ties affect economic outcomes. Following the analytical framework offered by Boshma, I will consider links as kinship and friendships between agents at the micro level. These trust-based relationships facilitate sharing and communication between intimate partners, with tacit knowledge reducing the distance to the other proximity dimensions. Nevertheless, long-term relationships based on trust and commitment may lock a social network member into established ways of doing things, thus harming the capacity for innovation. Furthermore, close trust and reputational systems may incur opportunity costs because outsiders with new ideas are denied entry. The dynamic element is represented by the process of decoupling and refers to the autonomisation of personal relations. In other words, this occurs when a relation is decoupled from its original context and ends up existing for itself (Breschi & Lissoni, 2009).

Institutional Proximity

While social proximity has been defined in terms of socially embedded relations between agents at the micro-level, institutional proximity is associated with the institutional framework at the macro level, accounting for Polanyi and MacIver's (1957) understanding of embeddedness. If an institution has important devices to solve problems arising from collective actions connected to innovation and is a provider of useful public goods for competitiveness, it may also represent a strong resistance to change, thus decreasing the whole system's capacity for innovation. Indeed, strong institutional players usually react to change in a very conservative way, particularly when their interests are threatened or have obligations towards actors in their network. Unsurprisingly, institutions and networks coevolve through a process of institutionalisation. Knowledge networks can play an important role in socially constructed institutional structures and increase the degree of institutional

proximity. Indeed, it is claimed that an important factor of success in the coordination of economic activities is that actors continuously reinforce and adjust their coordination rules. Continuous collaboration contributes to creating and recasting common values and consolidated practices and a shared understanding of the definitions of problems and goals. Thus, cooperation plays an important role in forming and adapting both formal and informal institutions.

Geographical Proximity

What role can geographical proximity play when considering the roles of the different forms of proximity? The first reason to consider is purely spatial, as this co-location reduces the transaction costs related to any kind of exchange or relationship. In addition, it provides a proxy for others as an initial grade of homogeneity between local actors. Having said that, geographical proximity can also lead to perverse effects since the beliefs about the convenience of co-located partners can lead to a spatial lock-in, in which the potentiality of external ties is underestimated. The agglomeration process lies at the base of the evolution of geographical proximity. As localised networks grow and develop, two dynamics of attraction and spin-off unfold, which foster a concentration of firms in the same territory. Thus even if geographical proximity may appears less relevant, it is important to notice that it is at the base of agglomeration phenomena and its externalities. It is precisely the colocation that origins communities of firms engaged in similar and related production that origins territorial social externalities as local buzz (Storper & Venables, 2004), knowledge spillover (Trippl & Maier, 2011) and skilled labour force concertation (Crouch, Galès, Trigilia, & Voelzkow, 2001), only to make some examples

1.3.5.Conclusive remark on Evolutionary Economic Geography

EEG presents an important theoretical development and an interesting new research agenda. While it is still new, it provides an integrated framework for studying the evolutionary dynamics of local economies based on the interconnection of three levels of analysis: the change in the number of firms that

form a local production system, how the social relation interacts with production structures to shape this change and the coevolution of institutional frameworks with the previous two levels of analysis. Remarkably, these analyses rely closely on those at the base of Becattini's industrial districts theory, which represents the starting point of the local development Italian schools (Becattini, 1979). This overlap does not imply that EEG does not introduce novel elements but that the two approaches can present several points of integration. While the industrial districts debate provides valuable elements for the developmental turn advocated by Martin and Sunley (2006), the focus of the evolutionary dynamics of EEG provides useful tools for overcoming the static and self-contained study of local resource and collective goods endowment. According to Ramella, a conscious territorial study must be dynamic and oriented toward a process that combines many explicative levels from analytical and space perspectives in both local and global contexts (2016).

1.4 INDUSTRIAL DISTRICTS AND THE TERRITORIAL NATURE OF INNOVATION

Innovation is becoming a more and more critical factor in economic development. Since the rise of post-Fordism, scholars, observers and politicians have stressed the importance of flexibility in recent years as the focus turns towards innovative performance. Abilities to introduce, absorb and exploit innovation represent the key elements of economic success. Thus, the industrial district's model of flexible specialisation is not enough to ensure competitive performance on external markets. As was already stated, the integration of external knowledge, i.e. absorptive capacity, has always been a fundamental part of the reproduction of the industrial districts, but its relative importance has grown over time. Moreover, the rising complexity of formal knowledge casts a shadow on small firms' absorptive capacities and consequently on their abilities to introduce innovation. Marshall (2009) has already noted this:

For it is almost impossible,… the characteristic task of the modern manufacturer, that of creating new wants by showing people something which they had never thought of having before; but which they want to have as soon as the notion is suggested to them: in the pottery trade for example the small manufacturer cannot afford even to make experi-ments with new patterns and designs except in a very tentative way. (p. 234)

If the weaknesses of small firms in producing innovations represent a historical constant, what does change is the capacity of local systems to distribute resources to overcome individual plant limits. There is little doubt about the importance of territorial context for innovation dynamics; them does not occur everywhere and are more prevalent in specific places. Actors located in different locales, regions and nations present very different innovative capacities fostering territorial differentiation. The unequal distribution of local resources to facilitate innovation reinforces local agglomeration dynamics, and this agglomeration creates more innovative contexts which follow an incremental feedback process (Scott & Storper, 2003).

1.4.1 Agglomeration of Specialisation and Diversity

Despite the consensus about the importance of firms' colocation and contextual resources, a largely unsolved debate examines which form of agglomeration displays positive effects and whether regions benefit most from being specialised or being diversified. This empirical question, put forward by Gleaser et al., originated from the contrast between two opposing theories and Jacobs's economic externalities (1992). Marshall, Arrow, and Romer (MAR) suggested that spill-over takes place primarily within a single industry. Territorial specialisations generate three main resources: a great number of suppliers specialised in different phases of production and commercialisation, the presence of a highly qualified labour force for specific production and the presence of a dense information flow and a knowledge spill-over related to specific activities. These elements foster collective innovation are based on the constant implementation of minor novelties developed

through learning "by doing" and "using", which are constantly integrated through learning by interacting (Ramella, 2016) in a more general local innovation. In contrast, Jacobs argues that most important economic externalities take place in contexts where a sectorial variety is present. Different regions are able to integrate more distant pieces of knowledge that can be locally recombined to catalyse innovation. These two opposing views distinguish two different types of agglomeration: economy of localisation, which is related to specialised peripheral areas (MAR), and economies of urbanisation, which is related to the urban dimension of cities. While the first generates incremental innovation, which leads to a general increase in local firms' productivity, the latter generates high levels of radical innovation, fostering the creation of new firms in different sectors (Content & Frenken, 2016).

The idea that 'resources of variety' are an important factor in local economies' economic dynamism was recently reinstated using the concept of related varieties (Frenken, Van Oort, & Verburg, 2007). In agreement with Jacobs, the authors saw innovation as essentially a recombinant process, but the notion of recombination was qualified, with researchers arguing that some pieces of knowledge are much easier to combine when productive common ground is present. In other words, what provides territorial competitive advantages is neither specialisation (excessive cognitive proximity) nor variety (excessive cognitive proximity) but merely the presence of technologically related sectors (Asheim, Boschma, & Cooke, 2011).

Empirical investigations of the importance of verity and specialisation as local development drivers present mixed results. While in specialisation, roughly the same number of positive and negative correlations have been found, a large share of studies indicate a positive correlation with variety, but the majority of research has found no effects or even negative effects (De Groot, Poot, & Martijn, 2016). This picture indicates that specialisation and variety theoretical notions are too simplistic to capture the varied effects of an economy's composition on its further development. Though specialisation can present several advantages, it is also exposed to a high risk of a local look-in. The many studies on (related) variety that have been unable to find significant effects on innovation and economic dynamism

cast a shadow over the semi-automatic nature of the recombination process and our capabilities to determine ex ante which sectors are technologically related. For example, Italian schools have highlighted how, alongside the main production activities in districts, several producers of machine tools specialised according to local needs are present. This line of thinking leads to two important considerations. First, specialisation and related variety are not two opposite phenomena. Remarkably, it is again Gleaser et al. who presented an interesting point (1992). They concluded that the best performing local economies are characterised by sectorial pluri-specialisation, which offers a certain degree of complementarity. It is difficult to explain the innovative performance of local economies and, more generally, economic dynamism purely on the basis of the degree and form of their agglomeration.

1.4.2 Innovation in Industrial Districts

Industrial districts are favourable for innovation for several reasons. The competition between them and the division of production in many specialised units co-locals are only a part of the explanation. There are also social and normative reasons, as reputation dynamics and work ethics. The embeddedness of local production systems in dense social relations networks fosters cross-fertilisation and the diffusion of innovation through imitative behaviours. Thus, technological innovation processes take a collective and diffuse characterisation (Ramella, 2016). The mix of competition and cooperation that has characterised district "community markets" creates both a constant pressure to innovate and a collaborative attitude. Since necessary skills are dispersed among several different actors and organisations, innovation attempts lead to searches for multiple contribution, making the whole process a truly collective effort (Dei Ottati, 1986). Storper and Venables underline the importance of long-term relationships based on repeated personal face-to-face contact in innovation dynamics (Storper & Venables, 2004). This type of relationship has four main features:

1. It is efficient communication technology.
2. It can help solve incentive problems, fostering trust and collaborative behaviours.

3. It can facilitate socialisation and learning, stimulating the creation of shared norms and codes of communication.
4. It provides psychological motivation.

At the territorial level, this set of factors determines specific local "buzz effects", facilitating the communication of complex knowledge and the cross-fertilisation of ideas, rendering the companies operating in this area more productive and innovative.

'Relational goods' not only make different areas more or less able to learn and develop new knowledge but also to transform this knowledge into competitive advantages which are difficult to imitate (Storper, 1997). In industrial districts, learning and the creation of new knowledge typically take the form of incremental innovation. Difficulties in generating radical innovation and rapidly adapting local contexts to more advanced technology are seen as major economic dynamism problems in industrial districts. Their typical competitive advantages do not appear to overcome this limitation in the modern economy.

This is only partly true. Empirical enquires on the Italian case –which is considered a 'Moderate Innovator' (European Commission, 2016) – reveal sectoral and geographical variability. Using the European Patent Office's data analysis on Italian companies, two distinct territorial and sectoral innovation systems can be identified (Ramella & Trigilia, 2010):

1. High-tech systems are present in northwest regions and concentrated in large metropolitan cities, such as Milan and Rome and in some Third Italy medium-sized university cities. These systems are characterised by the presence of a university, large firms and advanced service sectors.
2. Mechanical engineering systems related to medium–high technological fields. These systems are more often embedded in Third Italy medium-sized cities and characterised by high levels of specialisation and the significant presence of medium-sized firms.

This territorial differentiation is further confirmed by micro-level analyses on collaborative networks that emerge from patent documents (Caloffi, 2010). While the northwestern network is concentred in metropolitan areas and linked with

actors outside the region, the network involving Third Italy presents a more polycentric structure, and its links are more self-contended in local regional boundaries.

If it is true that collaborative networks in traditional districts are more locally-focused than ones located in the more urban environments, a closer investigation of 400 innovative firms reveals the significant impact of extra-local relations in both contexts. Highly innovative firms operate in local contexts highly qualified in socio-institutional terms and rely on both cohesion and variety. Successful innovative strategies are those that allow local resources to complement extra-local resources. This underlines the importance of the local socio-institutional context in providing and managing collective goods capable of generating both tangible and intangible external economies. This deliberative capability of local governance is responsible for the production of specific competitive advantages and the unfolding of a successful inclusive development path. To understand the difference between regional innovative and absorptive capacities, a researcher must focus both on ecological and relational analyses and consider the agency of individual firms and local governance collective actors.

2 ITALIAN INDUSTRIAL LANDSCAPE AND THE TERRITORIAL DIMENSION, INDUSTRIAL DISTRICTS STILL MATTER? ARE THEY CHANGING?

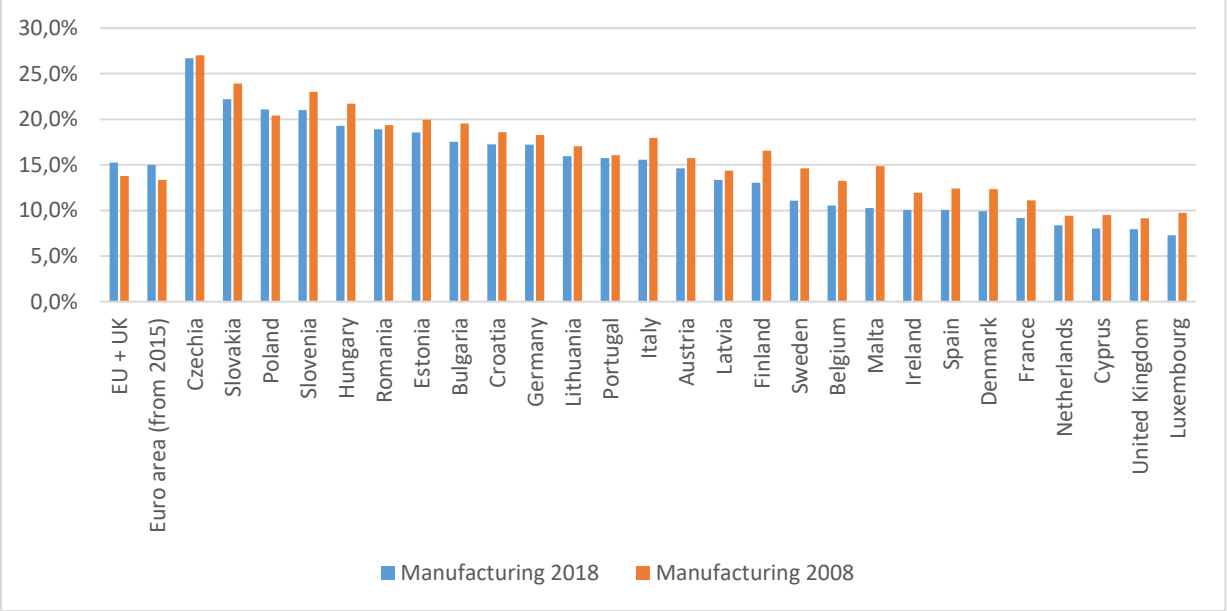
INTRODUCTION

This second chapter aims to address the following question: Do industrial districts still matter? Providing an answer to this interrogative means considering different aspects of both empirical and theoretical nature and imply different consequential steps. The starting point is to understand the relative importance of industry in comparison to other countries in terms of occupation and economic dynamism. In other words, understand the role played by manufacturing in the Italian economy nowadays. After this first step, it is crucial to figure out how manufacturing activity is divided between industrial districts and other local economies. Last, I will discuss how industrial districts distribute themselves among Italian regions and their sectorial and occupational structure. The discussion pursued in this chapter is not only a rightful descriptive exercise but also a relevant initial analysis of how industrial districts landscape has changed in recent years

2.1 THE MANUFACTURING ROLE IN ITALY

Macroeconomic data show that there have been substantial employment shifts from one sector to another. As documented by Herrendorf, Rogerson and Valentinyi (2014), in recent decades, many countries have experienced changes in the sectoral composition of their economic systems, and some common characteristics have been identified. Considering three sector classifications, agriculture, manufacturing and services, the share of the first has decreased, while that of services has increased and that of manufacturing has followed a non-monotonic path. However, a recent comparison of data on the manufacturing employment share in European countries between 2008 and 2018 shows that all nations have experienced a reduction in manufacturing sector representation (figure 3).

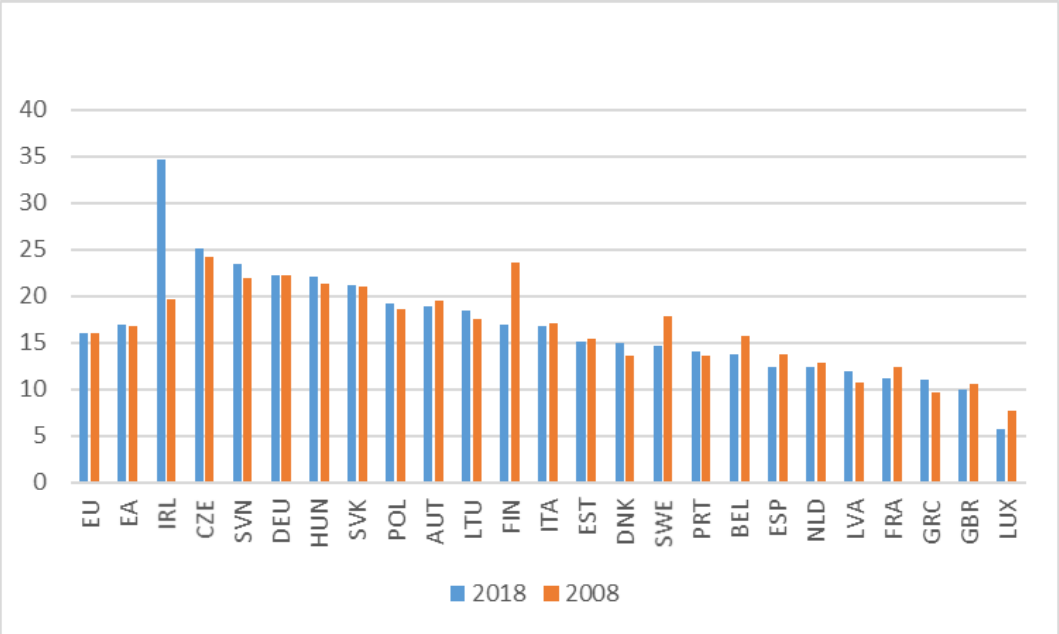
Figure 3 Manufacturing share over total occupation in UE27 and UK



Data source: Eurostat online database

The Italian case is characterised by a more significant reduction (-2.4) compared to other countries (mean -1,7), although in 2018, it maintained a considerable share of occupation in this sector (15.6). While this amount is only slightly higher than that of the whole European Union (EU), it represents one of the highest shares, together with Germany and Portugal, not considering Eastern members. These latter countries share a long industrial tradition and, since the late 90s, have also been the target of massive outsourcing and offshoring from other European economies. In particular, Germany and Austria have delocalised large parts of their manufacturing value chain in these areas (Gwosdz & Domański, 2008). The two rounds of Eastern enlargement of the European Union (EU) in 2004 and 2007 fostered this process but also led to a radical change in the spatial distribution of European manufacturing production. This enlargement is responsible for the general increase in manufacturing employment share in both the EU and the Euro Zone. Indeed, even though every country has experienced a reduction in manufacturing occupation, the total share has increased in aggregate. Returning to the Italian case, while the country has apparently lost its traditional manufacturing centrality, this industrial sector has been able to retain occupation despite increasing global and intra-European competition.

Figure 4 Manufacturin Gross Value Added GDP share in principal European



Data source: EOCD online database

This competition is particularly strong for low-medium tech manufacturing, which is the historical backbone of the Italian production system. However, comparing Italy and other European countries in terms of manufacturing occupation share only tells us part of the story. Indeed, it is interesting to add the sectorial contribution to the national Gross Value Added[2] (GVA) to this comparison (figure 4).

Since GVA is an important component of GDP, it can be used for measuring different contributions to GDP made by a specific industry or sector. In 2018, Italian manufacturing accounted for 16.7% of GDP, slightly below the 17.1% figure in 2008. Two critical aspects emerge from this information. First, compared with other European countries, the general manufacturing productivity in Italy is lower. As shown by Burroni et al. (2020), this is only partly caused by the relative specialisation in less value-added manufacturing sectors of Southern European countries. In fact, especially in R&D-intensive sectors, Italy shows low performance compared to North countries and Germany (Table 4).

Table 4 Hourly labour productivity (US$ PPP 2019)

	Medium-high R&D intensive activities	Manufacturing	Construction, Trade, tourism	Total productivity
Italy	42.8	34.4	24.5	47.5
Spain	44.4	37.1	24.5	47.2
Portugal	24.4	16.5	15.5	32.4
Greece	20.7	21	12.2	30.9
Germany	83.3	53.9	29.5	59.9
UK	64.5	35	25.1	47.9
Sweden	80.8	52.7	36.2	56.4
Poland	11.9	10.5	11.2	29.1

Source: (Burroni et al. 2020) elaboration on OECD data

The second important aspect arises from the comparison between the reduction in the occupation and GVA shares. While manufacturing has lost 13.4% of total employment since 2008, its participation in GVA has decreased only 2.3%. This

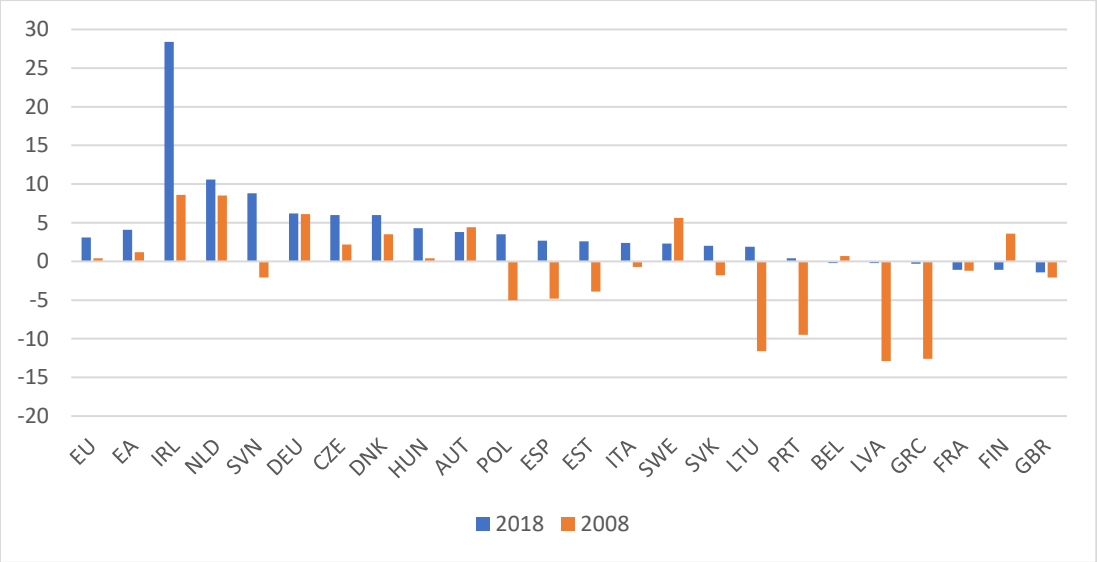
[2] "GVA reflects the value generated by producing goods and services, and is measured as the value of output minus the value of intermediate consumption. Value added also represents the income available for the contributions of labour and capital to the production process. Value added by activity shows the value added created by the various industries (such as agriculture, industry, utilities, and other service activities). The indicator presents value added for an activity, as a percentage of total value added." (OECD, 2020)

implies higher productivity growth compared to other economic macro sectors. To frame the Italian productivity problem, it is important to look at differences in performance between economic activities and consider firms heterogeneity. The productive Italian system shows strong polarisation. On the one hand, there are many micro and small enterprises, which are on average old and have a limited attitude toward innovation, advanced technology adoption and internationalisation. Such a large share of micro and small firms restrain aggregate productivity growth, not only through a composition effect due to the general correlation between size and productivity but also because, in Italy, these firms are on average less productive and dynamic than their Euro-area counterparts (an observation that does not apply to medium and large enterprises) (Bugamelli, 2018). On the other hand, there is a small set of firms, mostly medium- and large-sized firms, whose efficiency, performance and strategies related to innovation, technology and exports are comparable to those of their most successful European competitors. These firms have been able to react to the shocks that have hit the Italian economy in recent years by strengthening their innovation, investing in new technologies and upgrading their product quality. These firms are currently supporting growth. It is important to note that the average size of Italian high-performance firms is still smaller than that of such firms in other countries (Bugamelli, 2018). The polarisation of the productive Italian landscape is at the base of what Donatiello and Ramella have termed the innovation paradox in Southern Europe (2017). One of the main reasons for the poor productivity growth in Southern European countries is their moderate innovative performance. However, even though the 2008 recession hit Southern EU countries particularly hard, their innovative performances in the years immediately after the crises have matched or even exceeded the averages for the EU countries. This is due to two processes: first, through a reduction in the number of less-efficient firms and the arrival of new, more dynamic companies, and second, through the intensification of competitive and innovative efforts on the part of certain pre-existing firms. In other words, the 2008 Crisis has created a double movement that has reduced the share of old, less productive micro firms in favour of bigger, more dynamic ones.

2.1.2 Export and Regions, the locus of comparative advantages

To better understand the Italian manufacturing landscape, it is useful to consider one additional point: exports. Exports are incredibly important to modern economies to support GDP growth and employment. Moreover, exporting is one of the most effective ways to recover from a recession and economic stagnation (Kavoussi, 1984). The ability to compete in dynamic foreign markets allows local producers to avoid national consumption contraction and has the secondary effect of pulling resources from the external economy to the internal one. While these exchanges are important from an economic point of view, they are also tied to other positive economic externalities, such as knowledge spillover, technological transfer and access to important information flows (Falvey, Foster, & Greenaway, 2004). In other words, exports imply more than one positive external exchange, which can lead to endogenous economic growth.

Figure 5 Net export GDP share in principal European counties (2018/2008)



Data source: OECD online database.

Since the Great Recession began, Italy has experienced an increase in its export performance, and its trade balance has moved from a negative to a positive one (Figure 5). More precisely, in 2008, import/export dynamics had a negative impact of -0.7% on GDP, while in 2018, net exports generated 2.4% of it. Despite this

remarkable growth of 3.1 points, it is still inferior to the level in Spain (7.5%) and is well behind rich Central EU countries, such as Germany (6.2% share of GDP) or Austria (3.8% share of GDP).

According to the theory originated by David Ricardo in the early nineteenth century, export is strictly related to comparative advantages. The idea behind this theory and this relation is simple: international trade originates from the differences in production capability between different areas for specific goods or services. These differences lead to productive comparative advantages for a specific production, leading to the specialisation of national economies, further increasing these comparative advantages (Pullen, 2006). The sources of comparative advantages are varied and may differ across countries. Although the Ricardian comparative advantage (CA) theory is still considered valid, over time, scholars have individuated different sources in addition to the classical focus on the differences in labour productivity as the main generators of CA. Krugman (1897) considered the initial endowment of a 'cumulative' production experience in a specific sector as the crucial factor of the CAs of an economy. The endowment of cumulative experience is formed through continuous learning by doing, where, although there is a partial spill-over across countries, it is assumed to remain incomplete. Rivera-Batiz and Romer (1991) emphasised the differences in technology, R&D and knowledge diffusion. Since early 2000, scholars have also considered institutional quality and institutional settings. Nunn and Trefler (2014) highlighted the importance of institutions for the formation of workers' human capital and the distribution of worker skills. Hall and Soskice (2001) claimed that the presence of an institutional setting with a high degree of complementarity results in different strengths and highly differentiated CAs.

In sum, the principal sources of CAs are as follows:

Specialisation and the accumulation of tacit difficult-to-transfer knowledge

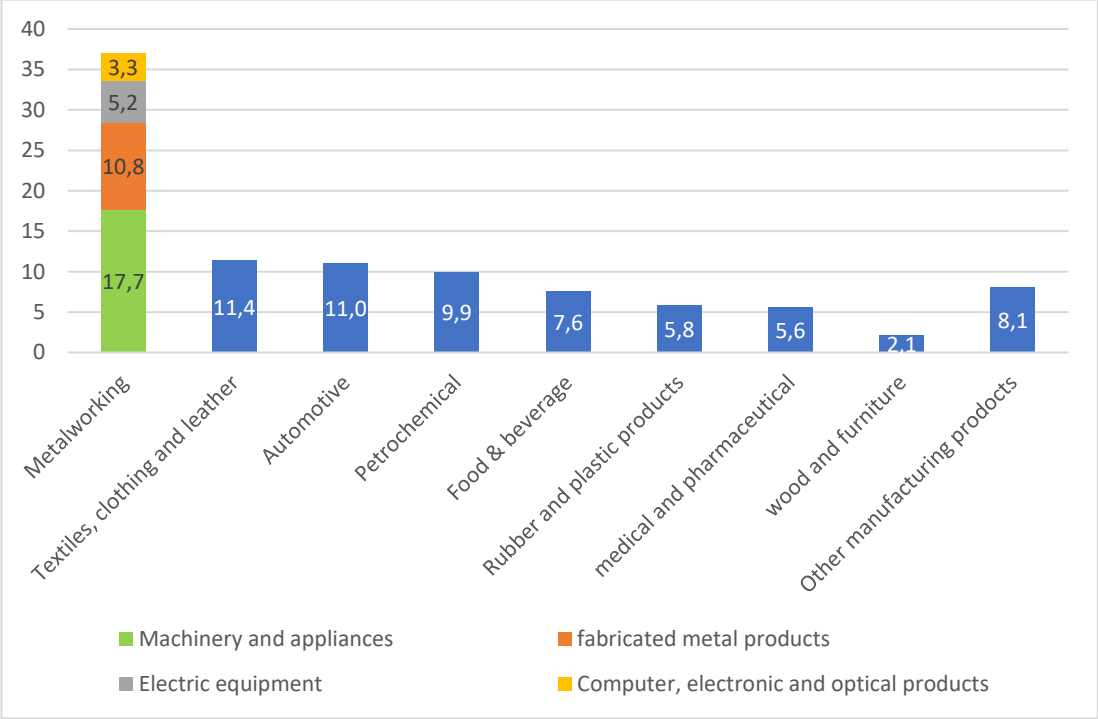
The production of innovation in a specific field and the ease of absorbing certain technologies and codified knowledge

The production of public goods for competitiveness as a skilled labour force

The production of a supportive institutional setting

All these factors have two aspects in common. First, they are strongly path-dependent, and second, they are all incorporated in the local development theories

Figure 6 Industry share of total export value in Italy (2018)



Data source: Istat export report 1 (2019)

discussed in the previous chapter. These two aspects imply that the aggregate Italian CA may partially be generated at a sub-national level and linked to historical regions' path of development. Considering Italian total exports, manufacturing accounts for 95.9% of total value. Given this, breaking down the general figure into a more specific sectorial distribution, the importance of metalworking is evident, accounting for 37% of Italian export values (Figure 6). Thus, Italy's CAs seem to be linked to metalworking sectors and, in particular, to machinery (17.7% of total value) and metal products (10.8%). While these two productions are often part of the same value chains, they have different characteristics. Machinery involves complex goods subject to moderate/high levels of innovation. Metal products is a more heterogeneous category, which includes not only the manufacturing of machinery parts but also, for example, cutlery. It is a sector with less complicated goods, and so it is less susceptible to innovation. In addition to metalworking, the

textile, automotive and petrochemical sectors also represent an important part of Italian export, accounting for 11.4%, 11% and 10% of total export value, respectively.

2.1.3 Macro areas different contribution and relative specialization

Every country is vexed by territorial differences not only rooted in historical reasons but also constantly renewed and reshaped by diversity in territorial outgrowth. It is important to notice that globalization has led to an apparently paradoxical effect by promoting divergent regional paths of development. Indeed, economic globalization has challenged the centrality of the nation-state, fostering divergent regional paths of development. Italy is a country characterized by great regional imbalances, alongside the still present North–South divide, which, in terms of GDP, has no parallels in other advanced countries. Further, the Centre and the two North (East and West) regions are following different growth patterns and achieving different outcomes (Felice, 2019).

Table 5 Italina macro areas total export share (2018)

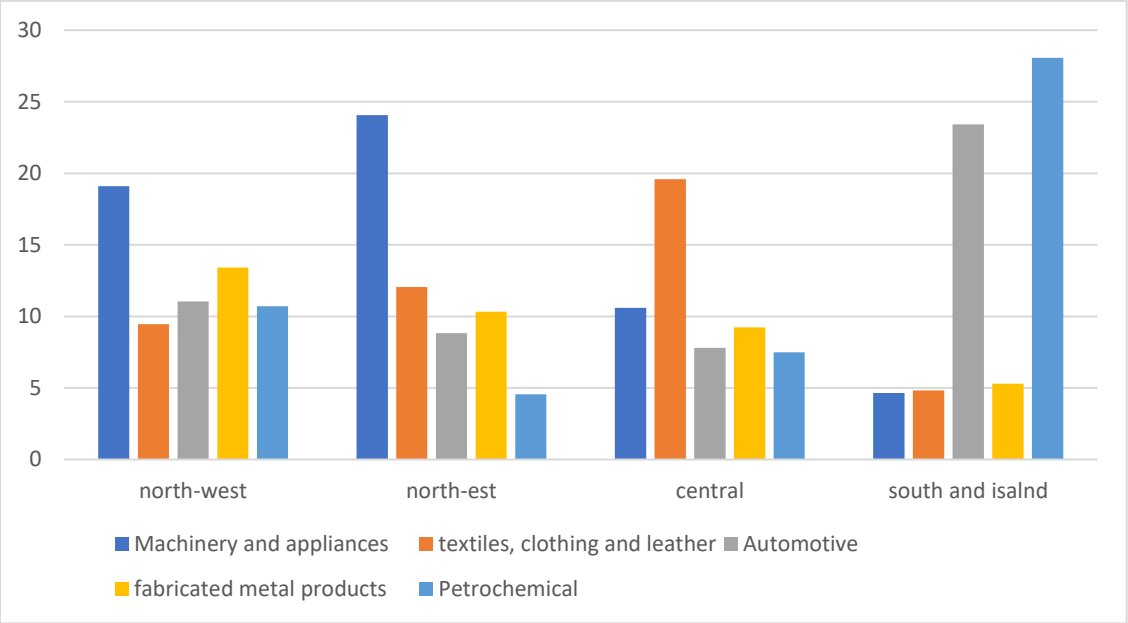
Macro Areas	Total export value share	Total employment share in manufacturing
North-West	**39.6**	**29.8**
North-East	**33.5**	**22.2**
Central	**16.2**	**21.4**
South and Island	**10.6**	**26.6**
Italy	**100**	**100**

Data source: Istat export report (1) 2019

Thus, not surprisingly, the export performances of Italy's macro areas vary dramatically (Table 5). This is a consequence of the well-known territorial inequality that has characterised Italy since its unification, with northern regions being far more developed than the Centre and South. Remarkably, the North is responsible for 73.2% of exports and accounts for 52.0% of total occupation.

As shown, different Italian territories participate in different proportions to the country's exports based on the respective dimension and economic development. However, the different regional paths of development have led not only to differences in quantitative terms but also in qualitative ones. In other words, specific regional CAs have fostered different geographical specialisations in the various export sectors (Figure 7).

Figure 7 Industry share on total export in Italian macro areas (2018)



Data source: Istat

North-West Italy was the traditional location of the so-called 'industrial triangle', the first place where the industrial revolution took hold in Italy. This macro area still benefits from its industrial past, which over time has created a well-developed and differentiated industrial landscape, both in sectorial and size terms. Thus, regional exports, although more specialised in machinery and appliances, have good performance in all sectors. On the contrary, the South is characterised by low export performance, which is heavily concentrated in only two sectors: automotive and petrochemical. This reflects the policy of 'cathedral in the desert', which describes an unsuccessful strategy of local development focused on implanting big firms in underdeveloped areas under central state patronage. The majority of this 'cathedral' was and is related to the automotive and heavy chemical industries.

Unfortunately, these state interventions have been disproportionate due to the lack of functionality of existing infrastructure and have failed to initiate a real process of spill-over and local development (Crouch, Le Galès, Trigilia, & Helmut, 2001).

North-East and Centre Italy, the so-called third Italy, as addressed in the previous chapter, experienced the highest industrial growth in Italy from the 1970s to 1990s. This process of industrialisation was associated with a particular form of industrial development described as 'flexible specialisation' or 'post-Fordism' (Scott A. J., 1988; Piore & Sabel, 1984). In short, it has been based on the development of networks of small and medium-sized firms in mainly craft-based industries spatially concentrated in industrial districts. What makes the economic development of these areas so surprising is not only the clustering of small and medium enterprises but also the sectorial specialisation in design-intensive, craft-based industries, such as clothing, footwear, leather goods and furniture (Boschma R. A., 2005). These sectors were believed to be most vulnerable to competition from low-wage countries due to their low rates of added value and low intensity of technology. Despite this common origin and the shared characteristics in terms of the organisation of production, over time their paths of development started to diverge. While the Centre remains bound to made in Italy sectors and to productive organisation based on small and horizontally integrated micro firms, North-East Italy has developed an important specialisation in machinery production, emancipating the region from craft-based industries. Moreover the North-East productive network has evolved into a more vertical one in which medium and big firms play a major role (Crouch, Le Galès, Trigilia, & Helmut, 2001). This divergent development is the foundation for the differences in export performance and specialisation. Indeed, despite a similar manufacturing employment share, the Center accounts for only 16.2% of Italian exports, compared to 33.5% for the North-East (Table 5).

2.1.4 Value added and the position in Global value chains

With the increasing importance of the global network of production, understanding the capabilities of different sectors in terms of participating in global value chains has become crucial. Here, the analysis of Italian CAs was conducted based only on gross value. To better understand the role of different export sectors in Italian economic growth, it is useful to consider how much value-added they are able to create. A study conducted by Dell'Agostino and Nenci (2018) comparing Italy's CAs with those of other 40 countries[3] showed how the relative Italian position changes based on whether gross or added values are considered. This comparison is made using the Revealed Comparative Advantages (RCA) Index of Balassa[4] (1965). This index is the ratio of national sectoral exports divided by total national exports and the world sectorial exports divided by the world total exports. The results are shown in table 6.

Table 6 Italian positioning in comparative advantages measured on gross and added value (2013)

Sectors	Relative position gross value	Relative position added value
Machinery	1	4
Fabricated metal	6	3
Leather	1	1
Textile	8	7

Data source: Author elaboration of (Dell'Agostino & Nenci., 2018) results.

While the machinery sector in Italy retains the first position when considering gross value, it falls to fourth when the RCA is calculated based on value-added. On the contrary, in the case of simpler metal products, shifting from gross to added value causes Italy to rise to third place. Meanwhile, for the more traditional made in Italy products, such as textiles and leather, the position remains roughly the same. These

[3] The countries considered are EU-27 countries plus Turkey, Canada, the USA, Mexico, Japan, Korea, Taiwan, Australia, Brazil, Russia, India, Indonesia and China. The data source is the World Input Output Database and refers to 2013 (last year available).

differences between gross and added value are linked to the relative position of national enterprises in global value chains (Chiarvesio, Di Maria, & Micelli, 2010; De Marchi, Gareffi, & Grandinetti, 2017). If the case of machinery, Italian firms are suppliers and are in central positions, whereas for more classical made in Italy products they are direct exporters. Explaining the positive gaps in the case of metal products is more complex, but they are likely due to different factors. First, Italy has a long tradition of highly specialised, high-quality production of intermediate metal goods by so-called hidden champion firms, which are able to generate high value through flexible specialisation. Second, this sector includes many productions related to design activities that export directly to other countries.

2.1.5 Conclusive remark on Italian manufacturing nowadays importance and its possible future

In conclusion, manufacturing is still an important part of the Italian economy with regard to occupation, GDP generated and, undoubtedly, export. As is well known, Italy is the second larger manufacturing country in the EU. Perhaps less well known is that this fact also applies to the medium-high and high-technology sectors (Donatiello & Ramella, 2017). Despite this potential, Italian manufacturing has been slowly declining and is characterised by historical problems related to productivity and poor innovation performances. In addition, even though the Italian manufacturing sector has been slowly recovering its competitiveness, it is growing slower than the other main European economies. Given this context, the capability of Italian manufacturing to face the so-called fourth industrial revolution is crucial. Dealing with this revolution means absorbing and exploiting the industry 4.0 technological paradigm. If, on the one hand, there is a failure to widely implement these technologies, Italy would lose even more competitiveness; on the other hand, the spreading of this new technological paradigm could foster the productivity and innovative performance of the Italian industry. However, the challenge of the fourth industrial revolution is not only important because it appears to be an effective way to overcome Italy's main manufacturing problems; it could also spur the service

sector. Indeed, industry 4.0 can be seen as the culmination of a more long-standing process of manufacturing servitisation, which has led to increased interweaving between industry and knowledge intensive service. The interactions between manufacturing and services can be found along the whole industrial value chain (Tolio, Copani, & Walter, 2019) pag.4 :

"Upstream services in the value chain, e.g. product design, innovation activities, research and development. The acceleration of production and information technology innovation requires more specific and advanced scientific and technical support (Corrocher & Cusmano, 2014)."
"Core services in the value chain, e.g. services strictly related to production activities, such as supply management, process engineering, production engineering and maintenance services."
"Downstream services in the value chain, e.g. marketing, distribution and pre- and after-sales services to generate further value-added (Anderson & Narus, 1995).
Transversal services, e.g. Information and Communication Technologies (ICT)-related services, management and strategic consulting to support global enhancement of company competitiveness (Kamp & Parry, 2017)".

These services are collectively known as KIBS (Knowledge-Intensive Business Services), and many scholars have underlined their role in fostering the innovation and value-added of manufacturing firms, simultaneously highlighting the importance of spatial proximity on relationships with customers (manufacturing firms) (Miles, 2005) and with other business service companies (Dolereux & Shearmur, 2010). This condition of double territorial concentration is mainly observed in urban areas, possibly adding a new layer of differences in development potential within a context already marked by significant territorial disparities, as is the case in Italy. This work focuses on this area, attempting to understand how particular peripheral territories, industrial districts, are facing this transformation and how much this reformation includes and involves small enterprises.

2.2 DISTRICTS IN ITALY

The principal characteristic of the Italian manufacturing landscape is the clustering of small and medium firms in productive territorial networks specialised in particular transformation processes or goods production—the industrial districts. This economic organisation is typical of certain regions that together comprise the third Italy. However, the territorial distribution of industrial districts drastically changed during the 1980s. The Post-Fordims economic transformation has resulted in a process of double convergences in productive organisations. This theory, postulated by Piore and Sabel, explains the dynamic whereby, in a complex and dynamic competitive environment, large companies must focus on their core business, outsourcing other activities, thus leading to the creation of a network of companies (Piore & Sabel, 1984). At the same time, small businesses must cooperate in networks in order to create innovative products with high added value. This creates double convergence: in both cases, an organisation of production is based on this network. This double convergence is also related to the dimensions of the firms that compose the network. If this process leads to big firms downsizing, the pivotal firms in the SMEs network experience dimensional growth. In Italy, this process has led to a redefinition of the composition and territorial distribution of districts. Meanwhile, in the third Italy, mainly the Veneto region, medium-sized firms have increased in number and importance, while in the North-West the reorganisation of Fordism production led to the formation of new SMEs clusters, particularly in Lombardy (Dei Ottati, 2017). The aim of this part of the chapter is to identify more recent changes in Italian districts related to their role in national manufacturing, their regional localisation and, finally, their dimensional composition and sectorial specialisation.

First, however, it is useful to discuss how industrial districts are statistically defined. The statistical individuation of industrial districts is based on the original Sforzi-Istituto Nazionale di Statistica (ISTAT) methodology (ISTAT, 1996) (Sforzi &

Lorenzini, 2002)[5]. This method involves the individuation of local labour systems (LLSs) with particular features. LLSs, as proposed by ISTAT, represent places where the population resides and works; therefore, where the majority of social and economic interactions take place. From a technical and methodological point of view, LLSs are built as an aggregation of two or more municipalities in an attempt to maximise the level of interaction between municipalities belonging to the same SLL, which is calculated based on daily commuting flows between the place of residence and the place of work. The individuation of these areas follows these principles (Istat, 2014):

Purpose: each zone represents a labour market
Relevance: the zones allow diffusing reliable and comparable statistical information
Completeness: the zones are a partition of the entire territory of the state
Unambiguity: each municipality can belong to only one zone
Contiguity: each zone is an aggregation of a contiguous municipality set
Consistency: each zone is made up of a set of non-fractionated municipalities.
Conformity: the zones may not respect administrative boundaries (regions and Province).
Homogeneity: the zones are not too large territorially or too numerous in terms of employees

LLSs are an incredibly useful unit of analysis for research, such as this, that focuses on the territorial embeddedness of economic activity. Indeed, other territorial entities like regions are too big and heterogeneous to shed light on this kind of phenomenon. On the contrary, LLSs represent small homogenous labour markets that present particular features according to their territorial-specific socioeconomic characteristics. Industrial districts are LLSs with two particular features: first, they have a manufacturing vocation, and second, their production activities are carried out by networks of specialised small and medium firms. In order to identify this

[5] This statistical definition has been revised in its more recent utilisation. The element of discontinuity is represented by the widening of dimensional classes, with the subdivision of the traditional class 'up to 49 employees' in the two ulterior classes of micro (up to 9 employees) and small (9–49 employees) enterprises. The classes for medium (50–249 employees) and large enterprises (250 or more) remain unchanged.

peculiar local reality among the 660 Italian LLSs, a hierarchical procedure is used composed of four steps aimed at the following:

Identification of predominantly manufacturing SLLs;
Identification of predominantly manufacturing SLLs of SMEs;
Identification of the main industry of mainly manufacturing SLLs of SMEs;
Identification of industrial districts.

The first three items are based on the Location Quotient index (LQ) (1991). The LQ is basically a way of quantifying how concentrated a particular industry, cluster, occupation, or demographic group is in an area as compared to a larger one that contains it. It can reveal what elements distinguish local areas in comparison to the national average. More precisely, LQ is a ratio that compares a region to a larger reference region according to some characteristic or asset. Suppose X is the amount of some asset in an LLS (in the case of our first step, manufacturing employment), and Y is the total amount of assets of comparable types (still in the first step, total employment). X/Y is then the regional 'concentration' of that asset in the region (in this case, the manufacturing employment). If X' and Y' are similar data at the national level, then the LQ or relative concentration of that asset in the region compared to the nation is (X/Y) / (X'/Y'). While the first steps use LQ to identify LLSs with a manufacturing vocation, in the second step, the index is calculated in the same way for employment in small and medium firms. Thus, it is possible to establish which LLSs show a concentration of SMEs higher than the national average. In the third step for each manufacturing LLS of SMEs, the LQ index for all the manufacturing sectors (e.g. metalworking, textile, automotive, etc…) is computed in order to identify the main local specialisation. Differently from the previous ones, the final step does not rely on the LQ index; rather, it checks whether the main production in which the LLS is specialised is carried out by small–medium-firm clusters. In methodological terms, this implies that more than 50% of the total occupation in the sector of specialisation is accounted for by small and medium firms. In addition, small firms must employ the 50% of this 50%.

Unfortunately, with data available for recent years (2012-2017) is not possible to accomplish the final step for the statistical individuation of industrial districts[6].

Because of this I have followed a different methodological strategy based on the Istat individuation of industrial districts that was done as part of the last general census of Italian industry (2011). In this report, from a statistical point of view, industrial districts include predominantly manufacturing SLLs of SMEs that presents a level of specialization above the national average (the first three standard steps) and are already identified as industrial districts by Istat in 2011.[7] Even if this choice is driven by data constraints, it is far from problematic. From a sociological point of view, this strategy of individuation can be considered correct and even conservative. Indeed, as discussed in the previous chapter, the sociological conception of industrial districts emphasizes the importance of social factors, such as the development of a context-specific culture, the presence of dedicated territorial institutions, and the existence of a reputational network based on repeated and frequent interactions, all phenomena that need some time to be established. More generally, all these forms of territorial social capital present a certain degree of path dependence and are generated over a medium or long temporal horizon. Thus, considering only local economies that present a specific economic structure for more than ten years as industrial districts is particularly rewarding. The methodology adopted has two important characteristics. First, it does not consider LLSs that have developed structural district forms only recently and therefore have hardly demonstrated the social factors connected to the sociological concept of the district. Second, it still considers district LLSs that have recently experienced a minor shift in the relative importance of micro-firms in favour of bigger ones, a structural adjustment that does not put into question territorial social capital accumulated over many years.

Applying this method to 2017 ISTAT data (the last year available), it is possible to identify 122 industrial districts, which represent 20% of Italy's LLSs. Since this work

[6] I have used Istat dataset Asia (Registro statistico delle imprese attive), which do not contains the dimensional disambiguation for NACE at 3 digit need to accomplish the last step of standard industrial district statistical individuation. The need data granularity is available only on the occasion of industry general census, which is done every ten years.

[7] For a more detailed discussion about the adopted method, see appendix A

focuses primarily on manufacturing, it may be interesting to compare them not only against national figures but also with those of other LLSs with an industrial vocation. In other words, this means local systems that present an LQ index in manufacturing activity bigger than one,[8] but which lack other characteristics to be considered industrial districts. Table 7 presents the relevant indicators for the different types of LLSs.

Table 7 Local labour systems share in employment (total and manufacturing) over national figure and LQ (average) (2017)

	N SLLs	% Total SLLs	% Total employment	% manufacturing employment	Average Manufacturing LQ
Not manufacturing	365	59.8	54.0	33.0	0.59
Manufacturing not district	123	20.2	23.3	31.3	1.47
districts	122	20.0	22.7	35.7	1.68
Italy	610	100	100	100	1

Data source Istat Asia

In 2017, manufacturing SLLs accounted for 40% of local systems of production (245 in total). Remarkably, while representing only 20% of the national LLSs, industrial districts alone accounted for 23.3% of total national employment and employed more than 36% of the total manufacturing workforce. This is new evidence of the historical importance of this peculiar organisation of local production in Italy. Industrial districts can reach this outstanding weight in the national manufacturing landscape due to the exceptional concentration of productive activities by which they are characterised. An LQ index of 1.68 indicates that, on average, 36.2% of the labour force is employed in manufacturing activity. Industrial districts have remarkably high manufacturing employment compared to the national figure,

[8] A LQ value of 1 indicates a local proportion of manufacturing activity equal to the national level

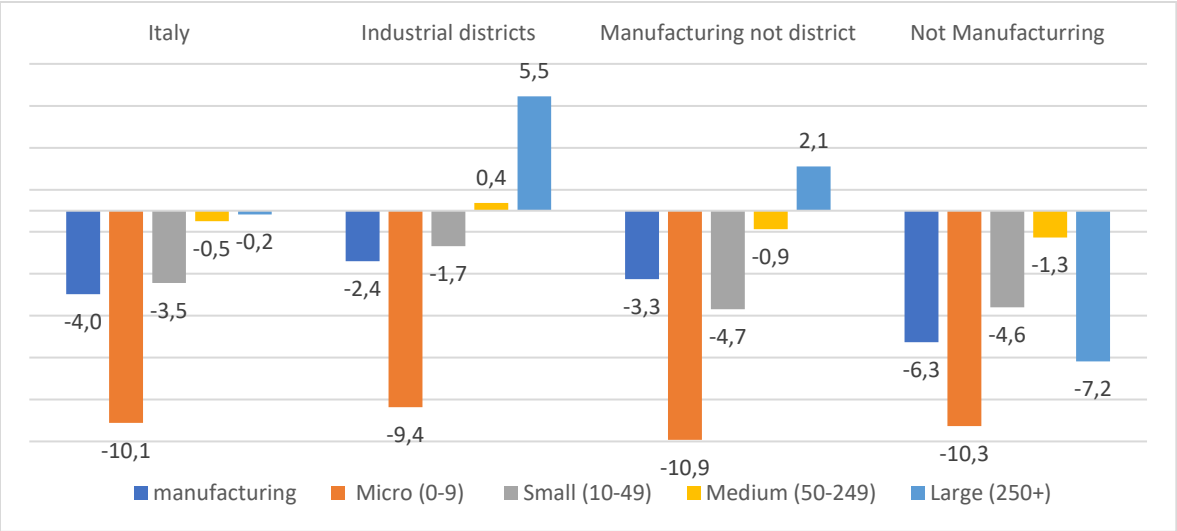
where it reached the 21.6%. Even other local economies with an industrial vocation do not reach these numbers, showing an average employment share of 29.0%.

2.2.1 Employment change in industrial districts after the grate Crisis

As discussed at the beginning of this chapter, Italy, similar to other European countries, has experienced a decline in the manufacturing occupation.[9] However, this loss has not affected local economies in the same way. According to their specific productive organisation and local embeddedness, LLSs show varying degrees of resilience to the deindustrialisation process, and different firm categories are affected in different ways. Based on agglomeration theories, it is plausible to expect that this process hits firms in a different way according to their size and localisation. To determine why this is so, data from 2017 were compared with data from 2012 (Fig. 8). The former was selected since it is the most recent year with available data. With regard to the latter, 2012 represents the first year of economic growth in Italy after the Great Recession of 2008. Despite the relatively short time spam, it is my opinion that 2012 is the most suitable choice for two main reasons. First, many works have already investigated how the crisis affected local Italian economies. Second, by considering this fact, this work seeks to shed light on the more recent path of development embraced by industrial districts.

[9] The data presented at the beginning of the chapter and those that will be presented in the following paragraph show some differences, which are justified, while Eurostat data use total occupation as a basis for calculation (people with a job), and the ISTAT data used are based on employment (Workers).

Figure 8 Employment change in the manufacturing sector in different types of LLSs by firms dimension from 2012 to 2017

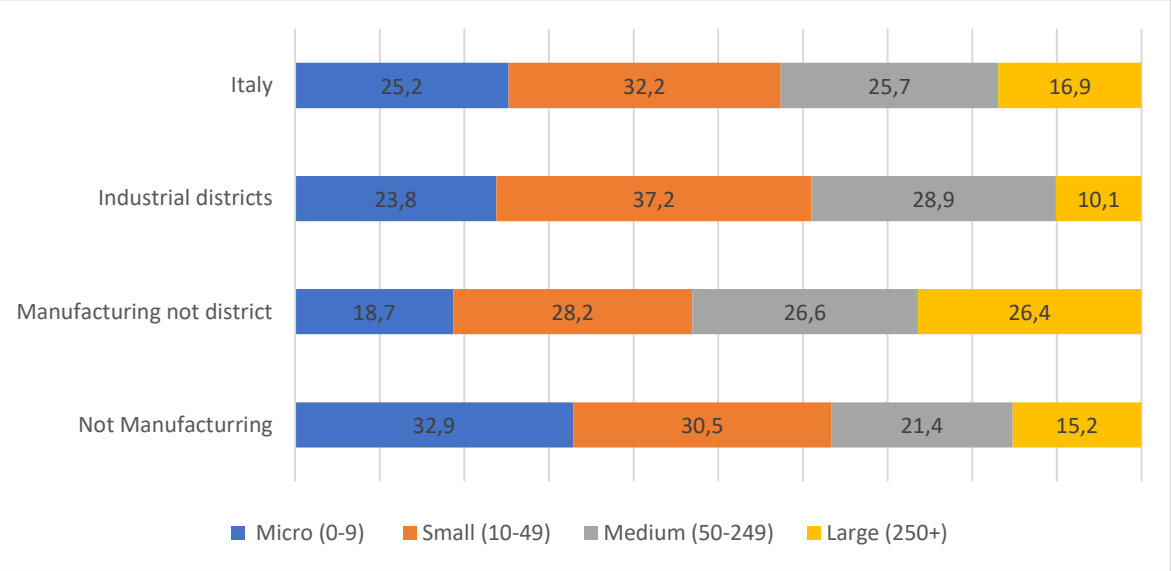


Data source: Istat ASIA

Industrial districts have experienced a lower overall reduction in manufacturing employment (-2.4) than the national figure (-4.0) (Figure 8). This result is not particularly surprising. Rather, the fact that it is also true in respect to other local systems of production (-3.3) is remarkable. The finding is particularly outstanding considering that, over the period considered, there is a consistent decrease in occupation in micro-firms (0–9 employees), which historically are a consistent part of industrial districts productive landscape. In fact, of the negative balance of -36,582 manufacturing microenterprises, 33.6% is due to districts (-12290 units). The resilience of industrial districts' manufacturing sectors is due to two different factors. The first is the higher occupational state of small firms and the occupational growth in medium and big companies. Interestingly, this latter category has experienced the largest increase in manufacturing employment. These results provide a quantitative view on a phenomenon that is well documented and has been explored in a recent study about districts: the rising importance of medium and big firms in the districts' productive networks. The increasing importance of medium and big firms is not limited to their capability to foster occupation in manufacturing; it is also qualitative. These firms generate important knowledge and

technological spill-overs and are essential for connecting local economies to international markets, thereby improving the overall export performance. The fact that micro firms account for the 94% of unities lost in the five years from 2012 to 2017 is another major insight into the importance of small medium enterprises' role in territorial industrial resilience. Despite this tendency toward firm enlargement, the general employment figures remain consistent with those of traditional districts understanding (Figure 9). Comparing the districts' LLSs with both the whole nation and other types of local economies makes it clear that they maintain their characteristic features: the lowest employment share in big enterprises and the highest occupation share in SMEs.

Figure 9 manufacturing employment share by firms size in different SLLs types



Data source Asia Istat

2.2.2 Districts across Italy: specialization and composition

To this point, the second chapter has highlighted the following facts:

Manufacturing in Italy plays an important economic role, both in terms of occupation and participation in GDP production.

Even if the long-standing productivity problem characterises it, Italian manufacturing shows a certain degree of dynamism due to export performances in machinery tools, metal products, and the textile/leather sectors

Their export performances appear connected to comparative advantages generated at the sub-national level.
It is possible to identify 122 industrial districts in Italy that account for 35.7% of the country's total manufacturing employment.
The industrial districts show a strong industrial employment resilience; however, they are undergoing a process of structural adjustment of the occupation structure that has seen micro-firms lose their traditional weight in favour of larger ones.

Regional development path variety has produced a diversification of Italian regions, which is reflected in the number and relative importance of industrial districts and their specialisations and occupational structures. These observations derive from an analysis mainly conducted at the national level; however, industrial districts are an intrinsically local phenomenon, and thus they are characterized by great territorial variability. This section aims to account exactly for regional differences and demonstrate how they are related to previous considerations about the broader national picture.

The relative importance of districts at the regional level

Uncovering the role districts play at the regional level implies answering at least three inquiries: how many districts are present? How much of the regional manufacturing activity do they account for? And, how important are manufacturing sectors to the regional economy? The answers to these questions are reported in table 8.

Table 8 Number of districts and relative importance by Italian regions

Region	**Manufacturing over total employment**	**District manufacturing employment over total manufacturing**	**Number of districts**
Marche	31.9	73.6	18
Veneto	30.0	69.1	25
Emilia-Romagnia	27.4	28.2	12
Piedmont	26.1	11.1	6

Tuscany	24.6	51.6	15
Lombardy	24.4	51.0	25
Puglia	17.2	19.5	6
Other regions[10]	14.8	6.0	15

Data source: Asia Istat

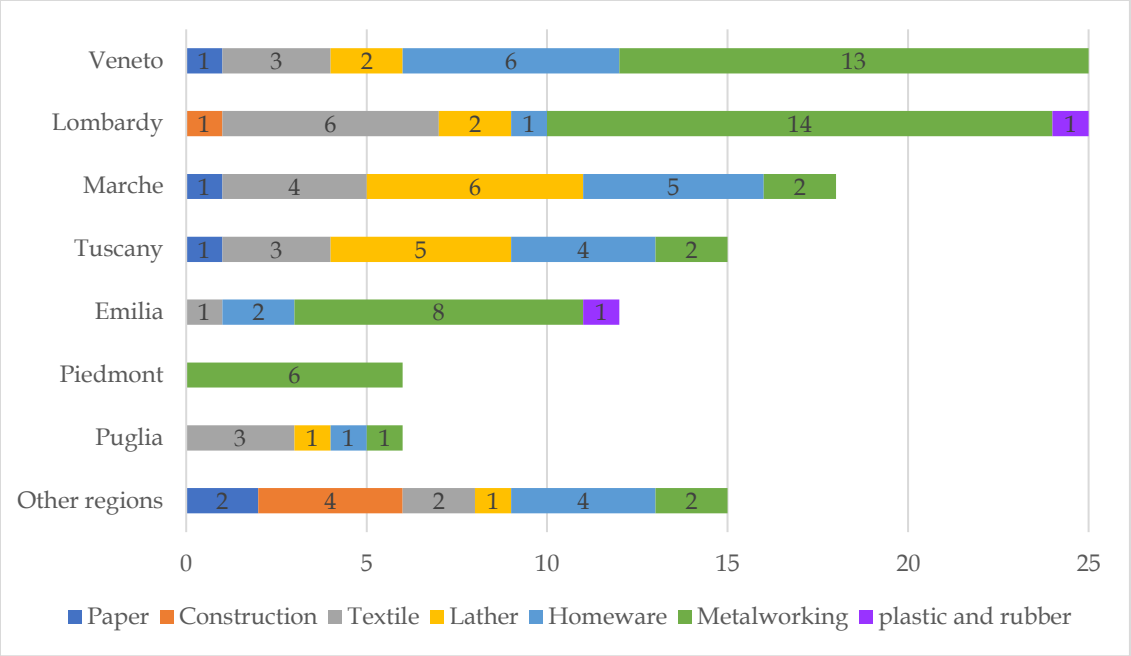
From a general point of view, every region with a medium–strong presence of industrial districts besides Puglia shows a level of employment in manufacturing higher than the national average (21.6%). Looking at the figures in more detail, only Veneto and Marche seem to totally confirm their historical path of development, related to the Third Italy Traditional production model. Indeed, these two regions have a strong manufacturing vocation and extremely high relevance for industrial districts. This is not true for Tuscany, which still has a high number of districts and places relatively high importance on them; however, it has seen regional manufacturing occupation decrease sharply in previous years (from 36.8% in 2001 to 24.6% in 2017). Despite containing a high number of industrial districts, Emilia Romania seems to have partially embraced a new path of development, which preserves a strong manufacturing core while remaining less bounded to industrial districts. This shift is the result of two different dynamics. The first is related to the decline of some historically industrial districts, such as Forlì. The second relevant phenomenon is connected to the path development diversification of small cities like Modena. These local economies, alongside a traditional manufacturing core, have unfolded new trajectories of growth thanks to a flourishing of the service sectors and the resumption of the old agri-food tradition, even if in a modern reinterpretation (Alberti & Giusti, 2012; Bertolini & Giovannetti, 2006). In the North-West regions, Lombardy and Piedmont appear to have embraced two radically different paths. Lombardy has effectively emancipated itself from its past as a region of large enterprises. It arose as the most relevant of Italian areas for its financial sector and, more generally, for its highly intensive knowledge services;

[10] This category includes the following regions: Friuli Venezia Giulia, Liguria, Lazio, Sardenia, Umbria, Abruzzo, Trentino Alto Adige, and Campania. In all these regions, a limited number of industrial districts are present. In the remaining regions–Sicilia, Calabria, Basilicata, Molise, and Valle da Osta–no industrial districts have been identified.

however, at the same time, the industry maintains an important role. Indeed, although the service segment generated 31.8% of its regional GVA in 2017, the industry still accounted for 23.2% of it. This remarkable manufacturing outcome is related to the performances of several industrial districts located in medium and small cities rather than the presence of large enterprises in wide metropolitan areas as in the past. Piedmont, in contrast, is facing more difficulties in overcoming its industrial past, which is linked to the presence of large firms in the automotive sector. The limited number of industrial districts is not only due to the region's hardships in freeing itself from its Fordist past. In the 1970s, local manufacturing economies based on networks of small and medium enterprises also arose in Piedmont. However, in the 1990s, they faced extremely rapid economic decline.[11] Finally, it should be noted that Puglia, despite its poor indicators, is the only Southern region with a relevant industrial district presence.

[11] Biella, Vercelli, Alessandria, and Ovada are all examples of local economies that have followed this trajectory.

Figure 10 Regions' number of industrial districts by specialisation

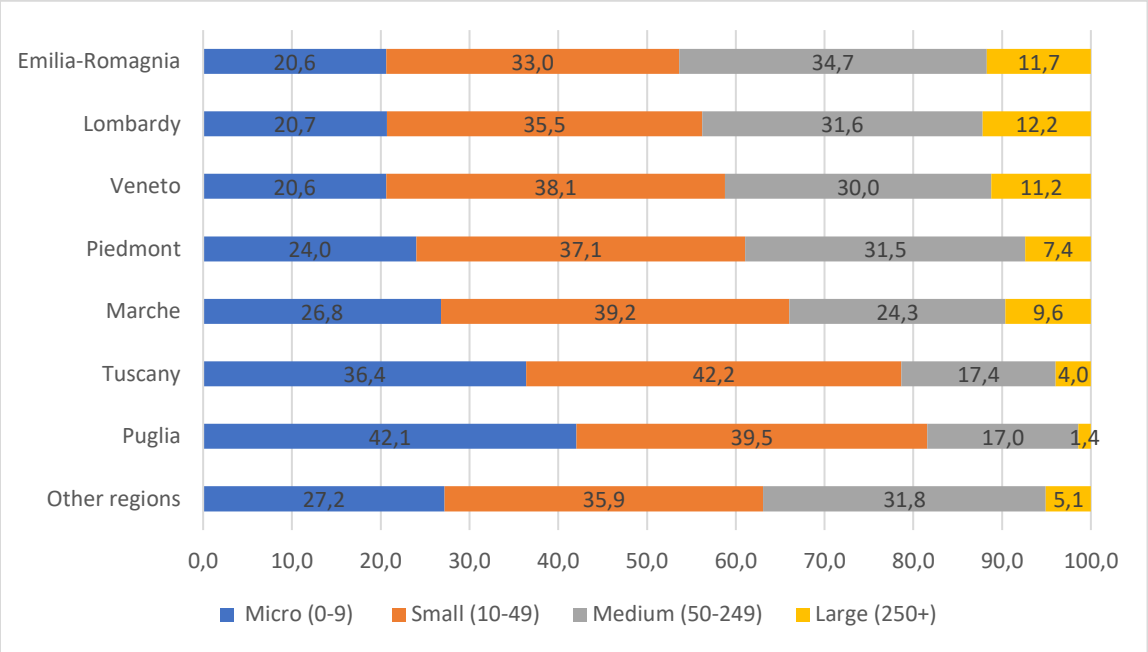


Data source: Asia Istat

As shown in figure 10, the specialisation of the industrial districts in each distinct Italian region follows the pattern of export performance previously discussed. The North (Lombardy, Piedmont, Veneto, and Emilia Romagna) focuses more on metalworking activity, and the Centre (Tuscany and Marche) is more engaged in classical "made in Italy" sectors related to fashion and design, such as apparel and homeware. Alongside this general trend, a wider range of specialisations characterises the district systems of Veneto and Lombardy. On the contrary, the Emilia Romagna and Piedmont district realities are heavily specialised in metalworking. This situation can be connected to a difference in regional governance, more focus on the economic sector in the case of Piedmont and Emilia Romagna, and more awareness of territories in Lombardy and Veneto. However,

regional district systems do not differ only in terms of specialisation but also in occupational structure (figure 11).

Figure 11 Industrial district manufacturing occupation structure by firm dimension



Data source: Asia Istat

As part of the canonical importance of small firms, which account in all regions for the highest number of occupations, the distribution of manufacturing occupations across different firm sizes produces another opposition between the North and Centre regions. The first is characterised by a higher share of employment in medium and large companies. In contrast, the second is still bound to a more traditional micro and small enterprises structure. Nevertheless, a more detailed look at this data reveals a wider variation in regional patterns. Indeed, Tuscany presents a limited number of both medium and large firms, which combined account only for 21.4% of manufacturing occupation. This level is quite low, even compared to Marche, in which these two categories account for 33.9% of industrial employment. Furthermore, the North group expresses relevant variety, with a share of the two larger categories that ranges from 46.4% in the case of Emilia Romagna to 38.9% of Piedmont.

To sum up, industrial districts not only hold different levels of relative importance in different regions, but also seem to follow different trajectories for their firms'

composition in terms of both specialisation and dimension. These structural changes partially reshape the conventional division between North–West and the Third Italy industrial model, creating new friction between the North and the Centre. The first is characterised by its specialisation in the metalworking sector and by hosting districts in which medium and large enterprises have reached a remarkable share of occupations. On the contrary, in the Centre, industrial districts maintain their traditional employment structures and specialisations in "made in Italy" sectors.

2.3 CONCLUSION

The straightforward analyses presented in this chapter show that industrial districts still play a relevant role in the Italian economy. This role is not only bound to territorial industrial resilience deriving from historic local path dependence but also to actual territorial economic dynamism. Indeed, the connection between regional export performance and the presence of industrial districts specialised in specific sectors is plainly evident. Moreover, Italian industrial districts appear to undertake structural changes, reshaping their internal occupational structures and territorial articulations. While Central Italy remains more bonded to traditional specialisations and occupational structures, Veneto strengthened the trajectory already noted by Crouch et. al. by shifting toward larger productive units and metalworking sectors (Crouch, Galès, Trigilia, & Voelzkow, 2001). However, the real novelty is that industrial districts' landscapes have moved the fulcrum from the southern 'Third Italy' (Emilia Romagna and Tuscany) towards Lombardy.

3 INDUSTRIAL DISTRICTS AND TERRITORIAL SERVITISATION: THE PATH TOWARDS INDUSTRY 4.0

If the previous preliminary descriptive phase is important to provide an answer to the questions at the base of this chapter, it is far to be exhaustive. Reflecting on industrial district role in the now day economy means also asking how they react to the changing economic landscape. Since '90, scholars have concentrated on the relation between local economies and globalization, and newly there is a focus shift on a different phenomenon, the digitalization and servitization of manufacturing. In respect to the previous debate, the reflection on territorial servitization can lead to a deeper recasting of Marshallian industrial districts theory. Indeed even if the reflection on globalization has brought a reconsideration of the relative importance of territorial and global relations, it can be seen as an extension of the traditional industrial districts core theory. On the contrary, even though in the beginning, the debate concerning manufacturing servitization and digitalization seems bound to have a significant impact on SMEs clustering theory due to the transformation of networks of relations, knowledge platforms and infrastructures within and without the local systems. Furthermore, these long-run processes are taking the shape of a new productive model, the so-called fourth industrial revolution based on industry 4.0 concepts and technologies.

3.1 TERTIRALIZATION AND MANUFACTURING SERVITIZATION

The first step to understanding both old and new industrial districts' development paths is considering the transformation of manufacturing activity over time. The most important changes can be detected in the relationship between manufacturing and service, particularly within the context of two phenomena: economic tertiarisation (Amin , 1994) and manufacturing servitisation (Baines T. S., Lightfoot,

Benedettini, & Kay, 2009; Lightfoot, Baines, & Smart, 2013). These two concepts have much in common and are connected to important changes in Western economies' economic reproduction and development, such as the importance of intensive-knowledge activities for the generation of added value, comparative competitive advantages, and innovation. Furthermore, they are linked in a similar way to the new competitive environment created by globalisation and its technological changes, mainly in information technologies (Bellandi & Santini, 2019). However, economic tertiarisation and manufacturing servitisation underline different and in some way opposed relationships between manufacturing and service. Economic tertiarisation can be associated with the expansion of the service sector in advanced economies and the resulting decline of manufacturing centrality in Western countries. Thus, this association implies a change in the relative importance between services and manufacturing sectors, in both quantitative terms (people employment) and economic centrality (generating added value). The reasons at the base of the shift from manufacturing to service are several, including a) technological change that has moved towards the productions of intangible goods; b) the creation of new markets bound to service activities; c) growth in demand by manufacturing firms for specialized services; and d) the externalization of service activity previously that was previously carried out inside manufacturing firms (Sforzi & Boix, 2019). These phenomena per se do not imply a substantial substitution of manufacturing actives by service ones, which would theoretically allow simultaneous development of both sectors. In addiction, a part of the tertiarization process is connected to a synergic relation between manufacturing and service (manufacturing servitization). However, from an empirical point of view, in Western economies, tertiarisation is associated with wide deindustrialization processes. This transition starting at the beginning of the post-Fordism and reaching its apex in the middle of the 1990s, led to the definitive loss of manufacturing centrality in the majority of Western countries. Indeed, outsourcing and delocalization enterprise strategies connected to economic globalisation, sparked by information technology’s revolution, have deeply reshaped the global distribution of production. The Asian-Pacific region arose as

the new dominant global manufacturing centre, while western industrial societies rapidly rearranged themselves around the service sector, facing high social costs (Castells, 2011). A more detailed discussion on this topic will be carried out in the fourth chapter. For now, it is enough to underline two aspects. First, tertiralization was characterized by a spatial decoupling of manufacturing and service. Second, during the first Post-Fordism phase, the typical industrial districts' production model of flexible specialisation emerged as one of the most relevant new ways of local industrial development in western economies. However, in the late 1990s, industrial districts struggled to face new challenges stemming from globalisation and technological change, a process that put into question the strength of these alternative paths of industrial organization in the long run. Despite the difficult times, many industrial districts were able to adapt to the new competitive environment and anchored parts of the new global value chains locally (Boschma, 2005; Becattini, 2000; Crouch et al., 2001).

Given the intensity of the deindustrialization process and its disruptive social effects, it is not surprising that manufacturing servitization received attention only in recent times, despite the common origins of the two phenomena. Unlike economic tertiarisation, the term servitisation refers specifically to a major hybridisation and intertwining between manufacturing and services and not substituting the two sectors. Since service is broad and heterogeneous, it is important to note that this process involved mainly advanced services, such as those linked to digital technology, called KIBSs[12] (Vendrell-Herrero, Bustinza, Parry, & Georgantzis, 2017). KIBS can be defined as 'those types of an industrial manufacturer's product-related services that create knowledge for the purpose of developing a customised solution to satisfy a customer's needs' (Kohtamäki & Partanen, 2016). Thus, manufacturing servitisation does not imply a sector substitution but the creation of greater manufacturing competitive advantage by incorporating the principles, strategies, technology and knowledge typical of advanced service sectors. This process, as economic servitisation, is fostered by technological change and the nature of a new global competitive environment. Over

[12] Knowledge Intensive Business Services

time, this pressure has led to the enlargement of KIBSs involvement in the different phases of manufacturing value creation. First, value is attached in the post-sales service to products through options such as enhanced maintenance, upgraded technical support and course formation (Baines & Lightfoot, 2014). Second, services are integrated into the upstream value chain (e.g. product design, innovation activities, research and development). The innovation in information technologies and the growing request for customised complex goods requires more and more specific and advanced scientific and technical support in the value chain. Finally, more recently, KIBSs have been involved in the core of manufacturing value chains production. The introduction of technologies, such as 3D printing, sensors, cloud technology, production datafication and the Internet of Things, created a new and deep hybridisation between manufacturing processes and the knowledge related to ICT sectors (De Propris & Storai, 2019). It is no coincidence that these technologies are now converging in a new technological and productive paradigm known as Industry 4.0.

3.1.2 MANUFACTURING SERVITIZATION AND TERRITORIAL DIMENSION

The academic debate about servitisation stems from business studies and mostly uses a firm-oriented approach. Even if these studies have not addressed the spatial perspective of this phenomenon in a systemic way, they provide important hints. In particular, to integrate KIBS, firms can follow two strategies: internalisation and outsourcing (Beines, 2015). Outsourcing is strategic for small and medium-sized enterprises (SMEs), which often have limited internal resources; thus, the possibility to access KIBS externally became essential (Corrocher & Cusmano, 2014). Outsourcing manufacturing servitisation modifies productive networks' composition, enabling a more systematic understanding of this process by considering the territorial dimension. If SMEs develop internally only a limited portion of the knowledge and material resources needed to face technological challenges, local economies' capability to provide them becomes strategic (Bellandi

& Santini, 2019). Therefore, recent works have started to conceptualise and empirically explore the specific phenomena of territorial servitization. These phenomena establish a foundation for servitisation by territorially recoupling manufacturing and KIBS, and it is based on two factors,. First, to achieve an advantageous position in the market, KIBS firms must provide value-creating services to manufacturers, and this is particularly true for SMEs (Teece, 1980). Second, the demand for knowledge-based services in territories with a strong presence of economically dynamic SMEs will be greater. Indeed, these firms' limited internal resources not only foster a higher level of outsourcing but also make spatial co-location more relevant (Horváth & Rabetino, 2019). Since SMEs and KIBS often have large cognitive and technological differences, territorial proximity plays an important moderating role in making the integration of the two sectors easier at the local level. The spatial convergence of manufacturing and service creates a symbiotic recoupling with a bound spatial dimension thanks to positive feedback effects. The development of a dedicated service sector generates a positive territorial externality for manufacturing, and more dynamic and resilient industrial systems create a greater and more stable demand for KIBS firms (De Propris & Storai, 2019). Industrial districts represent an exceptional unit of analysis for these local dynamics. Despite this, Sforzi and Boix's (2019) empirical analysis of data from 1991 to 2011 on Italian and Spanish industrial districts showed mixed results. First, industrial districts effectively showed a place-based form of manufacturing servitisation since the process takes more relevance in local economies than within single enterprises. Consequently, it is a change more related to the production process than to act as a supplement to the goods produced. Second, Italian industrial districts are characterised by both better performance and higher servitisation than Spanish industrial districts. However, in both countries, the general servitisation of industrial districts is still low compared to other LLSs (the percentage of people employed in business service firms in 2011 was 16.8% in Italy and 11.8% in Spain and the percentage of people employed in business service firms in the rest of the LLSs was 20.5% and 14.9%, respectively).

To understand the recent changes in industrial districts, I have performed a similar analysis for the post-crisis period, comparing data from 2012 and 2017 on three different sectors: KIBS, ICT and metalworking. At the base of this selection there is precise theoretical reasoning. The first relevant theoretical positioning is the selection of two specific groups of KIBSs. Business service more strictly connected to manufacturing composes the former group. Indeed, small and medium manufacturing firms do have not the same need as great companies (e.g. managing expensive advertisement campaigns), they often need to rely on specialized external services due to limited internal resources, as in the case of technical testing or patent appliance. On the contrary, a wide range of ICT activities composes the second group. In this case, the hypothesis is that the local presence of enterprises in this field can enhance technological absorption, innovation and productive changes in small and medium enterprises. Finally, considering the metalworking sector makes it possible to disentangle the deindustrialisation introduced by the economic tertiarisation processes and the place-based development of KIBSs driven by territorial servitisation. There were several reasons for selecting metalworking sectors as controlling indicators. First, as previously discussed, Italy retains significant competitive advantages and economic dynamism in the metalworking sector. Second, metalworking constitutes an important core sector in all industrial districts. Indeed, even in industrial districts that are not specialised in metalworking, an important portion of the local production is often involved in creating dedicated machinery and tools for the main activity. Therefore, in the case of deindustrialisation, an increase in service and a decrease in metalworking activities is expected. Last, as will be shown in chapter 4, this is the sector most involved in industry 4.0 adoption. Territorial manufacturing servitisation should be characterised by a KIBSs sector growth and at least stability in a core district activity, which is metalworking production. The results are reported in table 9.

Table 9 Employment structure (%) by sector in different types of local labour systems (LLSs)

	Industrial districts	Manufacturing not districts	Not manufacturing	Italy

% ICT 2017	**1.8**	**2.5**	**3.5**	**2.9**
% ICT 2012	**1.6**	**2.3**	**3.3**	**2.7**
% Others KIBS 2017	**2.7**	**2.9**	**3.6**	**3.2**
% Others KIBS 2012	**2.5**	**2.9**	**3.3**	**3.0**
% Metal. 2017	**14.7**	**14.8**	**4.7**	**9.3**
% Metal. 2012	**14.7**	**14.8**	**5.3**	**9.8**

Data source: ASIA ISTAT

While non-manufacturing LLSs seem to continue an economic tertiarisation process, ICT services and other KIBS show growth in their shares, jointly reaching 7.1% in these types of local economies, a value markedly higher than the 4.7% reached by the declining metalworking sectors. Another way to see this deindustrialisation process is to focus on the evolution of the gap between the metalworking sector's employment shares and those of KIBSs, which in five years almost doubled from 1.3 to 2.4. Manufacturing not districts SLLs present a more stable situation in which only ICT services have experienced an increase in their share, while the other two sectors remain substantially unchanged. Regarding industrial districts, as in the previous study (Sforzi & Boix, 2019), they emerge as the type of LLSs with the lowest employment share in both ICT services and other KIBS, and the occupation level of these sectors is significantly lower than the national one. Even considering the moderate growth of both KIBSs sectors and the persistence of metalworking, it is difficult to determine structural changes in these local economies. However, the general figures changed radically when examining the firms' shares (Table 10).

Table 10 KIBS and metalworking firms as a percentage of total firms in different types of local economies

	Industrial districts	Manufacturing not in districts	Not manufacturing	Italy
% ICT 2017	**2.0**	**2.0**	**2.1**	**2.1**
% ICT 2012	**1.8**	**1.9**	**2.0**	**1.9**
% Others KIBS 2017	**6.7**	**6.9**	**6.6**	**6.7**
% Others KIBS 2012	**6.3**	**6.6**	**6.4**	**6.4**

% Metal. 2017	**3.9**	**3.2**	**1.6**	**2.4**
% Metal. 2012	**4.1**	**3.3**	**1.8**	**2.6**

Data source: Istat ASIA

If focusing on the firms' sectorial shares, the differences between SLL types are considerably scaled-down. In particular, the relative position in industrial districts drastically improves, showing value similar to other local economies. Furthermore, industrial districts account for 34% of the new Italian KIBSs firms born between 2012 and 2017 and for 22.0% in the case of ICT ones. Another interesting aspect that involves industrial districts is metalworking firms' declining in respect to employment stability. Consistent with those already discussed in the previous section about manufacturing in general, these results highlight peculiar industrial district dynamics. While manufacturing activities are concentring on bigger companies, which consequently results in a reduction of micro firms, this loss is partially compensated by the arrival of KIBS small companies. What makes this dynami clearer is the analysis of employment evolution in KIBS sectors (Table 11).

Table 11 ICT and other KIBS growth, and share of total growth in different types of LLSs

	Industrial districts	Manufacturing not in districts	Not manufacturing	Italy
ICT employment growth	**12.1**	**10.1**	**8.9**	**9.6**
Others KIBS employment growth	**7.1**	**6.8**	**12.4**	**10.2**
Total KIBS employment growth	**9.2**	**16.1**	**21.3**	**18.8**
Total employment growth	**0.5**	**1.0**	**3.1**	**2.0**
ICT share over total growth	**36.8**	**23.3**	**9.5**	**12.8**
Others KIBS share over total growth	**34.0**	**18.7**	**13.2**	**15.1**
Total KIBS share of total employment	**70.8**	**42.0**	**22.6**	**27.9**

data source: Istat Asia

The total KIBS employment growth in industrial district LLSs is relevant, surpassing even the national figure. In particular, the ICT sector is growing faster in industrial districts than in any other type of local economies. However, what provides strong evidence of districts' territorial manufacturing servitisation is how much the growth in the ICT sector and other KIBS sectors has contributed to general employment expansion, measuring 36.8% and 34.0%, respectively. Even

considering catching-up effects and the small overall employment increase, the fact that KIBS sectors account for 70.8% of total growth is remarkable and surprising. At the same time, it is true that this share is partially due to the low occupational dynamism of industrial districts. They have seen overall employment growth of only 0.5%, and ICT and the other KIBSs aggregate employment share increased only by 0.8% between 2012 and 2015. Although these results may lead to interpret the industrial districts territorial servitization as a minimal phenomenon, the employment dynamics and the rising number of ICT and other KIBSs firms inside these socio-economic entities tell us one other story. Today, industrial districts seem to embrace a development path based on territorial servitisation, which leads to substituting micro manufacturing firms with KIBSs firms, particularly those related to the ICT sector. This may appear ironic given that they have been studied in the past, primarily for their resilience against the servitisation and deindustrialisation of Western economies; however, it is quite the opposite. This process represents an adjustment of the local productive reality to maintain a dynamic manufacturing core able to cope with the rising challenges of technological change and global competitiveness. The manufacturing territorial servitisation that industrial districts are experiencing relates directly to the emerging Industry 4.0 technological paradigm. While place-based servitisation is an important factor in fostering the adoption of a Manufacturing 4.0 model, the spreading of these theologies will probably lead to increased local demands for ICT services and KIBS in general, generating a higher level of servitisation and further empowering the manufacturing core. The combination of territorial manufacturing servitisation and Industry 4.0 spreading may not lead to only the 'manufacturing renaissance' advocated by Lafuente et al. (2019) but also to a considerable revision of the current theory regarding local development based on the industry by diversifying the local productive networks' compositions and creating new forms of labour division and productive organisation. However, before discussing how districts are facing the challenge of Industry 4.0, the new hypotheses that emerged in this chapter about local development must be corroborated, and the old theory of local development must be tested to determine if it is still valid.

3.2 TERRITORIAL DIMENSION OF LOCAL DEVELOPMENT: OLD AND NEW PATHS

3.2.1 Proper Data and Methods for a Multilevel Research Question

This work has highlighted different ways in which territorial embeddedness is related to manufacturing firms' economic dynamism. This section will provide an answer to the following research question: Which territorial features are connected to a higher level of firm productivity?

To answer this question, I will focus on the metalworking sector[13] for both empirical and methodological reasons. Empirically, in previous sections, I have shown that Italy maintains significant competitive and economic advantages in metalworking, which is responsible for the greatest part of the country's national exports. Second, metalworking represents a core activity in the majority of industrial districts, even if they are not primarily specialised in metalworking. Third, it is an important sector in terms of innovation performance, particularly when embedded in medium-sized cities' local economies characterised by high levels of specialisation and the significant presence of medium-sized firms (Ramella & Trigilia, 2010). Lastly, metalworking is the industry most exposed to the emerging technological paradigm of Industry 4.0 in both the production process and the goods created. Thus, the future of Italian metalworking firms' innovative capacity lies in their capability to absorb and exploit these new technologies. Regarding the methodological grounds, focusing on only a single macro sector enables the possibility to operationalise a broader and deeper conceptualisation of specialisation and proximity between sectors. Territorial specialisation is typically misused, in empirical quantitative works about local economies, considering a single NACE two-digit sector. However, when considering the case of industrial districts where the production is divided between many SMEs belonging to different NACE sectors according to the production phase in which they are specialised, it becomes clear that the local specialisation is generated by the convergence of related activities and not by the

[13] The metalworking industry is identified by NACE codes from 24 to 30.

concertation of the occupation in just one micro sector. For example, the production of machine tools (NACE code 28) involves different parts, such as gears (NACE code 25), servomotors (NACE code 27) and sensors and digital interfaces (NACE code 26). After defining the research scope, the next step is identifying the units of analysis. In this kind of study, it is possible to follow three main approaches: focusing on firms' level of analysis, focusing on territorial analysis or combining both. A study that uses firms as a unit of analysis basically investigates how a single firm's performance is connected to specific firm characteristics and its territorial localisation in particular. This approach has the advantage of relying on microdata and consequently large datasets, making it possible to create more stable and reliable statistical models. However, this approach can manage fewer territorial variables and, thus, makes it difficult to disentangle different territorial dynamics. This is why most local economy studies are conducted through ecological analyses. Using territory as a unit of analysis enables investigating relations between different ecological variables, often providing more interesting results. Nevertheless, this approach presents relevant shortcomings. First, it exposes the research to the problem of ecological fallacy, which is the invalid transfer of results observed at the ecological level to the individual level (Jargowsky, 2005) (Freedman, 1999). Second, relying on only ecological variables makes it difficult to isolate the so-called compositional effect, caused by the different characteristics distribution in different populations, from the impact of the environment in which these populations are located, the truly contextual effect (Arcaya & Subramanian, 2014). For example, consider the connection between firms' productivity and the degree of specialisation in local economies. Specialisation usually implies the presence of a great number of larger and more dynamic firms, which raises the mean of local firms performance (compositional effects). However, specialisation also implies greater knowledge and technological spill-over that enhance average local firms' performance (contextual effects). The last approach that will be followed in this research is based on multilevel analysis. This statistical method enables using more than one unit of analysis when individual units at the first level (metalworking firms, lower level) are nested within contextual/aggregate units at the second level

(LLSs, higher level). Relying on two or more nested units of analysis is particularly useful in research with the following characteristics (Arcaya & Subramanian, 2014):

• The observations that are being analysed are clustered along spatial and geographic/political dimensions;
• Causal processes are thought to operate simultaneously at more than one level;
• There is an intrinsic interest in describing the variability and heterogeneity of the population in different contexts, over and above the focus on average relationships.

What makes this model so important for research that matches these characteristics is the possibility of testing the relationship between individual variables and the context in which these variables are embedded, thus controlling the compositional effects to determine the contextual ones. To accomplish these analyses, a dataset was created by combining information from the 2017 balance sheet about 32,008 Italian metalworking firms, between 5 and 250 employees, whit variables regarding the 522 LLSs in which they operate.[14]

3.3.2 Hypotheses and Main Variable Operationalisation

On the basis of the theoretical framework discussed in the first chapter, it is possible to formulate the following hypotheses:

H1: Metalworking firms located in more specialised LLSs generate a higher level of added value.

This first hypothesis is based on the MAR externalities theory from Marshall (1890), Arrow (1962) and Romer (1986), which suggests that spill-over takes place primarily within a single industry. Territorial specialisations generate three main resources: a

[14] The firms' data source is the AIDA database by Bureau van Dijk, which contains data about all Italian firms legally obliged to provide interim financial reports. The SLLs' data are an aggregation of data from the ISTAT ASIA database (statistical register of active companies). For further information about the dataset, please consult Appendix A.

significant number of suppliers specialised in different phases of production and commercialisation, the presence of a highly qualified labour force for specific production and the presence of a dense information flow and a knowledge spill-over related to specific activities. These elements foster collective innovation based on the constant implementation of minor novelties developed through learning 'by doing' and 'using', which are constantly integrated through learning by interacting (Ramella, 2016).

To operationalise this first hypothesis, two elements are needed: a dependent variable capable of capturing firms' capacity to generate added value and an independent variable able to provide a good measure of a local economy's specialisation. For the former, the indicator chosen is the so-called apparent labour productivity, which is the value-added per worker. The latter is the location quotient (LQ) index, calculated on the whole metalworking sector's employment.

H2: Metalworking firms located in areas characterised by a greater variety of related sectors generate a higher level of added value.

The second hypothesis is based on the related varieties concept (Frenken, Van Oort, & Verburg, 2007). In agreement with Jacobs (1969), this theory sees innovation as essentially a recombinant process; however, the notion of recombination was qualified, with researchers arguing that some pieces of knowledge are much easier to combine when productive common ground is present. Thus, what provides territorial competitive advantages is neither specialisation (excessive cognitive proximity) nor variety (excessive cognitive distance) but merely the presence of technologically related sectors (Asheim, Boschma, & Cooke, 2011). To measure related varieties, I rely on Shannon's entropy index. This index is a popular diversity indicator in the ecological literature, and it assumes a value close to zero when the local economic activities are heavily concerted in a single sector, reaching the maximum when employment is equally distributed among all sectors considered.[15]

[15] Shannon's entropy index is computed using the following formula:

In local development study, entropy index is usually computed on the last three NACE digits among the same two-digit sector (Koen, Van Oort, & Verburg, 2007); however, as in the case of the LQ index, I have followed a different path, computing it over all metalworking sector NACE codes.[16] Metalworking activities are heavily related even between different two-digit NACE codes, as already discussed at the beginning of this section.

H3: Even accounting for this territorial feature, to be located in industrial districts still positively affects metalworking firms' added value.

This hypothesis can be considered the more 'sociological one'. For economic sociology, what enhances firms' performance is their embeddedness in the local systems of social production. From a sociological point of view, what truly characterises industrial districts' local economies is the economic externalities of the social matrix. Different scholars have highlighted different sources of these social externalities, such as high levels of trust between economic actors (Bagnasco, 1985), territorial social capital (Bagnasco, Piselli, & Trigilia, 2001), the presence of formal and informal regulatory economic institutions and the provision of public goods for competitiveness by local governances (Crouch et al., 2001). All these elements make industrial districts' local socioeconomic-specific entities have additional peculiar features aside from the simple specialisation in related economic activity. Therefore, it is expected that firms located in industrial districts will show better performances, even accounting for the other territorial features of an economic nature. From the methodological point of view, industrial districts'.
Based on the empirical results presented in this second chapter regarding territorial sensitization, it is possible to formulate a new hypothesis.

$$\sum_{k=1}^{n} s_{k,i} \ln\left(\frac{1}{s_{k,i}}\right)$$

where sk,i is the proportion of enterprises in class k (NACE code at level two) in region i. If k = 0, this implies that ln(1/sk,i) = 0; n is the number of identified NACE codes at the second level of analysis (LLSs).

[16] From 24-30.

H4: Metalworking firms located in SLLs characterised by a relatively denser network of KIBS generate a higher level of added value.

Since this issue was just discussed, I will move on to operationalisation. To create an indicator of territorial servitisation, I have computed two LQ indexes, one for ICT[17] firms and one for other KIBS.[18] Computing LQ not on the employees' share but on the firms' share qualifies the index in different ways. If taking into consideration employment provides a measure of local economy specialisation, considering the number of firms captures the relative degree of territorial clusterisation in certain business activities. Indeed the fourth hypothesis point to the importance of the presence of a cluster of ICT firms, which provide specialized service to local manufacturing firms.

3.3.4. Control Variables

Testing these hypotheses implies disentangling how much a firm's performance is accounted for by a single unit of production characteristics and by the local economy features in which it is embedded. Thus, the main control variables in this paper's multilevel model are firm-level characteristics connected with economic performance:

- The firm's specialisation matches that of the LLSs (dummy variable computed on NACE first two digits);
- R&D expenditure (last five years' mean in thousands of euros);
- Fixed assets (last five years' mean in thousands of euros);
- Patent investment (to have acquired or developed a patent in the last five years, dummy variable).

[17] ICT services are identified by the following NACE codes: 58.2 - Software publishing ; 61 - Telecommunications; 62 - Computer programming, consultancy and related activities; 63 - Information service activities.

[18] KIBS are identified by the following NACE codes: 70 - Activities of head offices, management consultancy activities; 71.1 - Architectural and engineering activities and related technical consultancy; 71.2 - Technical testing and analysis; 72 - Scientific research and development; 74.1 - Specialised design activities.

- The number of employees.

The number of employees is a particularly important control for two reasons. First, there is a well-documented relationship between the dimension and economic performances; second, there is general agreement in the different local development theories that firms of different sizes benefit in different ways from the local context in which they operate. More precisely, with the increase in firms' dimensions, the territory's characteristics in which they operate become less relevant. This implies that bigger firms benefit less from operating in a context rich in territorial economic externalities. To consider this dynamic in the statistical model, the number of employees is placed under the assumption of random slopes. Allowing the slope to vary between different LLSs enables capturing how the relation between contextual features and firms' dimensions change among places.

Results and Discussion

Table 12 model 1 multilevel model for productivity, units of analysis: 1 enterprise, 2 LLS

VARIABLES	Value added per worker	Slope	Intercept	Cor. slope/ intercept	Residual
FIRMS level					
Number of employees	**195.8*** **				
	(8.054)				
Fixed assets	**0.339*** **				
	(5.76e-05)				
Patent investment	**3,649*** **				
	(375.5)				
R&D expenditure	**-0.501**				
	(0.000767)				
Same specialisation	**2,411*** **				
	(516.0)				
LLSs level					

Industrial districts	**2,436*** **				
	(789.8)				
LQ metalworking	**3,124*** **				
	(461.3)				
Related variety metalworking	**5,254*** **				
	(1,461)				
LQ ICT firms	**3,702***				
	(1,937)				
LQ other KIBS firms	**13,780*** **				
	(2,537)				
SLL firm average dimension	**5,526** **				
	(2,353)				
Constant	**36,869*** **	**4.140*** **	**8.455*** **	**-0.157**	**10.39*** **
	(2,649)	(0.166)	(0.0942)	(0.189)	(0.00399)
Observations	32,008	32,008	32,008	32,008	32,008
Number of groups	522	522	522	522	522

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The first thing to observe in the results of model 1 (table 12) is that both the slope and the intercept are statistically significant, confirming a robust model fit. Thus, there are significant differences between the SLLs that cannot be accounted for by the differences at the firm level. Furthermore, the relation between the number of employees and economic performance varies consistently among local economies. Thus, this model corroborates the latent hypothesis on which it is based the whole work: territorial embeddedness matters, and the context quality has remarkable effects on firms' economic dynamism. Passing to actual hypothesis just discussed, these results are consistent with hypotheses 1, 2. Specialisation externality (MAR hypothesis measured with LQ on metalworking employment) and related variety (Jacobs eternality measured with entropy) are both positive and significant. Actually, for the 'Italian school' of local development, these are not surprising results. As Ramella (2016) pointed out, the idea of industrial districts' specialisation is a broad concept that covers not only the main productions but also connected

activities. It is precisely the clusterization of complementary activities that makes possible districts' reproduction over time (Becattini, 2000). These results about the operativization of MAR and Jacobs's concepts make it clear that the relation between the two different externalities is more an issue of method and definition than a real theoretical puzzle. However, firms positioned in core sectors of local value chains[19] show higher performances. This is probably due to their capability to concentrate the added value generated across the local value chains. Regarding the main hypothesis, industrial districts show remarkably positive effects even when controlling for local firms' characteristic composition and other territorial variables. For example, firms located in industrial districts generate the amount of added value corresponding to roughly 12 more employees, with respect to an identical production unit in a not district area. These results provide important evidence that local economies' dynamics cannot be reduced to only economic indicators. Societal, political and institutional factors have played, still play and almost certainly will play a significant role in fostering and orientating local development paths.

Finally, the fourth hypothesis concerning territorial servitisation and the positive effects of local KIBS firms' networks seems only partially corroborated. While other KIBS show a positive statistically significant effect, it does not apply to ICT sectors. these results conflict with the empirical findings presented in the previous section. Indeed, if an ICT sector is less present than other KIBS, it experienced good overall employment growth, and in districts, it is the sector that accounted for the largest share in new employment. To further investigate this issue, it may be worthy conducting the same analysis, splitting the total tested by firm dimensions (Table 13).

[19] Firms that match the prevalent metalworking sectors' specialisation, comparing the first two NACE digits.

Table 13 model 2 multilevel model for productivity separated by dimensional class, units of analysis: 1 enterprise, 2 LLS

VARIABLES	Value added per worker		
Firms	**Micro firms (5–9)**	**Small firms (10–49)**	**Medium firm (50–250)**
Number of employees	**820.4*** **	**318.8*** **	**77.09*** **
	(236.1)	(25.42)	(13.31)
Fixed assets	**0.541**	**0.515*** **	**0.298*** **
	(0.000379)	(0.000502)	(6.64e-05)
Patent investment	**1,697** **	**3,279*** **	**2,050**
	(663.6)	(481.1)	(1,326)
R&D expenditure	**7.082**	**-0.442** **	**-0.545**
	(0.00984)	(0.00204)	(0.000936)
Same specialisation	**2,626*** **	**2,425*** **	**2,264**
	(938.0)	(662.3)	(1,449)
LLSs			
Industrial districts	**2,098** **	**2,037** **	**6,150*** **
	(1,023)	(878.2)	(1,618)
LQ metalworking	**3,664*** **	**3,095*** **	**2,205** **
	(615.3)	(511.7)	(913.4)
Related variety metalworking	**4,763** **	**3,337** *	**10,615*** **
	(2,065)	(1,721)	(3,547)
LQ ICT firms	**1,473**	**7,374*** **	**4,308**
	(2,548)	(2,209)	(4,029)
LQ other KIBS firms	**17,211*** **	**11,605*** **	**16,344*** **
	(3,421)	(2,961)	(5,889)
SLL firm average dimension	**3,163**	**3,246**	**263.2**
	(3,387)	(3,219)	(6,071)
Constant	**32,543*** **	**8.668*** **	**10.37*** **
	(3,866)	(0.376)	(0.00731)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 14 model 2 slope intercept correlation and residual values

	Slope	Intercept	Cor. slope intercept	Residual
Micro firms (5–9)	**5.562*** **	**8.668*** **	**-8.091**	**10.37*** **
	(1.171)	(0.376)	(565.8)	(0.00731)
Small firms (10–49)	**4.540*** **	**8.469*** **	**-0.299**	**10.36*** **
	(0.636)	(0.204)	(0.479)	(0.00527)
Medium firms (50–250)	**3.487*** **	**7.463*** **	**7.161**	**10.52*** **
	(0.518)	(1.047)	(426.2)	(0.0115)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

As with the previous model, the model separated by three employee sizes shows a good overall fit. For space reasons, the results are presented as separate tables (Table 14). Model 2 (table 13) shows three interesting results. First, the importance of the number of employees decreases sharply, passing from category micro firm (5–9 employees) to small firm one (10–49 employees). Second, medium enterprises appear to benefit most from being located inside industrial districts. The second point is particularly interesting. If these results are consistent with the data previously presented concerning the changes in industrial districts' employment structures (Figure 8), they represent a significant novelty for this industrial districts study. Indeed, medium firms appear to benefit less from both variables connected to specialisation. The difference between firms that match the local specialisation and those that do not is not statically significant, and it is the dimensional category that benefits less from overall metalworking specialisation. On the contrary, medium firms benefit largely from sectorial-related varieties. It is possible to identify two main reasons for this dynamic which challenge standard industrial districts theory: one is related to the relationship between internal resources and territorial economic externalities, and the other is related to the relation between medium firms and local governances. Given the higher internal resources of medium firms, they have greater capability to exploit territorial externalities as boosting effects combining them with extraterritorial ones, rather than experiencing

local context as compensatory factors for internal limitation. Medium firms are also more able to influence local districts' governance and, consequently, the creation of local goods for competitiveness. With the rising role of more formal and institutionalised forms of local economic regulations, the possibility of directly influencing other local actors becomes strategic. The final relevant point from the findings is that only small firms benefit from the presence of ICT firms at the local level. Boschma's proximity theory provides an extremely useful framework to compose this empirical puzzle (2005). Micro firms, in the majority of cases, experienced a high level of cognitive and technological distance towards ICT that cannot be bridged by territorial proximity. On the contrary, medium metalworking firms are usually characterised by a certain grade of technological and cognitive proximity with ICT, and this makes the territorial dimension less relevant since they can more easily outsource these services outside the local context. However, for small firms, territorial proximity becomes a crucial factor, mitigating cognitive and technological distances. This gives room for a fifth hypothesis.

H5: Since firms in industrial districts experience not only a high level of geographical proximity but also organisational, institutional and social proximity, metalworking firms located in industrial districts benefit more from co-location with ICT and KIBS firms.

To test this hypothesis, I computed a model identical to the previous ones but that considered only industrial district firms and LLSs (Table 15); thus, the districts variable was omitted.

Table 15 multilevel model for productivity considering only districts, units of analysis: 1 enterprise, 2 LLS

VARIABLES	Value-added per worker	Slope	Intercept	Cor. slope intercept	Residual

Firms					
Number of employees	**224.2*** **				
	(14.40)				
Fixed assets	**0.278*** **				
	(6.25e-05)				
Patent investment	**3,653*** **				
	(570.7)				
R&D expenditure	**-0.154**				
	(0.00169)				
Same specialisation	**1,632** **				
	(762.2)				
LLSs					
LQ metalworking	**3,746*** **				
	(532.3)				
Related variety metalworking	**4,532***				
	(2,469)				
LQ ICT firms	**11,433*** **				
	(2,903)				
LQ other KIBS firms	**2,605**				
	(3,800)				
SLL firm average dimension	**122.4**				
	(4,285)				
Constant	**45,117*** **	**4.596*** **	**8.142*** **	**-0.301**	**10.38*** **
	(4,802)	(0.153)	(0.166)	(0.234)	(0.00609)
Observations	13,698	13,698	13,698	13,698	13,698
Number of groups	122	127	127	127	127

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The results from this model are surprising, as not only do district firms benefit from the presence of ICT firm networks but not from the relation between metalworking firms and different kinds of KIBS. Indeed, the presence of knowledge-intensive

services different from ICT ones does not show any statistical relevance for industrial district firms. The reasons behind this finding can be traced to socioeconomic and institutional specificity. Many KIBSs in industrial districts are indeed provided from outside the market or from market relations heavily mediated by social interactions. For example, information about new market possibilities is not acquired through economic exchanges but from cooperation and reciprocal relations. Different firms often collaborate to design new products and integrate different complementary specialisations on the basis of long-term relations and not as a project for remuneration. In addition, service as a technological transfer or a skilled labour force training is present, such as local public goods created by local governance actors. Model 3 results suggest that in industrial districts, versatile integration processes and the proximity on different dimensions not only make it easier to incorporate ICT in local productive value chains but also make less relevant other forms KIBS. These characteristics give space for a remarkable and largely unexpected capability of old fashion industrial districts to rapidly adjust to the challenge of Industry 4.0, especially if supported by effective industrial policies.

3.5 CONCLUSION

Today, industrial districts seem to embrace a development path based on territorial servitisation, which leads to the substitution of manufacturing micro firms with KIBSs firms, particularly those related to the ICT sector. This may appear ironic given that they have been studied in the past, primarily for their resilience against the servitisation and deindustrialisation of Western economies; however, it is quite the opposite. This process represents an adjustment of the local productive reality to maintain a dynamic manufacturing core able to cope with the rising challenges of technological change and global competitiveness. The empirical finds of these model have made it possible to corroborate partially and for the metalworking sectors, the hypothesis of Lafuente et al.:

"Territorial Servitization can contribute to local competitiveness and employment creation through the virtuous cycle generated when a resilient local manufacturing base attracts or stimulates the creation of complementary knowledge intensive business services businesses, which in turn facilitates the creation of new manufacturers." (Lafuente, Vaillant, & Vendrell, 2019 p.25)

Indeed, the co-location with KIBS sectors positively affects metalworking SMEs' productivity. In addition, the results obtained indicate a different manufacturing servitization pattern in manufacturing local economies and industrial districts. Indeed, while in the forms benefit from the presence of not ICT KIBS, in the case of industrial districts, the local presence of ICT firms shows a remarkable positive effect. These findings are relevant to cast light on the territorial manufacturing servitization process. However, they are also particularly important concerning the ways local clusters are adjusting themself in response to the industry 4.0 spreading. Indeed, industry 4.0 complexity requires a combination of traditional district dynamics with innovative ones, characterized by the emergence of new relevant local actors, activities and resources. These changes blur boundaries between different sectors and redefine relevant local knowledge. The territorial manufacturing servitization process can lead to a local embedding of ICT service providers' populations, useful for industrial districts in facing 4.0 challenges

4 TECHNOLOGICAL CHANGE, PRODUCTION MODEL AND LOCAL ECONOMIES

The previous chapter discussed the transformations involving industrial districts after the Great Crisis, particularly the process of territorial servitisation. As shown, in the Italian industrial districts, this process resulted in a substitution, at the local level, of manufacturing micro-enterprises with ICT ones. This represents the particular districts' response to the general trend of industrial digitalisation involving not only an enterprise's production reorganisation but also an adjustment of local economies. On the one hand, Industry 4.0 can be seen as the apex of this recombination process of industrial and digital processes both within and between the enterprise's boundaries. On the other hand, it has emerged as a new technological paradigm, leading to the Fourth Industrial Revolution. The strict relationship between economic growth, technical innovation, and social change is a well-recognised "fact" in economic sociology. In addition, there are few doubts that only a mutual understanding of these aspects can trace the boundary of industrial revolution theoretical concepts.

To better explain this point, we can take as an example the Second Industrial Revolution. This era was based on the following technological innovations: development of the production and distribution of electricity, electrical machine tools, internal combustion engines, science-based chemical processes, and efficient steel casting (Castells, 2011). These technologies converged in a new industrial process called mass production. However, the application of these innovations is not the only factor that explains the establishment of this industrial model. Another important factor is the development in the same years of a new organising principle, Taylorism, based on the technical-scientific organisation of work (Jessop, 1992). If the new technological cluster and the emergence of new organisational principles represented the abstract, codified, technical knowledge at the base mass production raising, the Ford Motor Company was the one to make the first actual implementation. More precisely, in the production plant for the model T car, where the conveyor belt led to the first assembly line and the famous salary of $5 for 8 hours of work per day.

However, it is important to consider that the translation of technological and theoretical principles to practical application is never an automatic and acritical process. Regarding the first attempt at scientific management implementation, Ford production manager Charles E. Sorensen wrote: "Cost were rising and production falling in the name of 'efficiency'… This system can't adapt itself to our kind of manufacturing." (2006p. 40). This empirical translation, in which the technical and scientific aspects were integrated with contextual and tacit knowledge, represents the real starting point of a new system of economic and social reproduction, Fordism, destined to dominate Western economy for more than 60 years. It is important to note that the development of Fordism not only implies a technical development following a distinctive technological trajectory (Dosi, 1982) but also the formation of specific institutions (Edquist, 1997). Indeed, a model of development is created by the interplay between the technological trajectory specific to a particular technological paradigm and the established institutional regime.

The expansion of the mass production/consumption industrial society created its own set of social institutions, which present several common features but at the same time are characterized by great variability, taking different forms in different places. This creates specific institutional regimes at different geographical levels. The first source of differences, and for this model the most important, refer to the national level, particularly to central formal institutions that regulate monetary management, the configuration of wage bargaining, and the different forms of welfare state provision and competition regulation (Boyer, 2005). However, regional differences can also be significant sources of differences. First, the local level displays specific institutional structures (formal and informal) that provide advantages and incentives for specific production regimes. Second, also central regulation outcomes may vary according to local characteristics. For example, the same policy can advantage disproportionally different local economies, public investment at the local level can lead to different outcomes according to previous territorial resources and others. (Martin, 2000). This brief summary clarifies not only the strong relation between technological innovation, economic change, and institutional development but also the complexity of their interweaving. Indeed, even if it is largely recognised as strictly related, the nature of the relationship between technology, economy, and society is a controversial issue in sociology theory. These theoretical problems concern the direction of the causal relationship, the degree of independence of technical change, the role of institutional

factors in determining innovative activity, and the result on technological application. In other words:

"Technology does not determine society. Nor does society script the course of technological change, since many factors, including individual inventiveness and entrepreneurialism, intervene in the process of scientific discovery, technological innovation, and social applications, so theft the final outcome depends on a complex pattern of interaction". (Castells, 2011 p.5)

The societal and technological determinism problem actually represents a false dilemma since a society cannot be understood without considering its technical bases, and technology is an integral part of human culture (Rosenberg, 1994). Although addressing this dialectical relation between the technological innovation and economic reproduction of society is far beyond the scope of this work, we can nevertheless provide a valid conceptual framework to trace the boundaries of the ongoing change and its possible implications for Italian industrial districts.

4.1 TECHNOLOGICAL PARADIGMS AND THEIR TRAJECTORY: A TALE OF INVENTORS, INTEREST, AND INSTITUTIONS

The theoretical notion of the technological paradigm was formulated by the Italian economist Giovanni Dosi (Dosi, 1982), and his basic intuition was applied to technology elements of Kuhn's thoughts on the evolution of natural since. Dosi started from a broad definition of technology that includes not only artefacts and the codified knowledge embodied in them but also theoretical and practical knowledge. Therefore, this definition takes into consideration the devices, tools, know-how, methods, procedures, and experience accumulated through the trial and error process. Following this idea, technology can be seen as a combination of physical and symbolic tools applied to problem-solving activity, including tacit forms of knowledge embodied in individuals and organisational procedures. These elements compose the technology cluster at the base of every technological paradigm. However, a paradigm is not limited to the state-of-the-art of interconnected principles and tools selected to approach specific

tasks; it also entails a perspective of "how to do things" and how to improve them. This implies a collective cognitive frame shared by the community of practitioners in a particular activity, which follows an incremental accumulation (Constant, 1987). The technological cluster and the connected cognitive heuristics[20] of any given paradigm shape a particular technological trajectory, which is the progressive realisation and exploration of the paradigm's innovative opportunities. This trajectory follows an incremental path leading to incising returns in the application of given technologies and enlarging both the technological task and needs to which the paradigm is applied (Cimoli & Dosi, 1995).

Returning to the earlier example about the Second Industrial Revolution, the invention of an internal combustion engine and its mass production was not only followed by a continuous increase in the efficiency/power relation and the reduction of the production cost of this technology. Automotive mass production also stimulated innovation in other related fields, such as industrial chemistry, fuels, and tyres. Moreover, the technological paradigms of Fordism spread quickly to other sectors, in particular, the manufacturing of household appliances and audio-visual equipment and the mass production of mass media devices (Nelson et al., 1993).

At first sight, this theory may appear to suffer from a certain technological determinism; the concept of a technological trajectory, especially, appears overly "natural" and autonomous. However, it is quite the opposite: The success of Dosi's theory is related to the great attention given to social and institutional factors in establishing technological paradigms and shaping their trajectories. As already discussed in the introduction of this chapter, even in extreme synthesis, it is possible to identify distinctive times of economic development characterised by their specific "engine of technological dynamism" and a governance model ruling the relation between major economic actors: state, unions, business associations, firms, investors, and workers (Amin, 1994). The composition of these actors' interests, along with the ingenuity of individual innovators and entrepreneurs, is an important force in directing technological trajectory, setting complex networks of positive and negative incentives (Dosi, 1982).

It is a fact that institutions play a major role not only in shaping the technological evolution of an established paradigm (industrial maturity, following Dosi's language)

[20] A given paradigm provides both paths of inquiry to avoid or neglect (negative heuristic) and other promising paths to pursue (positive heuristic).

but also in the paradigm's genesis itself (the Schumpeterian phase). Given the intrinsic uncertainty always associated with any innovative process, for firms, undertaking this activity is extremely risky in terms of both technological and economic success, even considering high expected rewards (profit). Indeed, the establishment of a new technological paradigm can be seen as a process of trial and error, which sees the market as the first selection device. However, public institutions operate following interests not related to short-term economic interests. National economic agenda, policy and other government bodies, such as military and university interests, play a major role in focusing direction and effort in technological development (Cimoli & Dosi, 1995). In addition, other social and more informal social groups, such as particular user communities, can carry out particular innovative activity following interest different from short time market returns.

To use a different example, we can take the Third Industrial Revolution. Its technological paradigms were based on a cluster of information and communication technologies, particularly microprocessors, software, personal computers, and network link protocols. Behind the development of the internet, there are two main institutional actors. First, the US Defense Department's Advanced Research Projects Agency (ARPA) needed to design a communications system invulnerable to a nuclear attack. Second, a consortium of universities[21] needed to exchange information and make it available, even if it was not collected centrally. The outcome was a network architecture not controlled by any central infrastructure, consisting of thousands of autonomous machines with innumerable ways to link up. Even considering the importance of other "big science," such as CERN's creation of the World Wide Web (WWW), another force that gave form to the information technology paradigm was the result of the constant process of innovation enacted by early computer hackers and the network hobbyists' community[22] (Castells, 2011).

To sum up, institutions and other more informal social dynamics operate in different ways with regards to the market by:

[21] MIT, UCLA, Stanford, the University of Southern California, Harvard, the University of California at Santa Barbara, and the University of California at Berkeley

[22] The importance of these informal communities, even if more studied and detectable in the case of information technology, it is not an exclusive feature of the Third Industrial Revolution. An example of their contribution to today's revolution is provided in "Fab Labs in Italy: Collective Goods in the Sharing Economy," by Ramella and Manzo (Ramella & Manzo). Taking the second one into consideration instead, some examples are provided by Lucsko in *The business of Speed*, in which the author explains how the hot rod constructor communities were an important source of innovation for the USA automotive sector, especially in the post-war period (2008).

- operating the selection of technological clusters ex-ante in respect to the market;
- providing negative and positive incentives through policy;
- providing infrastructure to make the physical and cognitive spread of technology possible;
- exploring innovative opportunities not directly related to economic returns.

It is almost universally accepted that institutional support for innovation is important for correcting market failures. Indeed, the state plays a major role as a risk-taker investor in the early stages of technological development, providing incentives to overcome technological look-ins related to technological switching costs and generating the public goods needed for the innovation process (Arrow, 1951). However, the reasoning provided until now points to a different understanding of institutions' role with respect to mainstream economic views. The role of institutions is not limited to that of market fixers; they may deliberately pursue an innovation path following their own interests. This brings us to a double meaning of institutional entrepreneurship. On the one hand, the institution can change through a process of trial and error in order to adapt to new economic conditions, as in the case of the emergence of a new technological paradigm (Streeck & Thelen, 2005). On the other hand, national and local institutions are real entrepreneurial actors selecting and focusing technological paradigms pursuing their own aims (Bathelt, 2003; Mazzucato, 2013).

4. 2 FROM THEORY TO PRACTICE: APPLYING THE DOSI THEORY TO INDUSTRY 4.0

There are few doubts that institutions are one of the major forces in creating the Industry 4.0 technological paradigm. The term 'Industry 4.0' originated in 2011 at the Hanover Fair in Germany as the title of the new policy strategy implemented (Morrar, Husam, & Saeed, 2017). We can identify three sets of elements in this paradigm: the technologies selected to compose the paradigm's technological cluster, the tasks to which they are applied, and the interest at the basis of these selections and applications.

Industry 4.0's enabling technologies can be divided into two interconnected groups: one with an in-house application and the other that can operate both intra- and inter-firm. The former includes collaborative robots, 3D printers (additive manufacturing), and augmented reality for production processes. The latter is composed of the process optimisation between interconnected machines (digital manufacturing), or the communication between production and products (the Internet of Things), and the data management technologies of cloud computing and cybersecurity (Bonomi, 2018). It is important to note that these technologies and their first application are not particularly recent; indeed, their creation ranges from 1986 (3D printing) to 1997 (collaborative robotics) (Frank, Dalenogare, & Nestor, 2019), and their actual implementation took place between the early and mid-2000s[23]. However, we have to wait roughly ten years, the post-Great Crisis era, to see these technologies converge in an actual enabling interconnected cluster.

To identify the technology cluster selected, it is important to focus on the problems or tasks to which this technological core is applied, in other words, to consider the normal activity of problem-solving that extends the application field and improves the economic outcomes of any technological paradigm. As with the previous point, we can categorise between activities carried out within the firms' boundaries and those involving productive relations that cross the firms' boundaries. An in-house activity application of Industry 4.0 allows for a higher level of automation for complex operations and makes possible the economic sustainability of low value-added activities even in high wage countries, increasing productivity and profit[24] (Rosin, 2020). Moreover, this technological cluster allows both a faster prototyping and implementation phase. In particular, the combination of additive and digitalised manufacturing makes possible not only a faster development and testing of new products but also an easier implementation of their production (Zawadzki & Żywicki, 2016). Thanks to the possibility of replicating virtually the whole production process in a cyber-environment, the design stage and the planning phase are easily integrated, providing at the same time the easier composition of innovative and replicative aspects and precise forecasting of

[23] The only exception is 3D printing which, although it was the first to accomplish sufficient technological maturity for industrial application, saw actual implementation only after the expiry of the original patent US5121329A in 2009.

[24] Actually, this is a simplification. As Biachi Laboey points out, investments in automation of low added value complex activity are economically justified only when they are ablo to generate stable source of value added and a certed stability n the demands. Stagional or extrmily unstable production of low value added level will still carry out by low wage, purly protect and precarious labours (2018).

production costs. The last in-house task to which this technology is applied concerns the connection of the different machinery tools of a plant within a common system, which makes it possible for machines to produce, communicate, and aggregate data.

This datafication of manufacturing improves production efficacy in numerous ways. For example, the communication between machines facilitates rapid response to problems arising in any part of the production process, and the analysis of the data collected allows for the identification of weaknesses in the production chain (Xu, Xu, & Li, 2018). However, this technology (mainly IoT, sensor networks, and digital manufacturing) not only permits a faster process of autonomous production optimisation but also provides valuable information for the decision-making process. Another important aspect is the simplification and reduction of transition costs related to administrative tasks and the management of both input and output resources.

Obviously, this interconnection between machinery in a cyber-physical system is not limited by a single firm's boundaries. This brings us to the second group of technological tasks, which involves enterprises external relations. The application of Industry 4.0 facilitates the management of the value chain, reducing organisational and administrative transition costs. Moreover, the interconnection of different firms linked by productive ties allows for more rapid adjustment of the whole value chain (Brettel, Friederichsen, & Keller, 2014). Even if an easier integration of productive links along supply chains is one of the aspects destined to have a powerful impact on the global industrial landscape, the Industry 4.0 paradigm also presents an important novelty in producer-client relations. Indeed some of the goods produced incorporate part of the principle of technological paradigms integrating hardware and software. To use a popular example, Tesla cars receive periodical software upgrades to increase vehicle performance and radically change the driving experience (Bassi, 2017). Other important examples are self-diagnostic tools and equipment that can predict breaks, making it possible for suppliers to operate "just in time" maintenance. This property of 4.0 goods allows for generating value through post-sell service, contributing to manufacturing servitisation (Li, Wang, & Wang, 2017).

The last technological task is related to cloud technologies, which permit access to high-performance virtual tools and low costs. A modern enterprise's operation involves numerous decision-making activities, requiring a large amount of information and intensive computation. At one point, manufacturing enterprises required multiple computing resources, such as servers for databases and decision-making units (Xu, Xu,

& Li, 2018). Cloud computing provides an effective solution to such problems since all data can be stored in private or public cloud servers and analysed with digital tools (such as optimising algorithms and learning machines), often offered on demand. In the case of open-access cloud technology, it also allows for more complex and open links between producers/providers and consumers/users, as in the case of co-designing (Petrelli, 2017).

Once we have identified the 4.0 technological clusters and the tasks to which they are applied, it is time to consider the actors' interests, namely firms and institutions. In general, firms see in the Industry 4.0 application the possibility of reducing both production and transaction costs raising profits. However, to frame it more precisely, firms' interest is changing considering other aspects, mainly the dimension, big enterprises against small and medium firms, and sector manufacturing versus knowledge-intensive services.

From the perspective of service sectors and, in particular, information technology providers, Industry 4.0 represents a great market extension. While big enterprises have a strong interest in developing new technologies of wide diffusion and in setting implementation standards, small ICT firms see in this technological spread the rise of specialised service demand in local economic systems. In other words, big enterprises are interested in investing in creating successful patents connected to these technologies, while small firms develop specific services for specific local context applications (Bianchi, 2018).

Considering manufacturing, for large enterprises with high productive volume, the implementation of Industry 4.0 allows, on the one hand, easier management of both their own production units and suppliers and, on the other hand, a major improvement of flexibility and diversification of the production process (Anderson, 2012). Finally, for small and medium firms, the implementation of these new technologies is important for reaching the level of productivity usually associated with high volumes of semi-standardised goods in the case of small numbers of personalised products. Moreover, the interconnection between firms offered by Industry 4.0 reduces transition costs and makes it easier to adjust collaborative producing networks. However, industry 4.0 can not be reduced to the simple reduction of transaction and transitive costs.

Indeed, its principle and technologies make it possible to create new forms of interconnections and, consequently, cooperation between economic agents. Following this view, the current technological change can enhance new forms of collective

learning, innovation process and economic actions integration, in which social factors as reputation mechanism, trust, and informal institutional regulation play ma major role.

In a broader sense, these technologies enable the conversion of replicative manufacturing into an innovative one, which embodies the services sector feature (Rullani, 2015). At the base of innovative manufacturing, there is generative intelligence of people, factories, and local contexts, and consequently is based on both technological apparatus and intangible assets such as conception, R&D, design, innovation, modelling and production planning. The capability to operate this transition is increasingly important in the context of rising global competition. A manufacturing model based on innovation allows for more added value from global production chains, avoiding the productive attraction based on low labour costs. It is exactly on this basis of competitive capacity that institutions and firms see their interests converge. This common concern for a "highway" of development also crosses different governance levels. At the supranational level, Industry 4.0 can be the response to the European problem of creating an inclusive development model, a problem more and more salient after the Lisbon strategy's substantial failure (Ramella, 2016). At the national level, the principal European countries can focus their industrial policies on Industry 4.0 as a strategy to maintain manufacturing production within their borders. As will be seen, the relation between the interest of enterprises and local governance is even more intertwined, and the diffusion of these new technologies is intended to have strong effects on local economies' institutional frameworks. Finally, it is important to remake that industry 4.0 does not ensure an automatic advantage for advanced western manufacturing activities. Indeed the reduction of transaction costs and the possibility of better integration of globally dispersed networks connected to 4.0 technologies, allowing to enlarge the connections and control by leader enterprises of productive platforms located in a contest of cheap labour cost, simultaneously augmenting their productivity. However, Industry 4.0 open a relevant window of opportunity, which, however, to be seized, needs remarkable collective efforts to activate territorial resources at the local level. In other words, Western countries and regions must elaborate and incentive new paths of industrial development with action at all territorial levels.

4. 3 INDUSTRIAL REVOLUTION, TECHNOLOGICAL TRAJECTORY, AND PLACES

Even if technological paradigms present a considerable level of invariance between places, the ways that technological changes affect and take place in different contexts vary considerably. The composition and history of production systems, combined with territorial institutional and social factors, are at the foundation of wide heterogeneity in the territorial outcomes of technological/economic changes. Different nations unequally benefit from the emergence of technological paradigms. In the same manner, even when part of the same country, different regions are disproportionally affected in both positive and negative ways by these changes. Even if less prominent in the scientific debate, it is widely accepted that this is also true in the case of smaller local economies, particularly when they have unique features regarding urban dimension and sectorial specialisation.

In a broad sense, the relation between technological/economic change and place can be seen as a double-Darwinistic process. On the one hand, the emergence of new technological paradigms and their technological trajectory favour particular territories, setting them on a path of development or decline. On the other hand, territories do not suffer this selective process in a merely passive way; nations implement industrial policies, regions display innovative systems, and local economies adjust (Wolch, Dear, & et al., 1989). As discussed at the beginning of this chapter, the adaptive capabilities of territories are related to attempts to integrate new paradigms' principles and tools into local contexts and their outcomes. It is important to note that a successful contextual integration process contributes to shaping and directing the technological trajectory, changing the selective principle of the technological paradigm (Dosi, 1982). To address these complex relations, I will simplify my argumentation in two separate reflections. First, I will sketch the salient characteristics of the last three industrial revolutions through two keywords and what their implications are from a territorial perspective. Second, I will discuss how territorial integration takes place and its implications for technological trajectories. Indeed, it should not be forgotten that the successful process of integration is successful precisely because it extends the problem-solving activity to which the technological clusters are applied to contextual needs.

4.3.1 The Second Industrial Revolution: Mass, Efficiency, and the Industrial City

As already explained, the Second Industrial Revolution coincides with the age of Fordism, in which the primary source of productivity improvements in terms of process routinisation, specifically dedicated machinery implementation, quantity produced, and standardisation of outputs. Thus, the idea at the basis of productivity enhancement was the maximisation of output at minimum input. Maximum output was related to maximising individual worker efficacy, achieved through division of labour and mechanisation (Boyer & Coriat, 1986). The input minimisation was related to marginal cost reduction, pursued thanks to the systematic research of internal economies of scale benefit. This strategy can be followed thanks to high production volumes and standardised goods. These aspects also shaped the production organisation, which saw big, vertically integrated firms dominate national networks of upstream producers. The suppliers were medium and small firms that provided necessary physical inputs and services, often produced through non-Fordist artisanal labour processes (Sabel & Zeitlin, 1985).

Fordism from a territorial perspective is related to the prominence of the national central state. Indeed, this centrality and standardisation characterised both economic production and more relevant economic institutions. The central bargaining between oligopolistic corporations and big industry-wide labour unions led to a progressive codification and standardisation of employment relations, especially for blue-collar workers. The central state was also the more important provider of collective goods for competitiveness, including major infrastructures such as highways, railroads, high-voltage lines, and universities (Jessop, 1982).

Despite the prominence of the national level, Fordism was still characterised by important territorial differences. This era was defined by the rise of large metropolitan areas where the plants of dominant sectors' big firms and their connected service sectors were located. Networks of smaller industrial cities and the location of small and medium manufacturing suppliers surrounded these metropolitan areas. This spatial organisation originated industrial regions dominated by a limited—if not sole—number of big industrial cities, where a few large enterprises settled. For example, the US Rust Belt with Detroit, Cleveland, and Pittsburgh; the Rhône-Alpes region in France with Lyon and Grenoble; the Italian industrial triangle of Torino, Milano, and Genova; and the

Greater Manchester area. These industrial regions also represented places where states concerted the provision of collective goods for competitiveness[25] (Storper & Scott, 1989).

4.3.2 The Third Industrial Revolution: Flexibility, Connection and Networks "loci"

By the end of the 1970s, the Ford model of development was facing its final disarray, but in the background of this crisis a new technological revolution was taking shape. The innovation in information and communication technologies provided the technical tools for the Third Industrial Revolution, related to the new socioeconomic regime, which following Castells' terminology, we will call Informationalism (Castells, 2011). These new regimes arose from the reorganisation of manufacturing production in Western countries, the rising importance of new service and high-tech sectors, and the emergence of the new international division of labour. Informationalism, alongside new technologies, brought a new conception of productivity: the mass production emphasis on maximising output and minimising marginal cost was replaced by the importance of generating elevated value-added, keeping under control the average cost of production (Coriat, 1992). Indeed, the new market featured differentiated and unstable demand and growing international competitions that led to a flexibilisation of all productive relations. Alongside the introduction of new programmable machinery adaptable to a broader set of tasks, enterprises undertook major organisational adjustments. At least as important as technological changes, these changes aimed to find a compromise between integration and disintegration in terms of production and organisation costs. Smaller, flexible specialised units of production minimise internal transaction costs and try to maximise economies of scope through "modular" integration (Piore & Sabel, 1984). The new organisation paradigm allows for tight control over quality and easier reconfiguration to adapt rapidly to both demand fluctuation and new market opportunities (Leborgne & Lipietz, 1988).

At first glance, the theoretical base seems like a Williamsonian recast of the Coase transaction costs concept. However, the well-known "make or buy" theory is still centred on marginal costs (Williamson, 1981). More sociologically concerned theories

[25] Or at least where they have displayed positive effects. Indeed, attempts to reproduce this model of local development have faced major problems, as already discussed in Chapter 2 on cathedrals in the deserted Italian season.

were proposed, for example, by social scientists Bagnasco and Sabel (1995) and geographer Martin (2000), giving "make" and "buy" a different meaning, less related to mere marginal cost evaluation and more concerned with the capability to generate value thanks to know-how, creative problem-solving, innovative capacity, customisation, and co-design. From this perspective, "make" implies controlling the value-added of a firm's workers and investing in fixed capital related to this activity. "Buy" implies sharing with external firms the cost of fixed assets needed to create final products and the cost to externalise part of the surplus value-added generated by other firms' workers.

Therefore, the new flexibility is obtained both through internal flexibilisation and more complex external relations. Inside the firms' boundary, it is achieved thanks to multipurpose machinery and more flexible and skilled human capital. In the inter-firm relations' domain, flexibility is achieved thanks to interactions in complex networks able to recombine both vertical and horizontal firms' productive linkage rapidly. This leads to the intensification of the external economy of scale in the whole production system and generates a more complex environment of productive relations, in which the coordination costs are brought low by information and communication technologies (Storper, 1997). In contrast, with the Fordist "one best way," the flexibility and network structure of the production process that characterised Informationalism takes a broader range of forms. Indeed, during this phase, the organisation of production tends to differ alongside two dimensions. The forms are related to market characteristics and, more precisely, if they present relevant market niches, or are mass markets even if of differentiated goods. The latter dimension derives from the industry feature and is organised alongside a continuum between labour-intensive and R&D-intensive production.

To better understand the two poles of this continuum, it is worthwhile questioning the standard economic views. Indeed, this distinction is only in part related to the actual quantity of labour or research effort needed to produce the goods; what really matters is in which phase the value-added creation is concentrated—actual production or development. The different organisational outcomes are presented in Table 16

Table 16: Different Production Models in Informationalism

	Labour-intensive	R&D-intensive
Mass market	Mass production	Global network of division of labour
Present of niches	Flexible specialisation	High-tech network

It is evident that these are ideal types; thus, in the empirical world, the boundaries between categories are more blurred, and it is possible to have markets where these different organisation forms coexist both in competition or participating in the same value chains. Nevertheless, understanding their different features and how they shape production spatial articulation is an important exercise for understanding current changes.

Mass Production/Differenced Production of Quality.

These are productions that maintain substantial similarity with the Fordist model of industrial organisation. They are the kind of production that has faced a massive delocalisation toward developing countries, attracted by low labour costs. The value-added creation is still strongly related to the economy of scale and a high output volume. However, this model has also embraced organisational reforms, in particular when still localised in Western countries, as in the example of line production as introduced by Toyota. Remarkably, one of the most important parts of this adjustment was the focus on the quality and value-added generated (Ohno, 1988).

Flexible Specialisation

Flexible specialisation is based on a network of small and medium manufacturing enterprises specialised in different production phases. These networks are typically created inside territorial firm clusters. To digress briefly, we should point out that the notions of small-medium enterprise networks and local clusters are often used as almost synonymous. This is not only inaccurate but also makes important empirical and theoretical issues unclear. Indeed, a territorial cluster is a territorially defined

community of firms engaged in similar or related activities. Productive networks represent a group of enterprises bounded by productive links, which may or may not be confined locally. These two concepts are strictly related since the co-location of firms in a historically geographically and socially defined space makes it easier to create, adjust, and reshape productive networks. In other words, many productive networks that change their composition over time cross territorial enterprise clusters.

The competitive capability of the flexible specialisation model of production derives precisely from the flexibility and adaptability of these networks, in which different small and medium enterprises specialised in different processes collaborate. Value creation is based on the capability of the small dimension units of production to exploit the economy of scope in the phase in which they are specialised and develop complex external relations to integrate it in broader value chains. Thus, the contextual features arose as an important source of external economic and social externalities, which govern and enrich firms' external relations.

Given the importance of context characteristics, these production models characterise particular territories; the major examples are the Third Italy industrial districts. The local economies able to develop flexible specialisation presented common features, such as a dynamic entrepreneurial landscape and diffuse know-how composed of both technical and tacit knowledge. These characteristics were not exclusive of Third Italy craft local economies but also characterised the network of small industrial cities that surrounded Fordist metropolitan areas. The Italian cities of Bergamo and Brescia near Milan are two good examples of these second dynamics. To conclude, flexible specialisation presents a reverse territorial declination with respect to Fordism; the peripheral territories become the sites of a new path of development in the new phase, an outcome largely unexpected.

High-Tech Network

This production model presents many similarities with flexible specialisations, such as the network structure and the clusterisation of small-medium enterprises in specific local contexts. However, it also presents relevant, distinctive characteristics. First, as shown in Table 16, the generation of the value is more related to the ability to develop new products and maintain them on the technological edge rather than by the production process per se. This has important implications from the point of view of the kind of

relationship between network members. In the case of high-tech networks, the most important firms' external relations are created around projects following a logic of knowledge integration and complementarities (Ramella & Trigilia, 2010).

For the same reasons, productive relations tend to follow a medium-short temporal horizon. The enterprises interact to face projects beyond their actual capacity and internal resources, avoiding the need to invest in long-term fixed assets. In contrast, the flexible specialisation model tends to develop more stable relations and invest more heavily in co-specific assets to integrate productions in local value chains (Crouch, Le Galès, Trigilia, & Voelzkow, 2004; Powell & Grodal, 2005). These imply that the network structure, in the case of a high-tech network, is more unstable; however, the movement of people and firms between different projects enhances knowledge transfer, novelty creations, and the general absorptive capacity of the systems.[26] This is the principal reason behind an apparent contradictory fact of the local embeddedness of the high-tech industry. Indeed, sectors such as ICT that appear in principle productions easily pursued in technologically connected dispersed networks are, on the contrary, characterised by a particularly high level of territorial clusterisation (Ramella, 2016).

However, these clusterisation phenomena are based not only on local knowledge buzz. As in the case of industrial districts, they rely on particular shared local social conditions that facilitate the creation of business opportunities and ideas exchange. Despite the similarity between the two models, it is important to underline that the relative importance of different social local factors tends to differ. While in industrial districts, more relevant formal institutions tend to be interest organisations, in the case of high-tech clusters, a prominent role is played by universities, technological parks, or research centres. These organisations are essential sources of qualified labour forces. However, they do not play only the passive role of local collective goods for competitiveness. Take, for example, the classic case of Silicon Valley, the paradigmatic case of local high-tech clusterisation, in which universities and other government organisations have played an important active role in fostering local entrepreneurship.

Indeed, as already discussed, public-private interactions are an important component of the innovation process. What is important to stress is that the co-location of firms and public organisations implies an easier territorial arrangement of formal relations and

[26] On this point one of most illuminating works is an analysis of the video games sector by Vaan, Stark, and Vedres.

gives space to informal contacts and interactions that enrich local knowledge flows. Thus, these territories can rely on a territorial community where social processes, such as reputation mechanisms and generalised trust, underpin market and productive relations. The typical contexts surrounding high-tech clusters are metropolitan areas of medium-big dimension, which arise not around manufacturing activity but thanks to the presence of public institutions and service sectors (Burroni & Trigilia, 2011; Storper, 1995)

Global Network of Division of Labour

This organisation of productions is probably the most distinctive of the Informationalism age and is the typical organisation of the consumer electronics industry. These networks are centred around a limited number of big multinational innovative companies that decentralise part of their production, trying to exploit local competitive advantages scattered at the global level. This kind of decentralisation can be obtained by either locating different production phases in different contexts or selecting suppliers in a global environment (Coriat, 2005).

The network structure has a dual hierarchical nature. First, the core enterprises tend to exercise strong control over peripheral suppliers; this control can be exercised thanks to the differential in the market powers or by acquisitions/capital participations. Second, even the relation between the different units of the same central corporation presents a strongly hierarchical organisation, with the headquarters engaged in marketing, organisation, and, more important, R&D activities (Storper & Scott, 1989). The productive activities are usually delocalised in a context that favours explicitly production, for example, for the presence of natural resources, cheap labour costs, or less strict environmental laws. This organisation reflects how the value is generated. Indeed, central operations related to the development and commercialisation of new products are the primary value-added sources. Production sites must ensure a fixed standard of qualitative and keep the average cost low.

Despite the rigid vertical structure, it is important to underline two aspects. First, the central corporation often interacts in ways that are less horizontal and cooperative, as in the case of big partisanship, or even public-private projects. Second, the productive parts of the network are organised to ensure flexibility. Indeed, if the value-added is primarily generated through the development of new products, the production must

have the capability to adapt rapidly (Powell & Grodal, 2005). This flexibility is achieved through network reshaping and due to the internal flexibility of single production units. This system, called Coriat's dynamic flexibility, is based on a productive arrangement that makes it possible to modify the process according to changes introduced into the products and at the same time maintain low costs and delays connected to this adjustment (Coriat, 1995). The global networks of production headquarters tend to be localised in wide urban areas, which are characterised by high concertation KIBSs. This area is usually an old Fordist town that has seen the service sectors previously connected to manufacturing take an autonomous path of development, as in the case of Milan or Vienna. One other possibility is the emergence of these enterprises from high-tech clusters, as in the case of Silicon Valley.

Between these different kinds of production organisations, flexible specialisation is more discussed in terms of performance. Despite flexible specialisation being seen at the end of the 1970s, as the model emerging from the displacement of Fordism, the situation drastically changed during the 1990s. The rise of delocalisation phenomena, the growing importance of high-tech sectors, and the advent of global production networks have cast a shadow on manufacturing SME network economic dynamism. The Fourth Industrial Revolution is an important testing ground for the capability of flexible specialisation local systems, such as industrial districts, to become once again an unexpected source of economic development.

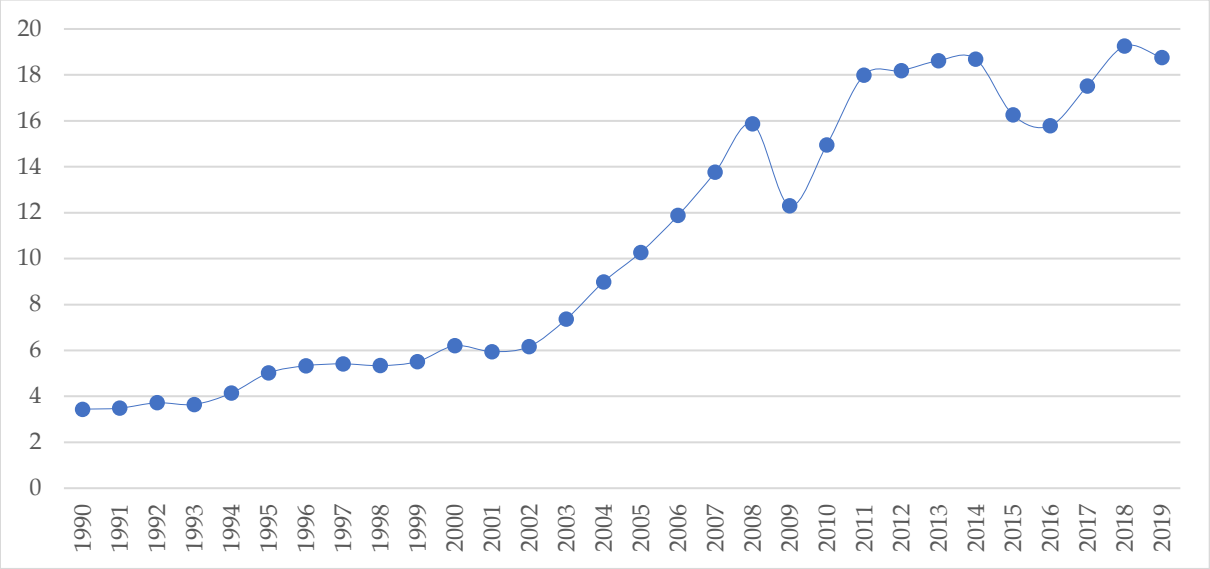
4.3.3 The Fourth Industrial Revolution: Digitalisation, Innovation, and Places

As previously discussed, the Fourth Industrial Revolution is based on 4.0 technological paradigms. Although it is still too early to identify the characteristics of this last revolution from a social and institutional point of view, it is worthwhile to summarise its general tenets and reflect on the implications for the different models of production previously discussed.

The Fourth Industrial Revolution took its first steps during the Great Crisis recovery. The post-crisis period was characterised by stagnation of global goods exchanges (figure 12). The fall of 2009 was preceded by the sharp growth of international trade, which started in early 2000. However, the post-crisis global economy seemed unable to recover

the old path of development. The 2008 crisis appears to be the implosion of a development model that believed in growth without production, considering manufacturing as outdated and the deindustrialised Western economy as a physiological if not desirable trend (Bianchi & Labory, 2018). In this context, Industry 4.0 does not represent only a technological change but also a cultural one, a culture of development that after 30 years once again looked at manufacturing as a possible economic growth driver.

Figure 12 *Value of International Goods Exchanges 1990-2019 (Trillion US$ Current Price 2019).*



Data Source: World Bank Open Data

The fact that at least some Western countries once again see manufacturing as an important economic driver does not mean a return to the past. This new development path is connected to manufacturing but points to an even greater emphasis on innovation and a new, less problematic relation between economies of scope and economies of scale. In other words, the Fourth Industrial Revolution is a process that moves from replicative manufacturing toward innovative manufacturing, which embodies features of the service sector (Rullani, 2015). The trace of this trend can be detected in the growing importance of high-tech exports over total international exchanges. Despite the slow expansion of total international global exports, the high-tech sector[27] follows a different trend, showing remarkable growth; consequently, its

[27] The OECD has developed a four-way classification of exports: high, medium-high, medium-low, and low-technology. The classification is based on the importance of expenditures on research and development relative

increase is of relative importance to the global markets (Figure 13). More precisely, given a total increase in manufacturing exports of 3.2% over the 2013-2018 period and high-tech goods exchange growth of 26.3%.

Figure 13High-Tech Export Total and Relative Growth, 2013-2018. Data Source: OECD Open Data

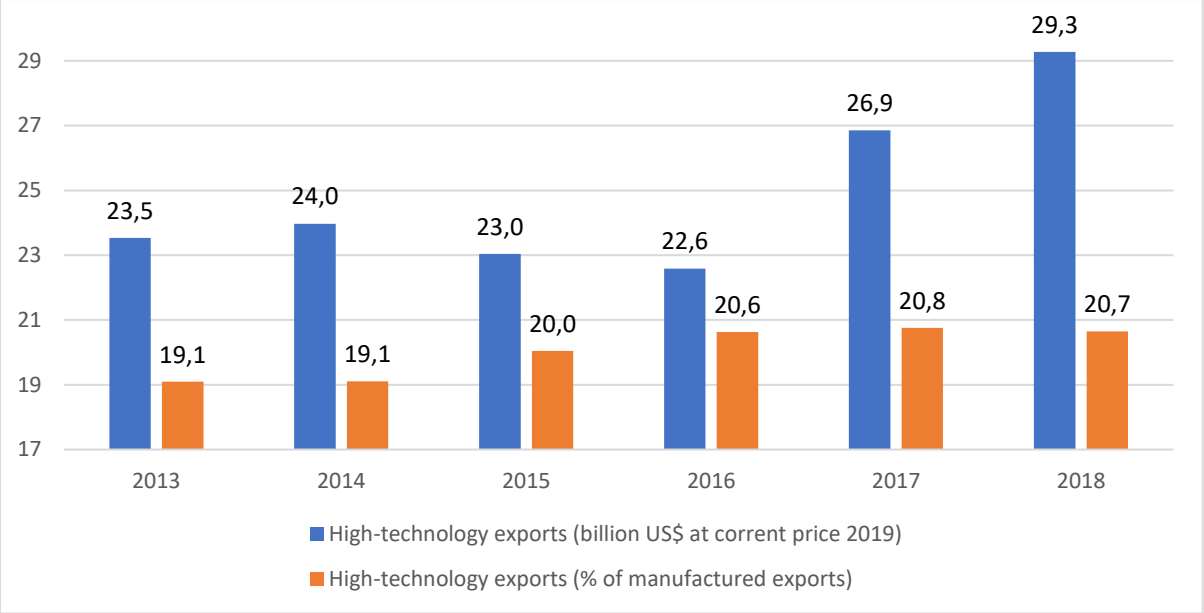
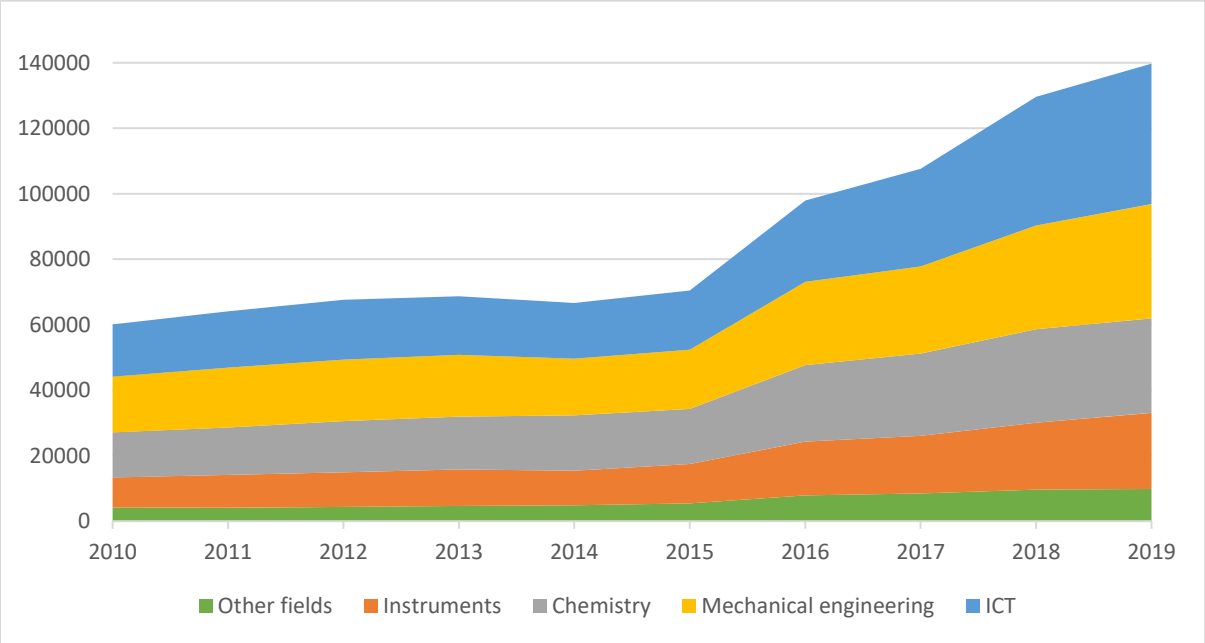


Figure 13 European patents granted 2010-2019 by field of technology. Data sources: OECD



to the gross output and value added of different types of industries that produce goods for export. Examples of high-technology industries are aircraft, computers, and pharmaceuticals; medium-high-technology includes motor vehicles, electrical equipment, and most chemicals; medium-low-technology includes rubber, plastics, basic metals, and ship construction; low-technology industries include food processing, textiles, clothing, and footwear. Industries of high and medium-high-technology intensity account for over two-thirds of total OECD manufacturing exports.

One other important insight comes from the growing efforts of companies in developing patents. Not only did the overall number of patents granted increase significantly in the post-Great Crisis; the fields more closely related to Industry 4.0, ICT, and mechanical engineering have grown proportionally (Figure 14).

The importance of innovative activities is only one aspect of the Fourth Industrial Revolution's main features; the second one is a new way to organise productions. Indeed, manufacturing digitalisation promises to strongly mitigate the tension between the economy of scope and scale. The 4.0 technological paradigms previously discussed move precisely in this direction, enabling the possibility to reorganise and more efficiently integrate different production phases, both within and between single production units' boundaries. The first aspect, related to innovation, and the second, which involves the possibility to both rapidly adjust production and develop new products, are strictly related and are the base of the Fourth Revolution's distinctive value generation engine. These new forms of value generation can be applied to all firms, but it takes different declinations. For large enterprises, it implies the possibility of mass production customization (Bianchi & Labory, 2018). For micro-firms, the 4.0 paradigm allows smart "micro-manufacturing" model of production, allowing producers to co-develop personalized and innovative products with customers (Bellandi, De Propris, & Santini, 2020). As we will see later for small and medium-sized firms, industry 4.0 opens to the possibility of reaching a level of production efficacy usually connected to larger organizations and enlarging the range of in-hose production activities. However, the fourth industrial revolution is connected to broader changes rather than the simple internal firms' production reorganization. It is probably still too early to fully understand how the present changes will reshape the relationships between production, society, and place. However, it is possible to reflect on how the previous revolution models of production are challenged and can benefit from the Industry 4.0 technological paradigm.

Mass Production and Global Network

Industry 4.0 technological introduction will have a remarkable effect on these organisational models, involving both single units of production and networks. In general, the new paradigms promise to achieve a large volume of customised production. This can be achieved thanks to advanced automation and machine-to-

machine interconnection. Indeed, the combination of this technology greatly reduces both the cost of unitary production and the one connected to production adjustments, thus enhancing the dynamic flexibility already at the basis of the value creation of these industrial models.

In terms of applications that involve the relations between different network members, Industry 4.0 provides instruments not only to integrate better and coordinate the different production plates but also to empower the control of operational centres over their production network. Indeed, machine-to-machine communication between different units and big data generation/analysis makes it possible to exercise granular control of productive processes remotely. The possibility of reducing costs related to manual operation thanks to automation[28] and the capability to control easier diffuse systems of production better will have profound effects on the relationship between space and production.

It is possible to detect the trace of a new emerging pattern of localisation, taking into consideration two strategies now available to the global production network. The first one is related to a new logic of delocalisation. While since the 1980s these terms have been associated with moving plants in a context characterised by cheap labour markets, now, given the relative invariance of automation costs between places, the focus is shifting from saving labour costs to reducing logistical ones. In other words, what is the utility of instantly exchanging data and adjusting production if goods need weeks to reach their destinations? Thus, at the foundation of this strategy, there is the advantage of localising productions directly near their final markets (Bianchi, 2018). Obviously, this process, which from a theoretical point of view is a new form of delocalisation in the empirical world, can result in its opposite: reshoring. Indeed, the final markets are often regions in which the operational centres of the global network of production are located.

The second strategy is theoretically connected with reshoring activity. To understand this second phenomenon, it is important to consider how Industry 4.0 affects human capital. Indeed, the new technological paradigms expand tasks that can be accomplished

[28] For an example from the automotive industry, in the USA the hourly wage is roughly $30 USD, while in China for the same level of qualification it is only $3. However, one hour of the same process executed by a robot costs only $0.30 USD (Bianchi, 2018).

by machines[29], but in doing so, the relative importance of human capital also changes. Certainly, nowadays, machines can accomplish increasingly more complex operative and analytics tasks; however, they still have to operate inside the boundaries of codified knowledge and predetermined logic. Thus, on the one hand, Industry 4.0 requires qualified workers able to interact in the new technological environment and thus able to acquire necessary codified knowledge. On the other hand, the new industry's most relevant human contributions are connected to specific know-how and tacit implicit knowledge that can generate novelty, innovation, and creative solutions to complex problem-solving activities (Pegoraro, De Propris, & Agnieska, 2020). Moreover, there is no way for machines to replicate the social intelligence and social capital that are essential factors in fostering innovative thinking and activities.

The local contexts in which this complex interplay can be found between contextual and tacit knowledge, technical skills and social dynamics are often specific metropolitan regions of advanced countries. For these reasons, international networks that reshore their activities within the boundaries of Western countries, as in the previous case, by the same logic can be at the basis of an inverse process of delocalisation. A delocalisation that is no longer directed towards low labour cost areas but heading for contexts characterised by high human capital difficult to find and reproduce elsewhere.

These new localisation strategies can potentially change the territorial articulation of productive activities. Moreover, They are consistent with both the reduction of global goods trades and the rising interest in studying the relation between local clusters and multinational enterprises.

Flexible Specialisation and High-Tech Networks

The scientific inquiries into the Fourth Industrial Revolution and local networks of small-medium enterprises are far less popular than the reflection on the models previously discussed for two reasons. First, Industry 4.0 primarily involves manufacturing activity that is labour-intensive enough to justify substantial investments in industrial fixed assets, an activity not often engaged in by high-tech networks. Second, small and medium enterprises generally do not have enough internal material and

[29] Remarkably, the automations not only involve more and more complex manual activity but also organisational and administrative tasks. This is the idea of a Smart factory based on digital manufacturing and learning machines.

immaterial resources to properly exploit 4.0 technologies. While this is mostly true, local clusters' role in the Fourth Industrial Revolution is underestimated. As we will see in the final part of this chapter, much depends on how the different local contexts will face current economic and technological change. Having said that, it is still possible to sketch the possible general effects on these particular forms of production organisation. First, both high-tech networks and manufacturing ones can benefit from more advanced automation. Indeed, suppose small manufacturing firms' case is less complex to reconcile with the economy of scope and scale due to smaller production volumes. In that case, these enterprises can still benefit from saving costs due to more routinised activity. Moreover, the advancement in technologies makes production implant more flexible, a big advantage for the production model known as flexible specialisation. In the same way, high-tech product clusters can benefit from introducing machine tools capable of more diversified and complex tasks; thus, the innovation activity is less bound to actual production plants. From the perspective of external relations, machine-to-machine communication has incredible potential for small firms' local networks. The possibility to exchange data in real-time enables a rapid response to the whole network to what happens in a specific node. For example, the real-time tracking of orders in a network makes room for a great increase in the productivity of dispersing productions.
Industry 4.0 technological paradigms also allow new forms of service provision, more precisely ICT cloud services, which can be offered both on-demand or open source. This is one of the most relevant aspects of the new digital economy and one of the fields where Big Techs are investing more. A good example can be Amazon Web services. The possibility of offering cyber/virtual tools on a territorial basis may appear as a distant and improbable future, but my opinion is different. First, these phenomena can be seen as a particular declination of the smart city, a concept that is increasing in popularity. Second, there are already empirical examples, such as the case of DITEDI, a consortium that provides this kind of service in Tavagnacco, a small town in northeastern Italy. Providing these services through local platforms implies different relevant aspects for local production networks. First, they can be provided as local collective gods for competitiveness and consequently accessible through an alternative way to respect market relations. Second, these services are developed concerning territorial specific needs. Finally, it makes it possible to integrate the provider organization into local clusters' social dynamics, embedding them locally and consequently generating relevant territorial economic externalities of the social matrix.

To conclude, it is certainly true that small and medium firms, on average, can rely on limited internal resources to face the challenges connected to the Fourth Industrial Revolution. Therefore, it will once again be the territorial socio-economic systems reaction as a whole that will make the difference between new development and a decline. This might be even truer than before, as Patrizio Bianchi wrote:

L'industria 4.0 non va vista allora del solo punto di vista tecnologico, ma anche dal punto di vista di saper coordinare scienza, tecnologia, competenze e contesto sociale, al fine di disporre della migliore capacità di far convergere tecnologie diverse ma complementari. (2018, p.58)

Translation: Industry 4.0 should not be seen only from the technological point of view, but also from the point of view of knowing how to coordinate science, technology, skills and the social context, in order to have the best ability to bring together different but complementary technologies.

Considering local clusters of small-medium enterprises, both manufacturing and high-tech, a successful adaptation to the new contest will probably pass through a profound reorganisation of the local interaction, blurring the differences between these two local economies. Manufacturing local clusters must develop relationships with new actors, mainly ICT and other KIBS firms and public technological transfer agencies. They will also need to strengthen and overhaul relations with old territorial actors, as in the case of universities and vocational training centres. This enlargement and reshaping of network relations involve not only a broader landscape of relevant partners but also a new form of interaction more related to short medium-time cooperative projects than long-term productive ties. On the other hand, a high-tech cluster to exploit the market opportunities offered by Industry 4.0 must develop services more specialized respects local productions through more solid and long-standing relations within territorial manufacturing systems.

4..3.4 Market, hierarchy and cooperation in industry 4.0. Wich role for territorial clusters

The Industry 4.0 technological paradigm undoubtedly provides great advantages in coordinating production networks. The reduction of transaction costs and the rapidity to adjust production allow, on the one hand, the integration of economic activities through tighter hierarchical control by central networks' nodes and, on the other hand, the continuous creation, dissolution and recreation of decentralised, self-organising networks based on market relations. These Industry 4.0 characteristics cast doubt on productive networks that see horizontal cooperation as their main competitive advantage, as in the case of local clusters. Moreover, enabling the coordination and integration of geographically dispersed and distributed activities seems to diminish the role of spatial proximity as a source of valuable economic externalities (Götz & Jankowska, 2017). Despite this, it is too early to declare that local clusters are an obsolete concept and that the path of development is doomed to fail. Local clusters offer more than the simple reduction of transaction costs through knowledge development, dissemination and accumulation based on social networks and spillovers. Local economies may be characterised by a population of firms that share the same values and a similar understanding of technical problems and that collaborate in an atmosphere of trust (Götz, 2020). These social elements stemming from territorial embeddedness can help in both the diffusion and exploitation of Industry 4.0, reducing the uncertainty and complexity of the productive relations mediated by new technologies. Despite these elements, the Fourth Industrial Revolution undoubtedly represents a critical challenge for local economies, particularly in the case of manufacturing SMEs clusters. Consequently, it is inevitable that while certain local economies will integrate successfully into the new global configuration, others will experience a decline. There are two factors at the base of these different outcomes: the endowment and capability to activate local resources and, second, the effectiveness of new institutions and policies elaborated at different territorial levels (Bellandi, De Propris, & Santini, 2020).

4.4 TERRITORIES' REACTIONS TO GLOBAL CHANGE: WHY TECHNOLOGICAL DETERMINISM IS WRONG

As we have seen, technological changes set both positive and negative incentives, which tend to favour different contexts in different ways. However, the changes in the geography of local systems' production arose from the contextual capability to participate and reshape the technological trajectory. As discussed at the beginning of this chapter, although productive technical/organisational paradigms present considerable invariance at the national, regional, and local levels, they present considerable differences connected to specific political, institutional, and social factors. To better explain the mechanism, I will start by pointing out what it means to benefit from technological changes. In a very simplified way, it implies a successful evolutionary path of technological learning, which means absorbing, adjusting, and producing innovations. Thus, this process is composed of three phases, usually consecutive: a) the acquisition of at least part of the established paradigm's technological cluster, b) the adaptation to the local context production and problem-solving activities, and c) the development of innovation capabilities with a certain degree of integration concerning the paradigm's technological trajectories (Dosi, 1982). It is therefore clear that technological determinism is a dangerous theoretical simplification, not only because it exclusively takes into consideration the first part of the process of technological acquisition, but more importantly because it underestimates the power of local adjustments and innovation capability in participating, reshaping, and focusing on the technological trajectory of a given paradigm.

The agents at the centre of this process of technological absorption, adjustment, and innovation are firms. They are the first repositories of the knowledge, know-how, and organisation potential to generate local economic and innovative dynamism. However, there are two other important factors to take into consideration. First, firms are nested in a network that links them to other firms and other organisations (universities, representative organisations, government agencies, and so on). It is precisely the presence and quality of these networks that enhance or limit the opportunities of firms to improve problem-solving and innovative capabilities, thus determining to what extent territories as systems profit or not from the new technological paradigms (Cimoli & Dosi, 1995). Second, national, regional, and territorial systems also entail a broader notion of embeddedness of economic behaviours into a set of social relationships, rules,

and political constraints. These regulatory frameworks provided by different governance levels are also responsible for the territorial dotation of collective goods for competitiveness. It is precisely the provision of different incentives and local specific resources by local governances, whether formal or informal, which is one important element for local development that is too often neglected.

In these brief conclusions, only a limited portion of the complex phenomena that bring territories to differentiate themselves in response to economic and technological changes have been returned. However, the initial chapters of these works provide a comprehensive theoretical framework to address the complexity of these phenomena. For this reason, my conclusion, instead of repeating concepts already discussed in detail, will present two interesting cases of unexpected territorial technological adaptation and participation.

The first example is Grenoble, a historically industrial area characterised by a large electrical equipment industry. This territory experienced important central state intervention in the early 1970s to counteract the ongoing crisis, most notably the creation of a scientific park, the ZIRST technopole designated towards computing and electronics. However, this intervention did not obtain the expected results[30], and large enterprises continued to decline. In contrast, the dissolution of greater enterprises, innovation park spin-offs, and the local peripheral systems of small and medium manufacturing led to strong differenced territorial networks. This new productive landscape began a true high-tech cluster in the late 1980s, which maintained a manufacturing vocation and exploited the old local collective goods for competitiveness (university, research facility, vocational training programme) originally dedicated to large companies.

The second and more recent example is the Italian jewellery district of Arezzo. This is a typical specialised locale composed of a rooted community of specialised small enterprises, which were generated thanks to the industrial reorganisation of old artisan activities. Despite its traditional character and specialisation in a medium technology-intensive industry, the districts have shown a remarkable capability to absorb and exploit additive manufacturing, one of the technological pillars of the 4.0 industry. Two elements are on the basis of this unexpected technological propensity. First, jewellery

[30] Also for perverse effects of s part of the so called “plan calcul” aiming to restructure computing activities in France (Lebrument & Soyez, 2020)

firms were already familiar with precision machine tools with a high degree of similarity to 3D printers. Second, the technological diffusion in the main sector enterprises has been coupled with the flourishing of firms at the local level that offers services and goods connected to this technology (Zollo, 2016). These two processes have enhanced a versatile integration of the new technology at the local level, making a reorganisation of the local process toward customer-centric innovation production (Martinelli, 2019).

From these examples, it is possible to draw an important lesson: local reality can react to both state innovation policies and technological change in unexpected ways by activating local endogenous resources to integrate external stimulus in a new path of local development that is hard to predict. It is exactly this awareness that is the foundation of the following chapter.

5 INDUSTRIAL DISTRICT AND THE 4.0 POLICY ADOPTION

INTRODUCTION[31]

In the previous chapter, we saw the importance of institutions and policies in fostering and focusing on both innovation performance and the technological absorptive capacity of economies. However, the chapter also examined how territories respond in different ways to this exogenous input, based on their endogenous resources. Precisely this consideration has led to the formulation of the two questions that form the basis of the following empirical investigation.

What is the territorial and sectorial articulation of 4.0 Italian policy?

Are industrial district firms early adopters of 4.0 Italian policy?

Understanding how territories and industrial districts respond to the 4.0 incentives plan gives not only valuable information about the policy implementation but also provides an important indicator for the capability of different local economies to absorb the 4.0 technological paradigms. Indeed, since the policy is a 'liberal' plan, the theoretical expectation is that the distribution of resources reproduces the distribution of Italian production activities. Therefore, being part of a district should not be a condition for an enterprise to have easier access to this type of financing. If, instead, it were possible to observe that the resources have gathered in district contexts, then this would represent interesting food for thought. It casts light on the relation between this industrial policy and territories, but also it would make clear that some territorial contexts, which government no longer sees as preferential objectives for intervention, continue to generate competitive advantages over other contexts in technological absorptive capacity

[31] These Chapter is largely based on a alredy published work by Alberto Gherardini and Gianmaria Pessina (Gherardini & Pessina, 2020)

5. 1 4.0 POLICY IN ITALY

Although the Italian economy is characterised by a strong local agglomeration of its production units, industrial policy has encountered territories only at intervals. It's only been since the '90s that national governments have started to directly intervene to strengthen local production systems. This doesn't mean that districts couldn't previously benefit from public intervention, but this would come prevalently from local autonomies.

Starting from the '90s instead, national policy began to intervene with at least three *place-based* deeds that involved several territories in Italy, from North to South: the 'patti territoriali' (Local Pacts) the 'progetti integrati teerritoriali' (local integrated projects) (2003-2010) and the technological districts/clusters (2003/2016). These interventions are very different from one another, but nonetheless embraced a single idea: supporting the local coalitions for development in order to consolidate, or at times create, socio-economic systems that were complex, competitive and socially compact. These interventions were created thanks to the consensus that local competitive advantage could benefit from, this being a consensus developed first of all thanks to a varied academic discussion around industrial districts and, furthermore, thanks to studies on *high-tech* clusters. In particular, the latter had clearly shown how some of the contextual factors that characterised industrial districts – trust, know-how, social capital, local *governance* – were also advantaging factors for *high-tech* enterprises. But the season of policies aimed at supporting productive contexts –so called *place-based* policies- progressively lost national relevance to the benefit of a return to a preponderance of interventions aimed at individual companies, i.e. so called *firm-based* interventions. There are several reasons for this shift. First of all, it can be attributed to the structural crisis of many local production systems in the face of the challenges set by globalisation, such as the new location and price competition from countries of the near and far east. These changes have shifted the focus of policy makers from 'place awareness' (Becattini G. , 2015) to the agency of enterprises, i.e. their ability to hook onto global value chains and to increase the quality of their productions with the aim of creating more profitable markets for themselves, also protected from price competition. Another

reason is that *place-based* policies have shown to types of critical issues. First of all these policies only produce results in the mid or long term, and are therefore unfit for increasingly shorter electoral cycles. Secondly, their effectiveness can be altered by *network failure* mechanisms (Schrank & Whitford, 2011). This means that the coalitions of players involved in implementing these interventions can encounter difficulties in cooperation and, finally, defer and weaken the outcome of such policies.

Also for these reasons, Italian industrial policy has returned to taking on the prevalent form of *place-neutral*[32] interventions. In some cases, these firm-based interventions have continued to benefit relational mechanisms, as in the case of 'network contracts' downsizing however, the relevance of the spatial and institutional dimension of these relations. In other cases, the focus has been on tax incentives and on credit support, as adequate measures for conditioning business choices. Although in recent years place-based interventions have entered the implementation logic of 2014-2020 European cohesion politics (this being the case of 'intelligent specialisation strategy), instances of industrial policies concerned with local specificities are now becoming more and more rare.

It's within this setting that must be read the introduction in Italy of the 4.0 Business Plan. The plan groups a set of interventions that should accompany Italian firms, independently from their sector, towards the fourth industrial revolution, promoting a type of technology innovation able to face the challenges of digitalisation, of interconnection and robotization of the production system. The 4.0 Plan is nonetheless a very heterogeneous industrial politicy, that encompasses several interventions- certainly aimed at strengthening the production system by promoting investments and research and development activities – but still not strictly focused on the challenges of the forth industrial revolution.

Differently from what the 'new industrial policies' (Mazzucato, 2013; Rodrik, 2016; Sabel & Zeitlin, 2012) might suggest, the Italian plan favours a 'liberal' approach, based on 'horizontal' measures aimed at supporting investments in capital goods, incentivising research and development activities and more in general promoting

[32] For a definition of place-based politics please see, amongst others, Barca et al. (2012)

entrepreneurship (Warwick, 2013). The State therefore supports only indirectly, by means of tax policies, the *upgrading* of the production system, not including interventions such as *public procurement*.

The most representative measure of the 4.0 Plan is the hyper-amortisation. With this policy the Italian government has provided companies, those which invest in certain types of equipment associated with 4.0 technologies, to benefit of a 150% increase of the amortisation rate and consequently, of reducing the tax base, on which to calculate IRPEF and IRES[33] (Income Tax and Corporate Income Tax). This is a measure directed to a large set of companies, even individual enterprises, with no formal exception based on sector. This tax relief is accessed automatically through self-certification, by filling out the financial statement and the tax payment prospectus. Only for investments above 500 thousand euros, the request for hyper-amortisation is subject to a sworn technical appraisal that can testify its actual compliance to the requirements of the technical legislation that completes the policy and that must to be exhibited during ordinary tax inspections of the Italian Revenue Agency.

Another similar measure is the super-amortisation. Preceding the hyper-amortisation, the super-amortisation is characterised by a rate of overvaluation of the lower amortisation (30%) and by the fact that it is not limited to investments in 4.0 technologies, a part from the case in which the firm invests in intangible capital assets (as in *software* or IT *integration systems*) for companies that have requested the hyper-amortisation.

The remaining measures grouped under the Plan's umbrella can be divided in complementary initiatives, coherent and aggregated. Among the first we can certainly include '4.0 training' that introduces, with 2017's Budget Law, a 40% tax credit for expenses relative to staff training in 4.0 technologies. There is then the 'Nuova Sabatini' (New Sabatini Law) for aspects relating to 4.0 technologies. This is a very simple financing system for companies in the form of a non-refundable aid

[33] Basically, if firm was to invest 10,000 euros in machinary, its tuerover 80,000 euro and the amortisation rate 10%, without such policy its tax base to fiscal purposes would be 79,000 (80,000 less than 10% of 10,000) whereas thanks to the hyper-amortisation it would amount to 77,5000 euros (80,000 less 10% of 250% of 100,000)

distributed on several operations for those who subscribe to a bank loan for the purchase of capital goods. This is a measure that precedes the 4.0 Industrial Plan, but connects to it in that, from March 2017, the firms that would ask financing for 4.0 technology could benefit of an increased contribution to the loan, that in this way went from 2.75 to 3.575% of the interest calculated. Finally, the voucher for innovation consultancy, a measure that was not initially part of the Plan but was included in the Budget law in 2019, approved by the first Conte Cabinet. The voucher is a contribution intended to encourage firms to ask for consultancy coming from *management innovation* experts with the aim of being in this way accompanied towards a digital and technological transformation, as well as towards the modernisation of management and organisational structures.

Among coherent interventions are included the tax credit for research and development activities, which evidently concerns activities upstream from the application of 4.0 technologies. Finally, development contracts are included, these being industrial policies of a contractual type for the financing of private development plans that, among the criteria for selecting initiatives, also have the employment of 4.0 technologies.

Measures that are 'aggregated' to the Plan have instead little to do with the advancement of the fourth industrial revolution. These refer to patenting support (c.d. patent-box), to innovative start-ups, and more generally, to access to credit (as the protection fund for bank credit).

For what concerns resources with which governments have supported the plan, the Ministry of Economic Development has presented a summary of the cost estimate that shows how the relevance of the plan is not just formal. Overall, the policies included in the plan are expected to generate benefits in investments that amount to almost 20 billion euros between 2017 and 2020, between fiscal reallocation of funds (amounting to almost 20 billion euros) and resources that are actually employed (359 million euros). Evidently, the final contribution will depend on the degree to which enterprises will use these tools. The first available estimates show that enterprises have taken part in the Plan in relevant numbers, hyper and super-

amortisation have apparently been applied, in 2017 alone, to more than 10 billion investments for capital goods.

Alongside these *firm-based* investments there are *place-based* measures which, nonetheless, have received less than 1% of all the financing provided by the entire packet. This is the case for the creation of *Centres of Competence*, of the allocations for *ITS*, advanced centres for professional training, and of *Digital Innovation Hubs*, which are local antennas that are founded to involve the PMIs in the fourth industrial revolution[34].

So the 4.0 Plan is only marginally addressed to the strengthening of innovation ecosystems, whether they are districts or not. Furthermore, the characteristic of the Italian approach, compared to the more famous German Plan (Hermann et al., 2016) is that of investing almost exclusively on enabling technologies, without however focusing the intervention on the integration of production chain. Industrial policy appears therefore to have little concern not just for the institutional thickening of socio-economical context of small and medium businesses, but also towards production chains which in those areas had assembled before extending into global value chains. In other words, this industrial policy has failed to take on the job of reinforcing both the territories that are most competitive and the most strategic production chains. In the words of the creator of the reform, Carlo Calenda who was minister of economic development during Renzi's (2016) and Gentiloni's (2016-2018) cabinet, have given to the policy a "liberal industrial plan" shape. This in so far as it doesn't require a-priori choices of sectors or business projects on behalf of a government that considers itself capable of selecting the most appropriate subjects, but leaves the selection to market mechanisms. The scarce focus and the extreme broadness of receivers of the 4.0 Plan are not however the sole consequences of this liberal approach to policy-making - nor of the will to help the electoral-political

[34] Competence centres are public/private organisations created in order to connect research centres and enterprises around technologies that are central to the 4.0 paradigm (cyber security, additive manufacturing, robotics, big data, etc.) Also due to the delays in the implementation of the tender, the eight centres that were financed by the 4.0 were unable to assemble until May 2018. The centres have formally started their activities in the course of 2019, however, only 5 of them have so far launched activities to support businesses. Digital Innovation Hubs have been included in the 4.0 Plan with no specific financing. Their implementation has been left to entrepreneurial associations, which have created their own capillary networks of contact centres on the subject of 4.0, through which they offer information and consulting services.

cycle by distributing resources the greatest possible number of beneficiaries – but instead also a choice that is moved by particular conditions in the economic setup that the country was facing at the time when the Plan was launched. Since 2015, the propensity of Italian enterprises to invest, which grew in the early 2000s and then strongly decreased following the financial and economic crisis, after peaking in 2011 began decreasing again, finally plummeting as low as the levels of the mid '90s (Giordano, Marinucci, & Andrea, 2018). The 4.0 Plan can therefore be legitimately understood as a *shock therapy* administered with the aim of increasing investments. These characteristics make this policy extreme useful for evaluating the capability of districts to absorb 4.0 technologies. First, the focal point is to facilitate a specific kind of technological investment connected to the 4.0 technological cluster. Second the fact of being part of a district should not, therefore, represent for an enterprise a condition for easier access to this type of financing. However, if it is possible to observe that the resources have gathered in district-like contexts, then this would open interesting insight. First of all, on about the relation between industrial policies and territories, but also on the reasons for which some territorial contexts, which the government no longer sees as preferential objectives for its intervention, continue to generate competitive advantages over other contexts, which facilitate to face the Fourth industrial revolution.

5.2 METHODOLOGY AND DATA

5.2.1 Data surce

In order to answer the questions that are outlined above, companies that qualify as *early adopters* have been identified, i.e. companies that have taken part in this policy since its first year of implementation (2017).

To identify the firms that took part in the plan, we considered those that benefitted from the two most representative measures: hyper-amortisation and super-amortisation. In order to do so, an operation of '*scraping*' was carried out, that is an expectation of information through semantic research, over the total of financial

statements filed by manufacturing enterprises in the year 2017. Therefore, this perimeter is composed of all the active companies belonging to the ATECO C class who filed their financial statements in 2017 and present in the Ceverd database, and it amounts to a total population of 112,085 subjects. In this way, 2,538 mentions of super-amortisation and hyper-amortisation were identified, 72.5% referring to super-amortisation and the remaining 27,5% to hyperamortisation. It should be pointed out that not only a single financial statement may contain the search words more than once, but also that the 4.0 Plan provides the opportunity to use both incentives simultaneously. This entails that the number belonging to the interest population is smaller than the number of total mentions. The companies that were identified are, in fact, 2,221, 70.2% of which only benefitted from the super-amortisation (1,419 in total), and 15.6% only from the hyper-amortisation (315 in total) and that the remaining 14.2% benefitted from both measures. (287 in total). This first step made it possible to gain access to the list of identifiers (VAT positions) of the companies that benefitted from the 4.0 plan. After this, by using the AIDA database, information about the companies was acquired, with regards to: productivity, profitability, size, location, sector, and investments carried out in recent years. The dataset that was gathered in this way allows for an analysis of the characteristics of early adopters and a comparison between these and the general population. This data, however, is not sufficient to answer the second question at the base of this chapter, which is whether the firms located in industrial districts are characterised by greater responsiveness to the 4.0 Plan. For this reason, always thanks to the AIDA databank, the whole population within the initial research perimeter was extracted. This has allowed us to create a counterfactual sample through a *matching* procedure.

5.2.2 Method

In order to establish whether districts have a higher chance of participating in the 4.0 Plan, a counterfactual sample was created. This was possible by extracting, via a matching procedure, an observation for each enterprise that took part in the Plan

that could be as similar as possible to all the identified variables, aside from locationing. In this way, it was possible to compare the population of enterprises taking part in the Plan with a sample of enterprises showing independent variables that are distributed in a virtually identical way, except for their geographic location and consequently their being part of an industrial district. With a sample built in this way and through a binomial logical regression that has a dichotomic variable as its dependent (with value 1 if the firm made use of hyper or super-amortisation) we can understand whether operating within a district or not, with other factors being equal, equates to a greater propensity towards the policy that's being studied. Usually, *matching* procedures are used to understand the effects of partaking in a given policy program over a certain *outcome*. The purpose is to compare how the outcome changes between two groups of subjects that are identical except the first have received a certain treatment whereas the second has not (Caliendo & Sabine Kopeinig, 2008; Rubin, 1974).This non-parametric method is utilised in quasi-experimental designs, in order to check some or all confusing factors within the observed data. In other words, the purpose of this procedure is to reduce the observations so that the remaining data may have a better balance between the population under treatment and the one used as control. *Matching* allows in this way to obtain a sample in which the empirical distribution of the covariates (x) is similar as possible in the two cases (Iacus, King, & Porro, 2012).

The analysis that is presented here follows a similar reasoning, but with some significant differences. Indeed the comparison will not be applied to a given outcome. Instead, it will be applied to the choice of adhering or not to the policy. The purpose is to verify whether the varying distribution of locations variables is statistically significant while the other relevant characteristics are equal. Among the various available methods we have decided to use a *coarsened exact matching* (CEM). The idea on which this procedure is based is that of temporary subdividing each variable into significant[35] groups and, subsequently, applying an *exact matching* operation on the various layers that have thus been created (Blackwell, Iacus, &

[35] Thanks to an optimisation algorithm that preserves the maximum informativity of the data o through choices motivated by theory.

King, 2009). Basically, this procedure creates groups that are as homogeneous as possible within their set, containing at least one case that has taken part in the Plan, and then randomly extract from this group the instances that are considered identical to then use these in order to assemble a counterfactual sample.

5.2.3 Relevant variables

The variables that have been used for the CEM procedure, as well as their operationalising, are reported in the following (Table 9). Their selection is based on the possible connection between these and the propensity to participate in the 4.0 Plan. First of all, some productive sectors are involved more than others in this process of technological transformation. One needs just to consider the production of machine tools for which a change in the paradigm does not just translate in profound organisational and procedural changes, but also a transofrmation of the actual goods that are produced. Profitability instead measures the enterprise's health, and therefore it is chance of making investments in productive factors with mid to long term outcomes. Revenue and the number of employees instead regard the size and therefore represent indicators of the allocation of internal resources. Finally, investments in research and development and increments in immobilisation give the pulse of enterprise's attitude towards investment, towards innovation the first and more generically the second.

Table 16 Description of variables used for coarsened exact matching

VARIABLES	OPERATIONAL	MATCHING
Sector	NACE two digit	Exact (not stratification)
Revenue	Revenue	Algorithm stratification
Profitability	EBITDA	Algorithm stratification
Size	Number of employees	*cut-off* a >5 >10, multiples of 10 before 100 and 50 from 100

R&D effort	Average R&D expenditure 5 years	Algorithm stratification
Investments effort	Average increase of assets 5 years	Algorithm stratification

From the initial population counting 2,022 firms, those with missing values regarding the sector have been excluded, thereby reducing the number to 1,926 units. For 1,921 observations, it was then possible to obtain at least one case to be considered as perfectly compatible with regards to the relevant variables listed above, creating for each variable a homogenous group of at least two elements.

5.4 FINDINGS

5.4.1 Articulation of the 4.0 Plan

By looking at variables for sector and size, it is possible to obtain a photograph of the main characteristics of early adopter enterprises. For what concerns the sector, the data tells that 46.4% of the firms that have taken part belong to the Metalworking industry, whereas the second most represented sector is the textile and clothing industry with only 10.7% of the total (Table 11)

Table 17 Comparison of the sectoral distribution of the companies adhering to Plan 4.0 with respect to the population

SECTOR	4.0 FIRMS	AIDA POPULATION
food	9,9	10,2
textiles, clothing and leather	10,7	11,9
furniture and wood	6,1	7,3
print paper and recorded media	5,0	4,9
plastic and oil	7,8	4,8
pharmaceutical chemical	3,4	3,2

glass and stone	3,1	5,0
metalworking	46,4	41,2
automotive	2,6	2,6
other manufacturing industries	5,0	9,0
total	100	100
N.	1921	115019

By comparing the enterprises that have asked the incentives with the reference population, it is possible to identify only two sectors, which are over-represented, these being the metalworking sector and plastics processing. In other words, the companies that belong to these two production compartments have adhered to the 4.0 Plan to a disproportionally greater degree compared to the other enterprises considered. As already discussed, there are several factors that can explain the greater effect of the policy on the Metalworking industry. First of all, this is the sector that is most exposed to the technological shift of the 4.0 paradigm, both from a process and from a product perspective. Secondly, this represents one of the most developed sectors in Italy, not just in terms of numbers of employees and enterprises, but also for its capacity for innovation (Burroni & Trigilia, 2011; Ramella & Trigilia, 2010; Russo, 2015). So it's no surprise if this is the sector that more than others has been capable of benefitting from the opportunities that the Plan offered. Rather surprising is instead the participation of firms belonging to the plastics proceeding compartment, albeit in only a limited total number. The reason behind this may be found precisely in the similarity that these two productions share in their characteristics. Indeed, the generation of value in these two sectors does not lie on reasons of brand, as it does for light industry, typical of the so called 'made in Italy', but rather on the quality and adaptation of their production process (Rabellotti, Carabelli, & Hirsch, 2009). Moreover, Metalworking and plastic casting firms often take part in the same value chain.

With regards to size, as we could have expected, as the dimensions of a firm increase, so does its participation in the 4.0 Plan. It is indeed well known that larger

enterprises have more resources to invest in, also for the purchase of new technologies. Greater resources do not just amount to greater financial availability and access to credit but also greater managerial equipment and more highly qualified personnel. Furthermore, large enterprises can access relevant flows of information more easily and have more ease at taking on long term investment strategies (Bos-Brouwers, 2010).

Table 18 Comparison of the distribution by size of the firms adhering to Plan 4.0 with respect to the population.

SIZE	4.0 FIRMS	AIDA POPULATION
0-9	28,4	56,5
19-49	48,6	35,5
50-249	19,8	7,0
250+	3,1	1,0
TOTAL	100	100
N.	1921	115019

Despite this, it is interesting to underline that almost 50% of the enterprises that took advantage of the 4.0 policy are placed in the segment counting between 19 and 49 workers. In part, this is certainly due partly to the actual structure of the Italian manufacturing system, but we should not underestimate the role played by organizational flexibility, something that small and medium enterprises can count on. Smaller dimensions and a less hierarchical and bureaucratic organisation guarantee a greater potential for adaptability to technological and market transformations in the face of limited availability of internal resources (Maillat, 1990).

From a geographical point of view, the data we collected shows that participation in the 4.0 Plan is concentrated in the two northern areas, whereas for the Italian south and Islands, participation is particularly low. We should also underline that central Italy only moderately partook in the policy.

Table 19 distribution by macro geographical area of the firms adhering to Plan 4.0 vs the population.

NUTS 1	4.0 FIRMS	AIDA POPULATION
NORTH-WEST	37,2	34,0
NORTH-EAST	33,5	28,2
CENTER	16,2	19,2
SOUTH&ISLANDS	13,2	18,7
TOTAL	100	100
N.	1852	109738

Table 20 distribution by region of the firms adhering to Plan 4.0 vs the population.

REGIONS	4.0 FIRMS	AIDA POPULATION
LOMBARDY	27,7	25,2
VENETO	18,5	13,6
EMILIA ROMAGNA	11,0	10,9
PIEDMONT	8,1	7,4
TUSCANY	6,5	8,4
MARCHE	5,0	4,2
OTHERS	23,4	30,4
TOTAL	100	100
N.	1852	109738

From the analysis that was carried out at a regional level, we can see that none of the Central-Northern regions was particularly penalised, except for Tuscany. This, a typically district-like area, with a manufacturing population standing at about 9% of all national enterprises, includes only 6.5% of the population taking part in the plan. On the contrary, Lombardy and Veneto have benefitted more from the policy with an over-representation of 2.5% and 4.9%, respectively. It may seem contradictory that Tuscany and Veneto show such different trends, despite the two being considered similar, as typical examples of districts of Third Italy. However, as discussed previously in section 2.3.2 their similarity mainly concerns

organisation modalities, whereas significant differences emerge in terms of sectorial specialisation and forms' dimension. Whereas Tuscany has only 15.9% of industries operating in the engineering sector, these are about twice as many in Veneto (30.8%). As we have already seen, the engineering industry is more involved in transformation processes and therefore is also more active in terms of partaking to the 4.0 Plan.

Finally, the main research question: does the participation of enterprises change based on whether these are within an industrial district or otherwise? In this respect, the data shows that the incidence of district enterprises among those that have partaken in the policy is higher compared to the incidence in the population (see table 6).

Table 21 Comparison of distribution by location within a district area of the firms adhering to Plan 4.0 vs the population.

	4.0 FIRMS	**AIDA POPULATION**
NOT DISTRICT	56,9	64,0
DISTRICT	43,1	36,0
TOTAL	100	100
N.	1921	115019

5.4.2 Isolating the district effect

Even though, as it was just shown, district enterprises reacted more promptly to the policy, this does not exhaust the main question at the base of this chapter. Two different aspects can explain the concentration within districts. On the one hand, there is a 'composition' effect, by which districts show greater reception by reason of the characteristics of the enterprises that shape its productive network, as for sector, profitability and propensity to invest. On the other hand, there is a specific 'context' effect. This entails that district enterprises can benefit from localised socio-economic externalities that generate a widespread and greater capability to participate in the policy and absorb 4.0 technologies. In light of this, our research

question can be specified further with the following hypothesis: given equal factors, does operate within an industrial district increase the propensity to invest in 4.0?
As previously discussed, in order to test this hypothesis, almost experimental reasoning was adopted. In this way, by means of a logistic regression, one can determine whether belonging to a district or not can guarantee a greater chance of having taken part in the policy in its first year of implementation. The model has a dichotomous variable that has value 1 if the enterprise has benefitted from at least one incentive connected to the policy. The main explication factor is a second dichotomy variable that has value 1 if the enterprise is located within an industrial district. As control variables, along with the macro localisation area, we inserted all the variables used for the *matching* procedure (CEM). However, these will not be shown in the results as they are largely non-significant, this being an outcome that confirms the good quality of the *matching* procedure.

Table 22 Binomial logistic regression results about 4.0 industrial policy district adoption[36]

VARIABLES	Coefficient	Odds ratio
Super/Iperammortamento		
North East	0.0751	1.078
	(0.0846)	(0.0912)
Center	0.0481	1.049
	(0.107)	(0.112)
South	0.0656	1.068
	(0.121)	(0.129)
Islands	-0.338	0.713

[36] The reference category for Macro areas North West is omitted. Since structure of the model is not possible to provide a synthetic misuse of model fit, for these reason in the appendix B is present detailed post estimations.

	(0.217)	(0.155)
DISTRICT	0.293***	1.341***
	(0.0731)	(0.0980)
Constant	-0.177**	0.838**
	(0.0785)	(0.0658)
N	3,282	3,282

Errore standard in parentesi

*** p<0.01, ** p<0.05, * p<0.1

As to confirm the main hypothesis at the base of this chapter, the only meaningful explanatory factor is that of belonging to an industrial district. Because all the other variables have been placed under control first through the CEM process and then the statistical procedure, this effect is entirely due to the locationing of the industries and not their characteristics. More specifically, unites of production located in districts, with other factors being equal, have a relatively greater propensity (34%) of belonging to the group of enterprises partaking in the 4.0 Plan.

5.5 DISCUSSION OF THE RESULTS

The result points out that incentives coming from 4.0 Plan have found greater receptiveness among district enterprises. There are at least two implications of this result. First of all, the idea that firms still benefit from a localised competition advantage is reinforced. In other words, despite how the recent economics literature has emphasised that the future of districts is mainly centred on the ability of certain enterprises, generally medium-sized, to connect to international value chains, to become servitised or have internal resources available that can be useful to build markets for quality products. This result indicates that competitive factors that are endogenous to enterprises find beneficial complementarities with factors that are exogenous to them but geographically limited. In describing the virtuous part of Italian manufacturing, we should not, therefore, restrict ourselves to emphasising the role of medium-large companies that have come out strengthened from the

economic challenges of the past twenty years, but instead, look again at their local roots and to how much they can allow districts to ride the wave of change.

The second implication regards the geography of investments in 4.0 and, consequently, the geography of the enterprises that are more competitive these days and that with all probability will be even more so in the future. What emerges from the descriptive analysis is that the traditional borders of Italian districts seem to be changing. If we look at investments in 4.0 technologies, central Italy appears to have been downsized, Veneto strengthened, but most importantly, the fulcrum of 'Third Italy' seems to have shifted towards Lombardy. This region shows signs of emancipation from traditional organisation models, those typical of the old industrial triangle. It breaks the axis with Piedmont, this being a region where enterprises continue to benefit less from the positive effects of industrial agglomeration, and consequently, seems to show a greater difficulty at promptly seizing the opportunities offered by incentives for 4.0 investments. Furthermore, if these trends of differential adoption should continue, not only would the gap between north and south continue to widen, but central Italy might enter a phase of strong decline of its manufacturing sector, with this being a compartment that ever since the '70s, has always played a significant role in the economic dynamism of the area. The inability to adapt to the emerging technologic paradigm of 4.0 may indeed translate into a significant loss of competitiveness of these firms, leaving the North alone as the productive centre in the country. These results are extremely consistent whit the picture that arose in section 2.3.2.

5.6 CONCLUSION AND HYPOTHESES FOR THE NEXT STEP

The results obtained make it possible to put forward hypotheses on some of the mechanisms that may characterise the greater propensity of district enterprises to invest more in this field, providing useful insights for the last empirical step of this research based on a comparative case study.

The first hypothesis on the mechanism by which 4.0 investments gather in industrial districts concerns the characteristics of the sectors that they are specialised in. As the descriptive analysis from the previous paragraph show and the monitoring carried out by Confindustria (2019), investments in 4.0 of Italian enterprises largely regard the engineering industry. This leads to the possibility the incentives were used with the aim of modernising the machinery, towards a greater interconnection with other machines or between machines and people. If 4.0 investments have had the greatest diffusion among engineering enterprises, it is easy to see why the policy was concentrated in certain regions. According to the data of Istat 2017, Lombardy and Veneto are in the first position for the number of units operating in the engineering industry, gathering respectively 23% and 12.6 % of the national total. Emilia Romagna (10.2%), and Piedmont (9.2%) and Tuscany (7.2%) follow. The data also reveals how in the two regions that lead the engineering sector, enterprises are mainly placed within district areas. This is 73,8% of local engineering units in Veneto and 51,0% in Lombardy, compared to 42.1% in Tuscany, 30.2% in Emilia Romagna and 18,5% in Piedmont. It appears that a sector effect emerges that can contribute to explaining the district effect. In other words, if the investment is principally made by engineering firms, then it is more likely to take place in certain regions, and within these regions, inside a district. It does not, however, explain why 4.0 investments are over-represented in the regions that are characterised by district engineering industry, as Lombardy and Veneto, whereas it is under-represented in regions where the engineering sector is present but less concentrated in specialised production contexts.

Another reason why incentives of the 4.0 Plan may have concentrated more in districts relates to the intrinsic characteristics of horizontal production processes that characterise these areas. The breakdown of the production line in activities that are handed over to sub-supplying firms (localised or delocalised in global value chains) may have created the conditions for a greater need for coordination in production through interconnected machines. In these circumstances, the opportunities for greater coordination deriving from 4.0 instruments may have encouraged some industries to introduce innovations of process and, subsequently,

to require their sub-suppliers to adapt their production processes to internal standards. In other words, the innovation action of one or more leader enterprises may have produced ripple effects on their sub-suppliers. From this point of view, the greater is the competitiveness of the enterprises, the greater are the chances of seeing innovation leaders emerge. At the same time, the more distributed is the production process the greater the magnitude of the innovation effect on enterprises in the more downstream enterprises in the production line, and consequently the increase in the number of innovation followers. This process can, in some cases, accompany a gradual process of hierarchy in production processes, pushing sectors to take on a conformation that is more similar to hub and spokes production model (Markusen, 1996). However, one should note that even if the presence of dynamic, medium-sized enterprises is nowadays an important element for explaining the success of districts, both in terms of economic performance and in terms of adoption of new technologies. This does not necessarily imply restructuring districts by following a logic of centralisation and verticality of relations.

Strictly connected to this aspect is also the third mechanism that may have increased district enterprises' gathering of 4.0 investments. This one relates to the greater concentration in these territories of medium and small enterprises. These may be more inclined to invest in 4.0 within districts for two possible reasons. First of all, because it's easier in local district contexts to compensate limits in internal resources thanks to the enterprises' embeddedness in local production networks. As Dosi (1982) has pointed out, thanks to the participation to a collaborative network, even smaller enterprises can gain access to sophisticated technologies and technical expertise for which direct implementation is precluded by limits in internal resources. Secondly, cooperation within these networks allows sharing the costs and risks connected to any innovation process. Cooperation also allows for the creation of common standards and access to greater knowledge of the markets (Bagnasco, 1985; Camagni, 1993). In other words, small and medium district enterprises are capable of taking on rapid adaptation processes, as long as they are integrated into widespread innovation processes.

Finally, one last active mechanism may have a strictly district related origin. This regards the unique availability of social capital – relational and trustworthy- within and outside districts (Trigilia; 1999). Inside contexts with a high density of social capital, information on opportunities for financing may have circulated more quickly and more pervasively. To this also certain information brokers must have contributed. First of all, organisations that represent local interests, that were strongly involved in the policy-making of the 4.0 Plan, that may have had the role of spreading information, creating alertness in the local environment towards measures that had been widely discussed and hoped for, to which a large request for incentives may have followed. Secondly, given the peculiar conformation of the policy's instruments, that as mentioned can be exacted in the form of fiscal incentives, the studies of tax advisors may have played a crucial role in the spreading of the policy, given how these advisors, as is well known, act as central intersection for the spreading of information and isomorphic behaviours in district enterprises (Sellar, 2015). Finally, also the local banking system may have played a relevant role in promoting these measures, with particular reference to the 'New Sabatini' law, but also the hyper and super amortisation that can be cumulated with it. The hypothesis is, therefore, that the promptness in responding to the industrial policy can be attributed to the greater connectivity of districts, that is to say, the fluidity with which information can circulate. The relevance of this effect is amplified if one considers that the reactiveness of enterprises to information coming from the outside is generally quite high. Within districts, innovation is, in fact, traditionally influenced by external agents, that on a local scale promote a continuous adaptation of contextual and tacit knowledge through a cognitive spiral mechanism (Becattini, 2000). Isomorphism mechanisms are therefore underway, having been stimulated by information both on what the companies with the best reputation have done and actors of the locale governance, who contribute to increasing the collective intelligence of the district.

To summarise, there are four hypotheses on the possible mechanisms that may justify the greater propensity of district enterprises to become early adopters of the 4.0 Plan. A *sector effect* that pushes companies in some district areas, prevalently

form the engineering industry, to partake in the 4.0 Plan. A *production chain* effect that to a greater degree exposes district enterprises to the need of increasing their interconnectedness, also though machines, being these enterprises by definition organised as networks. We have also highlighted a *size* effect, i.e. the possibility that the 4.0 Policy has involved districts more closely because here, there is a greater concentration of medium and small enterprises, typically dynamic and adaptive. Finally, the one true district effect, which emerges out of the greater fluidity with which information circulates from one enterprise to the next, and for the presence of certain *brokers* (tax advisors, banks, etc.). This same effect also develops because of district enterprises' greater propensity towards imitation attitudes and a matrix connected to locale governance, with trade associations that are more active and prepared to design economic development plans for the future.

6 INDUSTRY 4.0 ADOPTION AND ITS EFFECT IN TWO METALWORKING INDUSTRIAL DISTRICTS

The final empirical parts rely on qualitative methodology, more precisely, on a comparative case study that aims to cast light on the following issue:
What are the advantages of industrial districts firms in industry 4.0 adoption?
Which are the effects of 4.0 technologies spreading over the industrial districts' productive relations?
The two cases selected concern two metalworking industrial districts: one in the regions around Lecco (North Lombardy) and the second in the Cusio region (far North-east Piedmont), in which the small town of Borgomanero represents the most significant urban area. Data collection is based on semi-structured interviews with entrepreneurs, high-profile managers, and members of local business associations[37]. In order to identify which enterprises to contact, the AIDA dataset was used to select potential interesting cases. The potential respondent list was composed of all active firms between 5 and 250 employees specialized in the relevant sectors' in districts' productions that have invested in hardware and software during the two-year period from 2017 to 2018.

6.1 COMPARING THE DISTRICTS

Lecco metalworking district

The genesis of this district was due to a favourable combination of environmental factors: the presence of metalliferous veins in the neighbouring valleys, a wealth of woodland capable of supplying the smelting furnaces with charcoal and an

[37] For more details about the sample and structure of interviews, see Appendix D.

abundance of waterways from which to draw the power needed to operate the machines. However, its development was mainly due to its proximity to Milan (Valasso, 1996).

Although the iron and steel industry was heading for an irreversible decline in the mid-19th century, this was not the case for the secondary processing metallurgical industry, towards which the manufacturing activity of this district was progressively oriented. These were the years in which three great entrepreneurial dynasties, the Badoni, Falck and Redaelli families, linked their names to Lecco's iron industry (Valasso, 1996). However, alongside these dynasties, there was also a rich fabric of small, highly specialized and highly integrated wire-drawing mills and forges, which guaranteed a considerable and extremely diversified production of semi-finished products. It was this industrial fabric that formed the basis of the extraordinary economic development of the first post-war period (Garofoli, 1994).

During this phase, the large companies moved to Milan while maintaining close relations with the small and medium-sized enterprises based in Lecco. The close ties with the large Milanese companies allowed this network of small specialized companies to make significant innovations in production technology and commercial organization. In the 1970s, the district underwent a profound evolution due to the economic changes of the time. This led, in turn, to a radical adjustment to the district's competitive factors in the early 1980s, resulting, on the one hand, in a selective downsizing of the production units but, on the other hand, in maintenance within the companies of those processes with greater added value, thus differentiating and shifting the goods offered towards higher quality production. This process of economic readjustment into an even more networked form led to a strengthening of the district logic. However, the local socio-economic system of Lecco also presents a radical difference with respect to the classic concept of an industrial district. In fact, it is a process district and not a district of product. The companies there are extremely diverse, covering a very wide range of products, components and processes. The main district system, therefore, is focused on the creation not of certain final goods but of a large number of intermediate goods, both for production within the sector and for other sectors.

The reticular form and the orientation toward process rather than product mean that the production chains in the Lecco metalworking district are not arranged along parallel axes with numerous points of contact but are based on a truly reticular structure rich in overlaps and horizontal links. This allows for easier readjustment of production to market fluctuations and increases the system's ability to operate in the function of external networks (Garofoli, 1994).

Over time, the district has acquired important competitive factors, linked in particular to the presence of various training and research centres tied to the local economy. Not only has a university satellite been opened but also tertiary training courses (ITS in mechatronics) linked to local production. Companies and local authorities have also invested heavily in the area's technical institutes (Roveda & Vecchiato, 2008).

Borgomanero tap and valve district

This district has very particular characteristics. On the one hand, it is a typical district and therefore highly specialized around the value chain of a limited number of sectors; on the other hand, the two central productions of the area, valves and bathrooms fittings, have quite different characteristics. As far as taps are concerned, the typical characteristics of made-in-Italy sectors are to be found where the value is generated by the total quality of product, design and brand elements.

The Cusio-Valsesia area has a long tradition of brass and bronze production, dating back to the first foundries manufacturing bells near the River Sesia in the fifteenth century. This tradition was the basis for the development of today's tapware-valves industry, which has accelerated particularly since the 1950s (Fortis & Nodari, 2001). Over the last ten years, the Borgomanero district has consolidated its position at an international level. The presence of several leading companies has exerted a knock-on effect on the entire district, which has contributed decisively to increasing the district's worldwide reputation. This is due to its medium-high global quality levels, a high rate of process and product innovation and, in the case of bathroom taps and fittings, a high level of design. Historically, the success factors of the district have

included some elements common to the two distinct sectors of bathroom fittings and valves. First, as already mentioned, the area's tradition of working with brass and bronze has evolved over the years, giving rise to a very high level of specific know-how in the production of valves and taps. This has involved the on-site development of highly qualified labour and establishing a strong network of relationships within the district for the supply of components, semi-finished products and services.

Second, in more recent times, the district has been able to count on the important contribution of medium-sized and large companies that have become world leaders in these sectors. These companies have played an important role, both in terms of technological spill-over and in opening the district up to foreign markets. It should be emphasized that the positive externalities created by the presence of larger, economically dynamic companies are generated through the direct guidance of local production networks through processes of imitation and spill-over (Ferlaino & Sacerdotti, 2001).

Another factor in the district's competitiveness is the legacy of the industrial park located on its borders. In fact, although the science park project on Lake Maggiore never really took off and was closed in 2015, the activities of the scientific area related to mechanical engineering have given rise over time to innovative companies that have linked up with local production. A further important competitive factor of the district is linked to ecological aspects. In fact, the Cusio area is characterized by an efficient system of both special waste disposal and recycling of industrial processing waste. These elements of a green and circular economy are also linked to the history of the district. Pollution from local industries in the 1980s caused the death of the lake around which it is located. This ecological disaster generated strong public pressure that resulted in major actions to clean up the lake and a strong environmental commitment from local businesses.

Both cases represent large manufacturing local economies historically specialized in metalworking activities. The Lecco areas represent one of the largest industrial districts in the Italian landscape. More precisely, it represents the seventh largest

industrial district, considering total manufacturing occupation. Considering only the 57 metalworking districts and the connected sector employment, Lecco is the fourth district in terms of dimension[38]. The Borgomanero case is less known and considerably smaller in comparison to the Lecco reality. Nevertheless, this local economy is the largest industrial district of Piedmont and, considering the broader picture, it is the 19th Italian district in terms of manufacturing employees and 8th in the case of the metalworking sector.

Table 23. Manufacturing and metalworking specialization, 2017

	Manufacturing employees	Manufacturing LQ*	Metalwork employees	Metalworking LQ*	Metalworking entropy
Lecco	42295	1.85	28196	2.85	1.42
Borgmanero	15694	1.83	11780	3.25	1.04
Industrial districts mean	10757	1.71	4681	1.54	1.21
Metalworking districts mean	14150	1.76	8097	1.67	1.22

* Location quotient (LQ) calculated by employment.

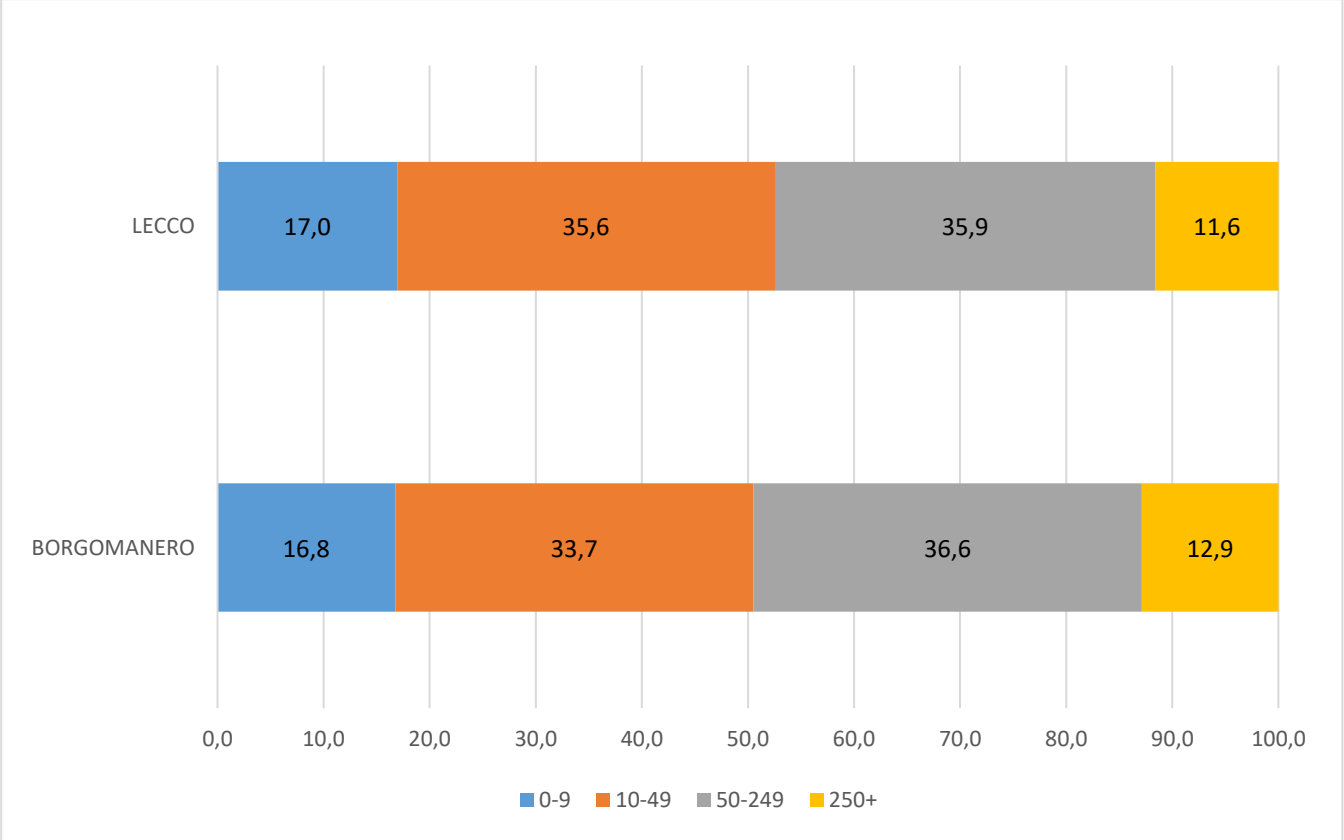
Source: Istat Asia.

Data reported in Table 23 makes evident the dimensional difference between the two cases. However, they lead to other two relevant considerations. First, this difference is due to the Lecco industrial district's outstanding extension rather than the Borgomanero local economy's limited dimension. Indeed, this last has a remarkable dimension respecting the industrial districts general mean and is above the average of those specialized in the metalworking sector. Second, both cases have

[38] The larger metalworking districts are in order fo dimension: Bergamo, Brescia e Padova.

an extremely high level of specialization in metalworking activities. Also, the occupational structure of the two cases is quite similar (Figure 15). Their occupational structure is consistent with the second chapter's observations about the emergence of an industrial districts model that characterized northern regions. In these metalworking realities, medium firms are taking a pivotal role in occupational structure and as a source of local economic dynamism, particularly concerning export performance. However, as already discussed and highlighted by previous chapters' results, this does not undermine the districts' nature of these local economies, which still benefit from social and agglomeration externalities typical of industrial districts. Quite the opposite medium firms seem the dimensional category that benefits more from being located inside such environments.

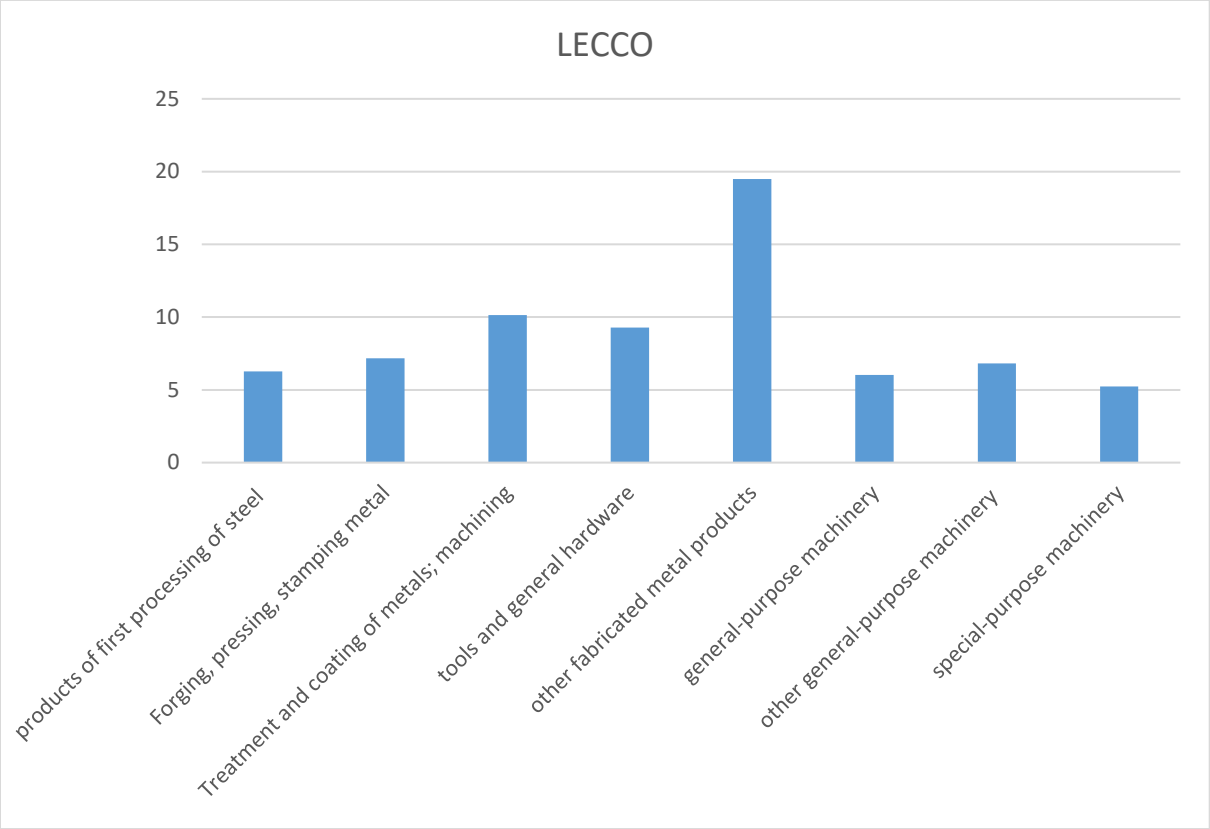
Figure 14 Occupational structure in the two cases, year 2017



data source: ISTAT ASIA

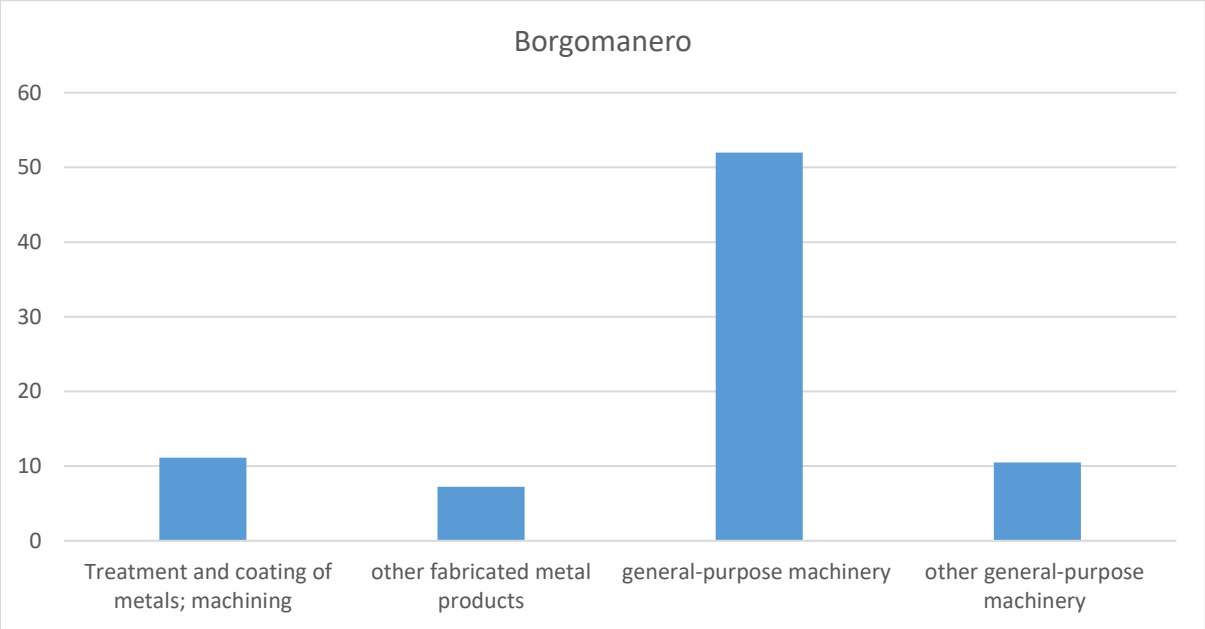
Despite the similarity in the degree of specialization and the occupational structure, as already anticipated, there is a highly relevant difference in terms of sector articulation between the two cases. Indeed, the two local economies present a relevant difference in terms of internal related varieties, as shown by the different metalworking sector entropy degrees (Table 23). Indeed, while Lecco presents a length of related verities superior to the average of metalworking industrial districts, the opposite occurs in the Borgamenro areas. Figure 16 and 17 provided a clearer picture of this synthetic observation; the Lecco district is characterized by a great variety of sectors, from the first phase of metal transformation to specialized machinery tools. On the other hand, Borgomanero sees local activity heavily concentrated in one sector, general-purpose machinery, which is the macro sector comprising tap and valve production.

Figure 15 Employment share of metalworking sectors that represent more than 5% of manufacturing employment in Lecco



Source ISTAT

Figure 16. Employment share of metalworking sectors that represent more than 5% of manufacturing employment in Borgomanero



Source: Istat 2017.

This difference is extremely relevant because it implies both a different way of value creation and local productive networks organizations. The case of Borgomanero sees its local economy centred on the production of a limited set of products. Moreover, in the case of taps manufacture, the capability to generate market values is connected to quality, design, and a "territorial branding" typical of made in Italy productions. In the case of Lecco's local economy, the value creation is centred on the quality and adaptation of their production process, which involve a wide range of activities, from the transformation of metals to the manufacturing of specialized machine tools. Moreover, as we will see in the next section, these local production organizations profoundly affect local governance. However, before discussing this topic, it can be relevant to consider another diversity source between the cases. Indeed the two contexts differ not only on strictly economic dimension but also in terms of urbanization (Table 24). While in the Lecco case, the local system has a medium city at the centre, Borgomanero district is born an actual peripheral area. It is important to note that despite the low level of urbanization, the Bororgomanero local manufacturing local economy is bigger than most well-known industrial districts of Centre Italy as Arezzo, Lucca and Pesaro.

Table 24. The two districts: urban structure, 2020

	Number of commonalities	Area (km²)	Population	Population density	Major city population	Major city density
Borgomanero	42	427	122669	287	21776	658
Lecco	85	732	327831	448	48131	1056

Source: Istat permanent census.

6.2 DISTRICTS GOVERNANCE

The final part of this section is dedicated to a comparison of the models of governance of the two cases. It aims to understand how different governance settings provide different advantages and challenges in respect of the ongoing technological changes.

Lecco metalworking district governance

The metalworking districts of Lecco can rely on a well-developed and formalized local governance that involves many local stakeholders. The rich associative life in this territory involves both entrepreneurs and workers and provides a strong and tight local regulatory regime. These benefits are due also to the presence of the administrative centre of the province. Local actors refer to it as the 'Lecco system'. To give an example, in the last mayoral election, all the candidates came from a leadership role in a business association, and the first question in the first public debate was about the future of the Lecco systems.[39]

Over time, this formal and inclusive territorial regulation model has provided relevant public goods for competitiveness in the form of infrastructure, local university departments, training institutes and specific local agencies dedicated to helping enterprises regarding technology absorption and becoming open to foreign markets. However, the importance of this local governance structure goes beyond the simple provision of territorial collective goods for competitiveness. The Lecco system provides a crucial deliberative forum in which several actors compose their different interests and organize collective action through common goals; it provides a shared sense of belonging and traces a clear path of local development. Moreover, this system provides the general framework integrating the local diversified industrial landscape.

As indicated (above), the Lecco district is characterized by more unstable production networks and a wider range of value chains. For this reason, the local governance actors, as business associations, have an important role in aggregating

[39] https://www.youtube.com/watch?v=5WHxCUVrvso

the demands of local firms and have organized territorial action involving more differentiated interests. Nevertheless, the integrating role of local associations is not limited to their formal representative activities. Indeed their members' informal relations as trust brokers between firms and information providers are relevant mechanisms to the coordination of local economic activities. Local business associations perceive the relevance of territorial relations and local cooperative culture. Consequently, they orient their activities in this sense, both regarding the services provided by single organizations and in relation to other local actors.

Borgomanero valves and taps district governance.

In contrast with the case of Lecco, the Borgomanero local economy does not have a highly institutionalized governance system. Indeed, it does not have a strong network of local associations, and there are no places predisposed to the concertation of local relevant economic actors. This is probably due to two reasons. First, Borgomanero has a level of urbanization that is significantly lower and does not have any relevant local government based within its boundaries. Indeed all its commonalities are of small dimensions. This leads to an absence of deliberative space where relevant social, economic and political actors may become involved together around common projects.

Second, medium firms have historically played a relevant role as integrators of local economic activities in Borgomanero since the value chains are stable and concerted to a few sectors. However, the district can rely on other, less formal forms of governance, stemming from both the power relations and professional community ties of enterprises. At the base at the basis of this absence, there are probably two factors.

First, the local production is hyper-specialized in a few stable value chains with many interconnections between them, making easier local economic integration given the stability of the market and power relations. Second, tight social ties between economic agents have generated a relevant regulatory frame. Rules of fairness and behavioural codes reinforced through reputational mechanisms allow easier collaboration and cooperation between district firms; this, in turn, allows for

the economic coordination of local economic activities. These informal relations are essential, moreover, in terms of knowledge spill-over, technological transfer and information flows. The different district dynamics are created by the different kinds of interactions and their different positions in local value chains and roles. First, it is important to distinguish between the so-called 'silver' and 'yellow' works. The former refers to the final production phases of tap products (it takes this name from the colour of chrome). The latter refers to the transformation of brass (which has a yellow colour) and involves the production of valves and taps components.

Yellow enterprise leaders: These are usually medium-large firms that operate in the valves value chains. They involve a wide range of production activities and represent an important source for technological spill-over.

Leader silver firms: This category is composed of firms that sell final goods – more precisely, sanitary taps – to the market. These leader firms vary in size from small to large and specialize in a variety of niche markets. They are not only important sources of knowledge spill-over but also the local bridge to international markets. They are also responsible for the positioning of the district toward high-quality production standards and, consequently, for its shared reputation. The activities of these enterprises have generated a sort of district branding, representing a significant competitive advantage of the districts.

Yellow supplier enterprises: These firms, often of medium size, serve both the valves and taps value chains. Their products are characterized by a low added value, but they play a strategic role in the district for two reasons. First, they are in a central position in local value chains. Second, their central position in productive networks makes them pivotal agents as trust and information brokers. Their value in the local market is strictly related to these social interaction aspects, the long-standing trust relations and their relevance as network integrators that make their survival possible. For this reason, during the 2008 crisis, many leaders companies entered into the ownership of yellow suppliers. Remarkably these investments take

the form of economic sustainers rather than acquisitions to exercise hierarchical control. Indeed in many cases, several different leader firms have entered with small investments in a single supplier's capital.

Specialized suppliers: To this last category belong small firms specializing in particular production phases and services. These firms are often essential collaborators with those in the other categories, even participating in co-design and new product development due to their extremely specific and valuable know-how.

Even if the local economic governance is expressed by informal social relations or hierarchical productive ties, business associations still play important roles. For example, these organizations provide useful services as support activities in the 4.0 investments' definition and implementations. However, in the Borgomanero case, these services are not granted as local collective goods for competitiveness but are delivered by local organizations from the regional centre as members' services. Thus, they are less well embedded in the local reality and are not created with the aim of triggering a territorial transformation but with the goal of strengthening the economic dynamism of associated firms. One other significant difference in the way that these services are arranged in terms of territorial dimension emerges in two ways. First, business associations in Lecco have implemented local divisions to provide the services they offer, whereas, in the Borgomanero case, it is the central regional organization that provides them. Second, in Lecco, business organizations are trying to connect local firms and actors around 4.0 industry implementation projects. On the contrary, the business associations of Borgomanero district follow a sector and organization similarity approach, relying on resources dispersed over the whole region. In other words, where the general idea in Lecco is to connect local resources and rely on territorial and social proximity, in Borgomanero, the basic idea is to create links based on other forms of proximity, such as cognitive and technical ones.

19 "*Once a company says "OK, let's do it", we search our database for all the companies that have approached us to present their services and products and that we know because they worked with companies similar to those in which we want to invest, in order to offer them a product that is tailored to their needs. And so we organize three or four interviews. In selecting these potential partners, do you follow a territorial logic?*
No, not really. I may have a company south of Cuneo, but if I think that the best supplier is in Ivrea, I will suggest that one. You could say that the territory comes in at a later stage, then, if I have to choose, I choose the nearest one". Association 9 Borgomanero

Despite not being centred around a territorial perspective, the service provided by the business associations plays a significant role also in the Borgomanero tap and valve district. Indeed, the information and knowledge resources provided by these organizations, even if directed only to members, generate broader territorial effects due to the informal relationship between district firms. Classic district dynamics act as a sort of echo chamber multiplying the local effect of these interventions. For example, firms that have implemented 4.0 technologies with their associations' support may share information with other district firms and trigger imitation behaviours.

The comparison logic

The two industrial districts present substantial similarity that allows a meaningful comparison, which can be sum up in the following characteristics:

a) Extremely high-level of metalworking activities presences

b) A relevant presence of economic dynamic medium enterprises

c) grate export propensity

d) are both historical industrial districts

e) strong manufacturing employment resilience, especially in the metalworking sectors.

However, the cases present relevant differences. Lecco is one of the largest Italian districts of process. A local economy is characterized by a high level of specialization in a wide range of similar transformation activities in the metalworking sectors but unrelated to any specific products. Therefore, a territorial reality displays remarkably wide related varieties. Moreover, it is a university medium city provided provide with a formal local governance structure. These features make Lecco a local context particularly favourable for economic innovation and thus enhancing local firms absorptive capacity (Asheim, Boschma, & Cooke, 2011) (Ramella & Trigilia, 2010). In contrast, Borgomanero is a typical industrial district specializing in the production of specific products, in this case, taps and valves. Thus, the local economy presents itself as an "industrial monoculture" underpinned by a dense fabric of firms specialized in different sectors related to the main activity. It is a peripheral area with local governance still based on informal communitarian relations and firms vertical integrations. Consequently, contextual externalities underpinning the local economy's innovation and absorptive capacity are related to classical industrial districts semi-automatic dynamics (Ramella, 2016).

6.3 4.0 ADOPTION AND ADOPTERS IN INDUSTRIAL DISTRICTS.

The adoption of the 4.0 industry in both cases appears to be related to three order of factors, first firm characteristics, second local context social externalities and finally, the central policy incentives. For what concerns the former, relevant features at the firm level appear related to organization members' personal orientation and idiosyncratic enterprise history, rather than economic and structural features. The process of interview selections can partially explain this find. Indeed the sample is composed only of dynamic economic firms that have invested in recent years and belong to the metalworking sector, the one more involved in the actual technological changes. However, an extensive body of literature has underlined how personal and organizational orientations are an extremely relevant factor in explaining innovative behaviours (Ramella, 2016). Indeed, as Rogers underlines, individuals generally tend to expose themselves to ideas, technologies and practices

according to their interests, perceived needs, or existing attitudes (Rogers, 1983). Passing to contextual factors, data collection shows the significant relevance of traditional districts' social externalities for industry 4.0 firms' absorptive capacities. Trust among economic agents, rich information flows, local association life and knowledge spill-over, play vital roles in the new technological spreading. Indeed, these local factors foster awareness-knowledge about technological innovation and, at the same time, decrease the uncertainty always related to innovation adoption, particularly concerning technological providers[40]. Last, the incentive provided by the central policy has proven to be an important factor in decreasing the opportunity cost of undertaking industry 4.0 adoptions. It is important to note that despite these resources being provided centrally, territorial social and economic relations have fostered the actual policy's implementation at local levels.

Based on the collected interviews, it is possible to identify five district firms' categories depending on the degree of industry 4.0 implementation and the role played by state fiscal incentives. In order to be considered an adopter, an enterprise must have acquired 4.0 machinery with specific characteristics and established an interconnection between them. The industry 4.0 technological paradigm is intrinsically bound to the interaction of physical assets in a digital system, originating a cyber-physical environment. The degree of adoption precisely refers to the degree and extension of this connection. In other words, to what extent the different phases of production are covered by interconnection. This categorization takes as theoretical references Rogers adopter categories (Rogers, 1983). However, for methodological and theoretical reasons in this study is not possible an application of these ideal types. Indeed, the sample is composed only of particularly economic dynamic firms and, consequently, most likely to be innovators and early adopters. Moreover, as the author himself admits, the ideal type categorization has two main shortcomings. First, it does not take into consideration the degree of adoption both in the general social context and in single organizations. In other words, these categories are not easily applicable in a particularly early stage of

[40] This is only partially true. Indeed if undoubtedly true in the case of hardware providers embedded in districts' social relations. On the contrary, as we will see late in the chapter, the interaction with ICT services providers is particularly critical for district manufacturing SMEs.

implementation. Second, Rogers has not included in the typologies the actors' sensitiveness to policies economic incentives, an important empirical issue in this works. Despite, this difference it is still possible to connect the Rogers ideal type conceptually to the category prosed in this work.

a) Non-adopters

The first category encompasses firms that have not invested in any 4.0 technologies. Even if entrepreneurs are aware of the changes underway, they follow a particularly cautious approach to investment in general. This reluctance appears to derive from experience connected to the Great Recession. Past difficulties deriving from the cash stock shortage and the deterioration of relations with lending institutions have had a profound and long-standing impact on some entrepreneurs' investment propensity. This approach did not imply immobility or inactivity but an investment strategy based on immediate implementation and bounded of actually economic internal resources. An extremely prudent approach to respect new pieces of equipment purchase clearly lowers the general expenditure on new technologies, but, even more important, it limits "experimental investment." This term refers to the acquisition of technology that, even marginal and without significant effect on the production capability or efficacy, plays a critical role in learning by using process. From this perspective, limited technological upgrades are also substantial in terms of knowledge accumulation and the enhancement of future capabilities to acquire and exploit new technology. In the SMEs' case, learning via this process displays a vital role in developing knowledge and generating absorptive capacity[41] (Malerba, 1992; Maskell & Malmberg, 1999). In Rogers terms, the firms belonging to this category of laggards or late majority. Due to the relatively scarce resources, these firms feel that it is safe to adopt the innovation only when almost all of the uncertainty about a new idea and technological application is removed.

b) Involved non-adopters

[41] Recognition of learning by doing and learning by using as important components of absorptive capacity (Choen & Levinthal, 2000)

This category includes the particular chase of firms that have not adopted 4.0 technologies but produce goods with 4.0 properties. Enterprises of this kind are particularly interesting for different reasons: first, because they provide a valuable example of districts' flexible specialization applied to industry 4.0. Indeed, the traditional process of division of labour and integration of firms specialized in different production phases and endowed with specific know-how, in the context of industry 4.0 change its traditional boundaries. The characteristics of 4.0 technological paradigms imply tighter cooperative networks, which integrate firms specialized in different fields of manly hardware manufacturing, electronic components, and software. Second, creating integrated networks for the production of 4.0 goods between enterprises with a significant cognitive distance gives room for an intense process of learning by interacting. Thus, even if not due to internal adoption, district enterprises can benefit from industry 4.0 spreading, first, due to an enlargement of market opportunities and, second, from the possibility of indirectly participating in new technological trajectories. Last, it is essential to note that such involvement in technological change appears to be strictly related to specific sectors, such as machine tools and work equipment. This observation further indicates the higher level of involvement of the metalworking industry. Indeed, some of their sectors see the possibility of participating in industry 4.0 both through internal adoption and production of 4.0 goods. This category has no parallelism in the Rogers ideal type since the author has not considered the involvement in the technological change following external productive relations and not internal adoptions.

c) Incentives-sensitive experimenters

The firms belonging to this category have undertaken an experimental adoption of 4.0 technologies in response to the state's tax incentive. In such cases, the central policy has played a significant role in investment choice through two basic mechanisms; first, the "since we are" approach. In these cases, previously-decided investments decided were diverted through software and hardware equipped with 4.0 enabling technologies. However, an awareness of the importance

of starting a path of technological upgrading represents relevant second steam from this experimental approach. In the last case, policy incentive did not have the effect of focusing on already-established investments but stimulating new ones, which, even if limited, changed the cost opportunity related to an explorative learning activity.

1 "We have taken advantage of the policies to get machinery and tools that will be useful for tomorrow's industry 4.0, because even if we don't use them one hundred percent today, we want to be able to do so tomorrow. It is clear that this has a higher cost at the beginning ... we started from the end and from a piece of the beginning" (of internal productions chain). Enterprise 5 Borgomanero small

Once covered central policy role, it is essential to understand the origin of firms' awareness of industry 4.0 importance. In actuality, the entrepreneurs interviewed have mentioned many different knowledge sources, but the machinery provider seems to play the most relevant role. Taking the opinions of machine-tool sellers into such high consideration may appear odd. However, in districts, market relations are embedded in social norms of fairness, and a robust regulatory system based on reputational mechanisms, generating a high level of generalized trust. These categories correspond to Rogers early majority group. They are individuals or organisations that may deliberate before completely adopting an innovation. However, the resources provided by the central policy give them the possibility to anticipate investments and start introducing innovation in the vision of future more widespread adoption.

d) True experimenters

True experimenters are firms that, despite not having reached full implementation since only a part of the production process is interconnected, have been planning a gradual upgrade to industry 4.0 before the policy's implementation. The entrepreneurs of this category had perceived the changes underway and adopted a congruent strategy of investment. Even if they do not position themselves on the

"technological edge" and follow a cautious investment approach, these enterprises put efforts into technological updates that proceed step by step. As in the previous category, machinery suppliers play a relevant role, jointly with software providers.

2 "*The technology has been moving in this direction for years, and we have been doing all the prototyping in-house for almost 10 years, investing in 3D printers and simulation programmes. Design, prototyping, mock-ups: it's all done in-house. Then, if we need special machinery or specific knowledge, we collaborate with others*". Enterprise 1 Borgomanero medium

3 "*In a way, all the recent machinery has already been designed with that in mind, then the issue of creating the circuit and the overall interconnection is another story ... And the technical department is already connected to the management system, what's the name of the latest version?... well, anyway, we have already integrated the warehouse phases*". Enterprise 1 Borgomanero medium

One other substantial common ground between the two groups of experimenters is the starting point of industry 4.0 investment. Given the adoption of necessary management software representing the prerequisite for the 4.0 application, the initial implementation involves the first and final production phases. As we will see later, this reflects how industrial district firms mainly exploit industry 4.0 applications. As in the case of the previous category, these firms can be seen as the early majority. However, differently from the previous one, the incentives have not played a pivotal role in orienting their behaviours.

e) Incentives-sensitive early adopters

In this category, we can find firms that must undertake a comprehensive implementation, taking advantage of the incentive policy. These enterprises display significant investment in 4.0 technologies in a relatively short time. Because of the investment magnitude and rapidity, incentives-sensitive early adopters had to rely heavily on external resources to define the technological assets to acquire and

implement them. These external resources take different forms, such as the previously mentioned advice from machinery suppliers and software providers or discussions with other district firms that have already widely implemented industry 4.0 technologies. However, for this category, a decisive role was played by business representative organizations. These actors provide consulting and technological transfer services precious for small and medium enterprises.

4 "*We have never ran before we could walk, the incentives were crucial not only in deciding to invest in Industry 4.0, but more importantly they led us to invest on a larger scale....*
We are members and whatever we do...er...Our company's approach is simple: when we have to do things we have one track: our professional and our trade association...
With the few companies with which we have close relations we have discussed things, growth by comparison is always important" Enterprise 3 Borgomanero medium

The possibility of relying on external support is extremely important to overcome internal limitations usually associated with little dimension. The exchange between the internal functions' limited complexity and the importance of external relations is a central pillar of Italian district schools, both from a theoretical and empirical perspective. Notably, the relevance of these external relationships is not limited to pure market aspects; their significance is due to the social element that they embody. This work's observations confirm the relevance of these dynamics. Associations' services are particularly interesting for SMEs because they have a lower market price and, even more important, the commitment between the parties involved. Trust and reputational bounds have two essential effects: first, they ensure that the investment plan is congruent with the actual enterprise needs and is not driven by the technology providers' market interests, which may lead to overinvestment. Second, business interest organizations play the role of trust brokers, mitigating the problem related to the lack of cognitive proximity between the different actors. The Italian 4.0 policy has displayed its most intensive effects in this category, raising enterprises' investment efforts significantly and focussing them on specific technological paradigms. However, the ability

to exploit the industrial policy's opportunities appears connected to the actions of various local actors, which have provided information concerning the opportunities offered by central incentives and how to take advantage of them from a practical standpoint. Making parallelism with Rogers category, these are early adopters, which have anticipated technological adoptions taking advantage of resources provided by the Italian 4.0 policy.

f) True early adopters

The last category includes enterprises that have made significant technological investments before the incentive policy occurs. The remarkable technological upgrade efforts of these enterprises stem from two attitudes. In some cases, it is related to entrepreneurs' or apical managers' specific human capital endowment. This specific knowledge, mainly related to ICT technologies, allowed these influential people to understand the importance of technological changes underway, pushing the organization towards industry 4.0 adoption.

5 "*I use LINUX, I am very keen on technology so I pay attention to what technology has to offer*" Enterprise 12 Lecco small

The second type of true early adopters involves firms that embrace an investment strategy more dynamic and strengthen their efforts towards the technological upgrade in response to the 2008 Great Recession experience. Interestingly, similar past experiences related to the crisis period have led some enterprises to embrace a completely different approach to investment behaviours, cautions in the case of not adopters, and propensity to a constant technological upgrade in the case of true early adopters. Even for this last category of enterprise emerges the importance of external relations as machinery and software providers. However, what is particularly interesting are connections between local business associations and true early adopters. What makes these relations extremely relevant is how they change according to enterprises' human capital and what this implies in terms of the interaction between firms' internal resources and contextual ones. In the case of

firms that lack internal human capital to invest in 4.0 technologies confidently, many enterprises have searched for help and information from their business associations. Unlike the previous category, true early adopters usually have received support from these organizations in informal or through structure not specifically designed for industry 4.0 diffusion since dedicated service was arranged after their initial implementation. In these cases, once more emerge the importance of contextual resources to overcome internal limits. In contrast, firms with internal human capital suitable to autonomously define and implement 4.0 investments become territorial resources themselves. They provide a useful example for other firms and spread information about 4.0 technologies at the local levels. In this case, business organizations receive help from their associated enterprises, which become an example of best practices.

6 "*We acted in advance with the incentives and we had support from our association*" Enterprise 5 Borgomanero small

7 Interviewer*: "Did you receive help in the definition and impetration phase of the investment from other companies in the area or from trade associations?*"
Respondent: "*No, we were among the first ones, so on the contrary, it's the association that sent people to us, four or five especially some years ago*". Enterprise 12 Lecco small

Finally, note that the two early adopter categories (*opportunistic* and *true*) are firms that have invested in both new human resources and workforce training to adapt their internal organization to industry 4.0 introduction. Moreover, true early adopters have benefited from the Italian central policy, even if the tax discount started after the firms' initial implementation. Policy implementation has allowed these enterprises to save money ultimately. This last category can be in some way represent the cases that Rogers identify as Innovators. Indeed these agents have played a pivotal role in the territorial economies by importing the innovation from outside of the local system's boundaries. Thus, the innovators have the function of

gatekeeping introducing new ideas into a local social system. However, for Rogers, the salient trait of innovators is venturesomeness. These agents are risk seekers able to cope with extreme uncertainty, not only due to their inclination and the capacity to the ability to understand and apply complex technical knowledge but also thanks to substantial financial resources to absorb the possible loss. These characteristics are only partially met by the fieldwork's cases. Indeed, also in the true early adopters, the policy resources mitigate the risk connected to innovation activity and accelerate the adoption.

From a more general point of view, qualitative data collection shows the significant relevance of traditional districts' social externalities for industry 4.0 firms' absorptive capacities. Trust among economic agents, rich information flows, knowledge spill-over, dedicated institutions, and collective goods for competitiveness play vital roles in the new technological spreading. Moreover, it is interesting to note that all categories are composed of firms of all dimensions, from small to medium. Even considering the importance of enterprises' dimensions discussed in previous chapters, the fact that even small firms (~15 employees) can be 4.0 industry early adopters sends a clear signal: SME manufacturing clusters can still embrace rewarding path development if an institutional intervention endorses them. It is against this background that the Italian 4.0 industrial policy, which seems to have reached its goals of fostering and focussing firms' technological investments, must be read. However, although these resources are provided centrally, social relations and territorial governance fostered the actual diffusion and implementation at local levels, originating the territorial articulation of the plan discussed in the fifth chapter.

6.4 INDUSTRY 4.0 IN INDUSTRIAL DISTRICTS

Having defined how districts' metalworking firms divided themselves by different degrees and paths of industry 4.0 adoption, the next point to address is what

technologies are implemented and what tasks they accomplish. In other words, what are the implications of industry 4.0 adoption for a productive perspective? In order to discuss empirical findings may be useful to briefly recap 4.0 technological paradigms composition and features discussed in chapter four. First, these technologies can be divided according to their field of application; more precisely, in house production versus networks of production management and coordination. Even if this last application had been identified in scientific literature by experts as one of the most promising implementations of industry 4.0, the fieldwork did not reveal any cases of adoption[42]. Not only there are no cases of integration in wider 4.0 networks among the firms directly contacted, but the business association members, based on their knowledge, describe this application as extremely rare. With a reasonable degree of confidence, this leads to the conclusion that industry 4.0 diffusion is not fostered by a "*production chain effect*" hypothesized in the previous chapter. Indeed, the traditional network's structure of districts' production systems has not led firms to exploit the technological paradigm's interconnection possibilities. Similarly, leader firms' external pressure on suppliers to adopt this technology in a logic of tighter integration and control does not appear to be relevant dynamics of industry 4.0 diffusion in industrial districts. As previously discussed, innovation leaders positively affect local technological diffusion in the guise of practical examples to follow rather than through imposition behaviour. Early adopters play a significant role in local knowledge spill-over and learning by interacting and enacting local imitation behaviour. The most advanced component of the 4.0 industry is related to big data gathering, systematization, and analysis, an operation that can involve machine learning and artificial intelligence applications. However, as in the case of external utilization, no cases of such implementation have emerged from the fieldwork. This finding is consistent with many studies that show how these kinds of adoption are present only in a few enterprises of large dimensions (Frank & Dalenogare, 2019; ISTAT, 2020; Masood & Sonntag, 2020). Empirical finds are aligned with the general innovation literature,

[42] This is not entirely true; a small firm in the tap and valve Borgomanero district, which shows a remarkably high level of industry 4.0 application, has implemented the total external traceability of orders. However, more than a real productive network interconnection, it has the function of a service offered to costumers.

which affirms that large companies are more prone to invest in edge-end innovations since they require high investments in both technological infrastructure and human capital, something non-viable for small companies. Given the extremely low degree of wide network application and advanced analytical tools, it is rewarding to focus on in-house adoptions, which does not imply advanced machine learning and artificial intelligence. Industry 4.0 internal application is based on ICT systems and IOTs that integrate production processes in cyber-physical systems; in other words, the integration of physical objects and hardware in the virtual dimension of the factory. (Jeschke, 2017). This integration is possible thanks to the machines' capabilities of producing data and communicating them to other machines[43] and operational software. This manufacturing digitalization's final goal is to increase transparency and control of the production process and support the shop floor decision-making activities. Moreover, the translation of physical transformation activities in digital information allows two extremely relevant tasks: productive simulation and internal traceability. Even if they do not directly connect to the transformation activity, these operations have profound implications for firm productivity. The possibility of creating a precise simulation of the whole production process makes reliable forecasting of time and costs of producing new goods possible. In contrast, internal traceability provides data that allows administrative and managerial tasks to be automated. Indeed, automatic controls of the flows of materials used and produced across the whole production process make possible the automation of routine tasks of stoking, inventory, and delivery notes redaction. Industry 4.0 also promotes and enhances automation (Bellandi, De Propris, & Santi, 2019). New machinery tools are more precise and able to accomplish both more complex and different operations. Moreover, 4.0 hardware can communicate effectively with other machines and humans, thanks to advancements in the human-machine interface, reducing errors and improving rapid adjustment in the productive process (Bonomi, 2018). In general, industrial district firms appear to have invested in industry 4.0 applications closer to their

[43] Machine-to-machine communication.

knowledge base and thus linked to in-house activities strictly related to production. These investments have two main goals, first, increase production flexibility in both quantitative and qualitative terms, and second, reach a high level of productive efficiency, which usually characterizes more standardized and high-volume production. In other words, contacted firms see in industry 4.0 adoption the opportunity to reach a high productive efficiency level while enhancing production flexibility.

8 "*We need to collect data, we try not to lose anything, to be as efficient as possible but it is difficult*". Enterprise 3 Borgomanero small

However, it is essential to underline that efficiency seems to prevail over flexibility seeking. This is most likely due to the already excellent capability of rapidly adjusting and diversifying production that characterizes districts' flexible specialization models. Before reaching higher flexibility levels, firms are interested in achieving better efficiency in differentiated goods small batch production. What makes particularly clear this priority is the production phase primary involved in the first adoption steps. Especially evident in experimenter firms' cases, the initial investments focus on upstream and downstream production phases. The reason behind this pattern of adoption is to achieve the automatization of routine management tasks in regard to input and output flows as early as possible, decreasing organizational costs related to operating on a small productive volume of differentiated goods.

9 "*The simplification and automation of certain processes that used to be very manual, that is, the same number, let's say, used to be reported around four or five software products (PCs) and their divisions, because it served various processes. Automating the collection and distribution of data throughout the production and invoicing process is incredibly beneficial, you can't imagine what it means for efficiency. I don't sell the hard labour work of my workers but the finished product and the added value is created by the workers when they*

work on the machines, not when they write on small pieces of paper" Enterpise Lecco 11 Medium

It goes in the same direction as the relevance of simulation to forecast time and production costs, an operation that makes it possible for district firms to determine the margins connected to different orders. The possibility of relying on precise estimation of expecting returns allows for both a straightforward competition of prices and greater confidence in strategic commercial decisions concerning the opportunity cost of engaging specific productions.

10 "*What we notice is that small and medium-sized enterprises often accept orders without knowing how much a product has cost them, or take orders without knowing how much they will earn... The small enterprise in Piedmont takes small, complex batches that others cannot or do not want to take, and additive manufacturing could help with this. To sum up, the two main points where 4.0 can help. Yes, of course, the cloud and cyber security, but there is also a question of infrastructure: in many areas there is no internet coverage. In small businesses, monitoring data and creating digital simulations is important for small orders because you can understand if you are within the costs or not, because it's OK to sell below cost so as to let the machinery run, but you have to be aware of it.*" Association 8 Borgomanero

Passing to the productive flexibility introduced by industry 4.0 adoption, its impact seems to involve more the extension of activities conducted with the enterprise boundary rather than the range of products offered. In other words, from a flexible specialization perspective, the promised flexibility of industry 4.0 does not flow in the direction of higher degrees of product customization, already a key competitive factor in this production model. The new technological paradigm is exploited to enlarge the internally executed activities, making the domain of their relative specialization more flexible. The spreading of industry 4.0 among districts' small and medium enterprises leads to significant changes in traditional productive relations as well as their knowledge configurations that characterize specialized

local economies. Remarkably although the adoption involves only in-house applications, they still have profound effects also on external relationships.

Change in firms' internal resources and context externalities

The introduction of industry 4.0 technologies pushes firms to adjust their internal resources in terms of competencies. This is due to the increasing importance of analytical knowledge supported by digital coding and an ever-deeper intertwining between manufacturing and service (Bellandi, Chiaminade, & Plechero, 2020). The needed human capital can be acquired both through works forces training and hiring new profiles. However, it is essential to keep in mind that the current technological transformations require a new and more complex integration between ICT and digital competencies and technical production know-how. Since external codified knowledge to be useful must pass to a process of contextual declination, reflecting on its relation with firms' internal know-how is extremely important. In the case of district SMEs, industry 4.0 implies a more complex tension between local contextual knowledge and an external technical one due to various intertwined reasons. First, this is due to the cognitive distance between small and medium-sized firms' knowledge base and technical knowledge embodied in the 4.0 industry. This distance stressed traditional internal industrial district mechanisms that support territorial adaptation via constant incremental upgrades and bracing out of local knowledge, which no longer seems sufficient to absorb and integrate new 4.0 technologies (Bellandi, De Propris, & Santi, 2019). The cognitive distance between 4.0 industry technical knowledge and districts diffuse local know-how also makes it extremely difficult to retrieve needed human capital from the local labour market. The difficulty of finding skilled labour forces was a significant problem for all the interviewees. This problem reflected how traditional local resources struggle to match the additional needs of local economic adjustments. As will be seen in the second part of the chapter, recreating a match between the territorial knowledge base and firms' changing needs has profound implications for local governance. However, for now, it is important to underline that the seeking of human capital

scarce at the local level is not the only effect of cognitive distance. It also implies the incapability to introduce certain human resources and, consequently, certain technologies. In other words, the problem is not only to search for the skilled workforce and not find it but also what firms are looking for. Indeed, the internal constraints that make it difficult for SMEs to adopt the most advanced 4.0 technologies, like artificial intelligence and machine learning, at the moment are not mitigated by any territorial externalities or contextual resources. A second relevant factor in the tension between the local knowledge base and external technical one is related to the paradigmatic changer nature of industry 4.0. As a paradigm shift, technological changes underway do not involve individual activities but the whole value creation process. Indeed, 4.0 paradigms lead to a radical redefinition of the whole production process and all activities connected to it, as managerial and administrative ones. Thus, implementing industry 4.0 is not only a matter of learning to use specific tools but facing an organizational change to accomplish old tasks in a new way. This challenge creates new difficulties in the industrial districts' typical adaptation process based on learning by doing-using-interacting, the so-called DUI mode, which is embedded in the specific local structure of each district (Bellandi, Chiaminade, & Plechero, 2020).

Despite these challenges, industrial districts can still rely on important local social factors, both traditional and related to recent changes that they have experienced. District firms are characterized by workers and middle managers' strong cooperation and commitment. From the fieldwork emerge the importance of this collaborative environment in facilitating and fostering industry 4.0 adoption. First, there has been no resistance to change thanks to personal trust and engagement between ownership and shop-floor employees. Instead, workers have shown remarkable efforts to acquaint themselves with new technologies introduced in many cases.

11 "The boys (workers) also came on Saturday and Sunday mornings to try out and familiarise with the machines, so when they weren't busy they played with them" Enterprise 6 Borgomanero medium

The relevance of workforce cooperation and involvement is not limited to the actual implementation phase. In many cases, the decision itself to embrace industry 4.0 resulted from the initiative of people different from entrepreneurs. ICT technicians, production managers, and department heads have often taken the function of "technological scout," gathering information about opportunities and possible applications of the new technological paradigm. Typically, these employees were able to play this role on the basis of personal knowledge and inclinations related to their profession but not strictly linked to their role within the firm. However, given their fundamental contribution to the strategic decision to undertake the path towards industry 4.0 adoption, these "technological scouts" were often chosen as supervisors of investment definition and implementation. As proof of this, in many cases, contacted enterprises have identified these people as the most suitable interview respondent. Even if not concerning technical aspects is important to underline the significant endorsement of high-profile administrative staff. They contribute by seeking information about the opportunities provided by the Italian 4.0 policy and managing the bureaucracy related to incentive provisions. Finally, industrial districts' cooperative culture has relevant implications in learning by doing-using-interacting of new human resources acquired concerning 4.0 industry technology investments. If this can appear contradictory with the previous statement on how 4.0 technological change put in question the traditional DUI model of industrial districts, it is quite the opposite. Given the necessity to obtain new employees characterized by a high endowment of specific, abstract, and technical knowledge not diffused in the local context, the problem began to transmit the contextual know-how to these people.

12 "*With us, more than learning by doing, it is training by doing*" Enterprise Borgomanero 3 medium

13 "*On paper, Industry 4.0 is a great opportunity for all companies. The problem is that in order to do this we have to start from schools, so as to start putting into people's heads that industry 4.0 needs: point one, a series of mechanical engineers, point two, a series of engineers at the management level, point three, people who immediately start working in a 4.0 perspective... To make industry 4.0 we have to start from the skills and only from there can industry 4.0be created. It's difficult otherwise without that it is difficult*" Enterprise 2 Borgomanero medium

14 "*I'm better off hiring someone who knows the technology and is already thinking 4.0 and teach the work we do rather than the other way around. Because knowing about Industry 4.0 doesn't mean knowing how to do a job or use a machine, it means having an overall view and a sound high knowledge of technology*" Enterprise 10 Lecco medium

It is precisely in the transmission of this tacit and contextual knowledge in which typical districts' social dynamics show their importance in local knowledge integration processes. What is possible to detect is the opposite process with respect to the usual understanding of the DUI model. In this case, the centre of the process is not the people with contextual knowledge that absorbs new external ones. On the contrary, it is the capability of new workers with formal knowledge to assimilate local know-how to applicate it. The collaboration between different firm members and the possibility of having a wide understanding of the whole production process, which characterized SMEs' work, allow an easier and faster transmission of contextual knowledge. Eventually, this process could decrease the cognitive distance between the districts' knowledge base and industry 4.0 technological paradigm principles.

Before discussing the implication of industry 4.0 concerning district firms' external relations, it could be interesting to discuss some insights about the occupational effects of the new technological paradigm introduction. Even if deepening this issue is beyond this work's aims, it is impossible not to address the problem given its relevance in public and academic. Generally, it appears challenging to evaluate the

effects of 4.0 introduction above the occupation. First, district firms seem to have acquired new human capital, incrementing the number of employees, detecting all substitution effects. Despite this, it is unclear whether the introduction of 4.0 technologies negatively affects new hiring. The only evident finding concerns administrative tasks; industry 4.0 implementation has a substantial impact over routinary administrative activities, allowing comprehensive automation. However, the effects do not appear disruptive also in this aspect. In many cases, the automation of these activities has resulted in a reconfiguration of middle management tasks more than an employment reduction. Notably, management involvement in revolutionary tasks is identified as a structural problem of SMEs, which usually lacks managerial staff and employs it in both shop-floor and directive activities. Because of this, the automation of administrative procedures has double-positive effects on SMEs, on the one hand, raising productivity to the other hand, allowing employees to focus on more strategic tasks.

The effects of industry 4.0 on local economies' external relations, cognitive distance, and local embeddedness

The diffusion of industry 4.0 does not only require adaptations internal to single firms in terms of competence pools and the relative importance of different knowledge bases; instead, it leads to a reconfiguration of the territorial production network and interactions. It is possible to identify two main changes in district external productive relations; the first is related to the new strategic interaction with KIBS providers, particularly ICT ones. The second stream of changes is linked to how the introduction of 4.0 technologies changes the division of labour among district firms. Indeed, if it is true that no case of 4.0 implementation was detected from the network integration perspective, the increase in the range of production activities accomplished inside the firms' boundaries due to productive flexibility introduced by 4.0 pieces of machinery has had remarkable effects on external productive relations.

6.4.1 Manufacturing SMEs and ICT service: a problem of cognitive distance or embeddedness

The rising importance of digital technologies in the core of productive processes deriving from the 4.0 industry technological trajectory makes central the support of specialized intermediaries. They are knowledge-intensive business service enterprises that provide specialized services with respect to a specific firm's field of local production systems. The specialization of service towards specific production already embodies a certain degree of integration between general abstracts technical knowledge and contextual ones. Indeed, as discussed in the previous chapter, these firms must adapt abstract knowledge regarding the contextual needs to exploit market opportunities connected to the upcoming technological changes. However, there are still present significant obstacles in properly integrating these service providers in districts' local productive systems. One more time, the starting point is the high cognitive distance between district-manufacturing SMEs and these service enterprises. Small firms' limited internal resources decrease their propensity to consume KIBS services and profit from them, but even more critical, generate particularly severe tensions in their market relations. Indeed, high information asymmetries lead small enterprises to perceive a lack of transparency, making it difficult for them to rely on the ICT service and goods market.

15 "*The biggest rip-off in today's world of work is in the field of IT in general, because you buy management software that costs an arm and leg lot of money and if you get the wrong supplier, you're finished, you haven't made a good investment and you've thrown money away, quite a lot of money. Nowadays it's hard to distinguish a webagency from a softwarehouse. Guys who came here and seemed very good because they were selling themselves well... we got ripped off*" Enterprise 13, medium Lecco

These difficulties in market relations generate fewer occasions to develop more stable relations, which can lead to productive network integration and increasing organizational proximity. Reading these dynamics through the lens of Economic Evolutionary Geography leads to the importance of other forms of proximity,

namely, social, institutional and geographical ones. It is undoubtedly true that social and institutional bounds can mitigate the effect of cognitive distance. Moreover, as the empirical results of chapter 3 show, the interconnection between ICT and small manufacturing firms has a robust positive effect on these last economic performances. However, it can be more rewarding to frame the interaction problem between district-manufacturing SMEs from a broader and deeper sociological perspective. The starting point of this work discussed how sociological local-development studies have a precise and distinct understanding of economic embeddedness. Following this view, the social regulation of the market is an essential source of economic coordination and positive externalities. Rules of fairness, cooperative culture, and relational standards are not only bound to straight rational economic behaviours, but they are also precious social devices for overcoming market uncertainty and coordinating local productive relations.

16 "*ICT companies would be part of a virtuous process when those who deal with that area provide companies with what they need and not what they want to sell them: this means being part of a district. This means selecting companies on the market (ICT), something that perhaps individual companies cannot do, but can be done as a system. As in the case of foreign relations: interpreters are needed to translate from one language to another in order to do a specific job. With ICT it's the same thing: we have to find and create someone who knows how to put these two worlds in contact, because this is the weakest link at the moment*" Business association 1 Lecco

From this perspective, relational tension between district SMEs and ICT is challenging for two distinct reasons. First, SMEs limited internal resources and the ICT knowledge base, and second, there was low local embeddedness of KIBS enterprises. It is essential to underline a strong connection between local embeddedness and social/institutional proximity. Network reputational mechanism provides a clear example of this relationship. Reputation mechanisms are based on social ties that make it possible to exchange information about third-party behaviours and the possibility of displaying positive and negative incentives

to reinforce them. Nevertheless, a reputational mechanism to exist must embody expectations, codes of conduct, and generalized trust among community members, all aspects related to an institutional system's presence.

Following the sociological local embeddedness understanding, proper integration of ICT enterprises in districts local social systems of production implies a more complex dynamic than the increasing of proximity over different dimensions. These firms must develop a sense of belonging to a professional community, forging and conforming to relational standards and, more in general, absorbing district cooperative culture based on long-standing interactions.

6.4.2 New forms of flexibility what effects on districts' division of labour

The introduction of 4.0, in many cases, is connected to a flexibility increase. As previously discussed, in industrial districts firms, the new flexibility acquired through technological investments involves more the extension of activities conducted within the enterprise boundary rather than the range of products offered. The possibility to conduct a broader range of industrial processes using the same mechanical tools has significant implications for the flexible specialization model of production, which characterizes industrial districts. The concept itself of industry district is based on peculiar territorial subdivision and recombination of the different transformation activities. Since the beginning of the reborn debate about industrial districts in the late 70s, scholars have underlined this dynamic process of labour division and integration in adaptive productive networks as the first relevant analysis level for such local economies (Becattini, 1979; Piore & Sabel, 1984)[44]. The spread of industry 4.0 technologies could have a substantial impact on both sides of this process, the productive network activity divisions and the principle of process integration. Starting from the division of labour, the possibility of operating more diverse activities with the same fixed assets reduces the need to divide different phases of production among individually specialized firms. It is

[44]As discussed in the first chapter according to Becattini the study of local economies must address three levels of analyses, the division/integration of productive process, social relations between local economic actors and the local economic institutional system (Becattini, 2000)

important to remember that from a district context, the make or buy choice implies, on the one hand, share costs connected to productive assets and, on the other hand, give up part of the productive value-added to other firms of the productive network. More flexible machinery decries the need to share the costs linked to specific asset investments, allowing them to retain more value-added inside single units of production boundaries. Thus, the diffusion of industry 4.0 can lead to a concentration of transformation activities in fewer enterprises of larger dimensions.

17 "*So, with the opportunity of 4.0, we decided to modernize our fleet of machines. This has given us greater flexibility in terms of production and design... Let me say first that we still try to produce the most complicated parts internally on an order, depending on our production limits. The second choice is to produce as many parts as possible. Knowing that we can do more things gives us more freedom, knowing that we won't need so many suppliers, with whom, let's say... we must argue on how much to produce, when, for how much and so on, giving up control of timing and quality*". Enterprise Lecco 15 medium

Following this perspective, the new emerging paradigms will strengthen the process of industrial district firms' dimensional growth already in place. However, it is essential to bear in mind that small enterprises' value creation is based on exploiting the economy of scope linked to specialized know-how and developing complex external relations to integrate it in border value chains. In this context, the possibility to accomplish a broader range of processes with the same fixed asset makes the specialization domain more flexible. In other words, more flexible machinery makes it possible for small firms to apply their distinct know-how to a broad range of activities.

18 "*Thanks to the new machines, we have taken on contract work, increasing our offer, but always within a niche. Wherever there is something that creates a problem with placements or materials, we apply for the job, it's like self-harming come up with it, we harm ourselves*". Enterprise Lecco 11 small

In this perspective, the integration in local value chains would be less related to the development of co-specific fixed assets and more to the complementary knowledge and know-how. This enables the possibility of micro-firms remaining an essential part of local value chains based relative to the value of their competence.
The integration process of ICT firms in manufacturing local manufacturing value chains and the recombination of productive networks more based on knowledge and know-how complementarities blur the traditional distinction between industrial districts and high-tech clusters. This process may represent the industrial district's peculiar response to the shift from replicative manufacturing towards innovative manufacturing at the fourth industrial revolution base.

6.4.3 Different governance, different challenges

As we have seen in the central part of this chapter, despite the differences between the two cases, they have experienced a similar pattern of diffusion and adoptions. They are also facing the same challenges to undertake a true process of versatile integrations as the difficulties in exploiting the DUI model of learning and in integrating ICT KIBS providers in their local regulative frameworks. However, until now, the analysis of the difficulties in establishing a versatile integration process has concerned the relations among strictly economic agents and manly firms. It is important to understand that industrial districts versatile integration is a complex dynamic that is only partially covered by these kinds of interaction and their externalities. To simplify the issue is possible to distinguish versatile integration processes involving only local strictly economic actors and those concerning the local community in a broader sense. The former see industrial districts as cognitive and regulatory machines that tank shared standards, rules, and entry conditions to enforce the system's efficiency both from an economic and knowledge integration perspective. This contributes to enriching local division of labour and, in this way,

establishing a reliable regime for sharing knowledge among the various actors involved in local productive activities. The resulting effect is that each agent belonging to the local system earns improving returns on his investment in knowledge. Follows these views are contexts where actors take advantage of their cognitive, social and physical proximity to generate an efficient "division of labour" in the production of local knowledge and use of external one (Rullani, 2003). However, the possibility of integrating external codified knowledge and local contextual one (versatile integration) also involves processes, too often neglected, that concern the local economic community in a broader sense. These processes are based on the possibility to create multi actors cooperation platforms to underpin common projects of local developments. From this perspective, the Industrial districts are institutional fabric able to provide collective local goods for competitiveness through collective actions of networks of organizations. At the base of these generative mechanisms, there is the local actors ability (explicitly or implicitly) to recognize the existence of shared values and common interests, and regulation takes place through forms of governance rather than the government (Pichierri, 2002). This implies that the versatile integration involves and is underpinned by the actions of different actors as sections of regional government and of other local authorities, associations representing special interests, research institutes in addition to individual enterprises. These enlarged actors networks through voluntaristic local concertation activities can provide useful regulatory frameworks and local collective goods to mitigate the difficulties of the local economic environments. To clarify how versatile integration is a process that involves different actors and not only local enterprises can be used the study of Capecchi on the relevance of local technical schools in the development of mechanical industrial districts (Capecchi, 1990). These technical schools have played a pivotal role in adapting existing technologies to the local production needs, generating local innovation processes. According to the author, the training of a group of technicians, albeit limited, in which professional know-how learned at school and experience acquired on the job is combined represents one of the peculiarities of the flexible specialization system reproduction (Capecchi, 1996).

There is an extremely useful example of how a local system in a broader sense can display instruments to enhance the versatile integration process. In the context of industry 4.0 spreading, the creation of new forms of training by local institutions can mitigate the problems related to the traditional districts DUI learning model in dealing whit the new technological paradigms.

To better understand how the two different models of local governance raise different challenges and advantages, it may be useful to recall some theoretical elements discussed at the beginning of this work. In the first chapter (Section 1.1.2), a dynamic model of the relation between local economies and local governments was introduced. Three elements need consideration in order to understand how the two districts' governance models affect the local adjustment in response to the fourth industrial revolution. First, only some enterprise needs can be resolved effectively through the market and social interactions with other local firms. Second, in the presence of formal local governance, firms can exercise a *voice* in order to solve these problems through the provision of needed public goods for competitiveness or other local institutional comparative advantages.[45] Also, in the case of informal local governance based on community regulation, a similar dynamic is still possible. Indeed local economic actors can undertake concerted actions in order to provide a response to new local needs. However, it should be noted that concertation is easier in local systems already characterized by a formal governance model and that the concertation itself leads to a higher level of institutionalization of local regulation activities. Third, local governance can act as an institutional entrepreneur focusing on and fostering territorial economic adjustments. These three elements generate important local adjustment dynamics based on feedback effects.

Local governance in both the cases considered here has played a relevant role in fostering the adoption of industry 4.0 technologies at the local level. In the Lecco metalworking district, it is easy to identify the role of local governance in fostering

[45] These included, for example, suitable skill formation institutions for the labour force or information about potential productive partners (both from a reputational and technical point of view).

territorial adoption. Indeed territorial actors, both separately or through multi-actor platforms, have displayed direct and conscious actions, such as conferences to spread awareness, technological transfer services and training institutions to foster technological adoption at the local level. In fact, it is more difficult to detect these 'entrepreneurial' actions in the case of informal governance of the tap and valve Bogomareo district. Nevertheless, even if not based on direct and voluntary actors' initiatives, the informal model of governance also provides relevant incentives for technological diffusion. Indeed, industrial districts are a favourable environment for innovation adoption not only for social reasons, related to relational networks, and for economic reasons, related to the divisions of labour, but also for normative reasons. Work ethic, social status and professional reputation are all important social forces orienting local actors' behaviours and consequently explaining the emergence of both innovation leaders and followers. However, although both types of governance show the ability to foster new technology adoptions, they display a very different ability in terms of providing a response to emerging local needs. This difference is particularly evident in how the two local economies face the rising problem of the lack of a skilled local workforce regarding industry 4.0. While Lecco's governance system has started to address the issue over the past few years, the local systems in Borgomanero have only recently begun to organize collective action in this sense. Moreover, tap and valve areas do not have previous organizations or local decisional platforms, which can be used as an initial reference point for this initiative. The presence of local appropriable social organizations was one of the primary forms of social capital identity by Coleman (one of the most important sociologists to have addressed this social phenomenon) (1994).

From the fieldwork, it becomes clear that formal governance shows a greater capability to establish positive feedback effects for entrepreneurial anticipatory activities and in responding to the local economy's new needs, to the creation of which they have contributed. This dynamic is particularly evident in the words of the directors of one of Lecco's business associations about the project for district internationalization, the strategy identified by local governance to overcome the great recession of 2008.

20 "*Ten years ago we created a structure to develop foreign markets, so we have (hired) export managers, professionals who work as accounts for us, we make them work alongside companies on a model of activities that private individuals used to provide but that we have made an internal structure of the company.... Many firms didn't even have a website, not even a page in Acrobat with a description of their services: the only thing they had to advertise their companies were paper catalogues, which were of no use except to at trade fairs... Or they go to visit a client, but normally they are all dedicated to their work and never leave the factory... we have provided this kind of support and have had tremendous, unforeseeable success because we provide it at costs that, I'd say, are below the market. This is very much appreciated by companies. It is a very practical and very operational support that then allowed us to develop other underlying activities. In addition to this type of activity, we have also provided supports because while we've been working with companies on this type of demand, other requests have arisen, for example regarding international contracts, customs issues, etc...*". Business association 17 Lecco

21 "*We have an obligation to anticipate the needs of businesses, because everything we have created on the basis of these needs is good and works... This does not exclude, indeed, it is our main duty, to be one-step ahead of these demands, and in different areas at different times and in different situations, we have also experienced it. We have tried to do this, for example, with the dynamics linked to foreign countries... but now even more so, in the field of technology, at the beginning in a more uncoordinated way but now co-ordinately*" Business association 18 Lecco

These feedback dynamics based on institutional entrepreneurial anticipatory activities, aggregation and response to the new local economy needs represent a local development translation of the general theory of an institutional adaptive regime as proposed by Streek and Thelen (2005) and discussed in the first chapter (Section 1.1.3). Despite Lecco's local governance capability to provide strategy and direction to local development and be responsive to new emerging problems, however, local enterprises benefit in a disproportional way regarding public goods for competitiveness and services provided. More precisely, medium-size firms seem

more able to take advantage of these opportunities. Once again, a clear example comes from the ability to acquire skilled workers.

22 "*I wouldn't say that the lists of technical institutes are stuck, but almost; there is a race to get young graduates from technical high schools or universities and, frankly, a more structured company is more attractive. I've had contact with some people but they prefer to work in more structured situations. Enterprise 16 Lecco small*
Now, in a co-ordinated way, we have proposed some meetings where few companies come, because the topics dealt with are not avant-garde, but perhaps they are a little bit too ahead of their time and so do not arouse mass interest, but with the companies that do come, we try to trigger processes of inquiry on which projects can then be built". Association Lecco 17

Thus the presence or absence of formal local governance and institutions is not the only factor to consider when evaluating a local economy's ongoing technological and economic adjustment. Locally, the actual changes of institutions provide different opportunities and risks for economic development. To better understand this point, it can help to recall the Bathelt and Conserva (2018) model for these double-adaptive dynamics, where industrial change can influence or trigger institutional adjustments and vice versa.

Table 25. Regional adjustment paths

Regional restructuring scenarios		Adjustments in the local institutional context		
		Persistence	Hybrid change	Fundamental change
Adjustments in the local industry and corporate structure	Persistence	- Loss of corporate competitiveness - No effects of regional learning - Regional decline 1	-Institutional stimulus unsuccessful -Stagnation of regional learning base 2	New institutions do not match Loss of regional learning base Regional crisis 3
	Change	-Limited new learning patterns develop -Hollowing out of regional learning platform -Slow regional change 4	-New and old industries integrated in new and established learning cycles -Growth in global economy consistent with localized learning 5	-New industries supported by new institutions -Established industries left behind -Bifurcated regional structure 6

Source: Bathelt and Conserva (2018).

In the cases of both Lecco and Borgomanero, the local industrial landscape appears to embrace a path of technological changes, which is a clear hint that the two districts are undertaking attempts to avoid local lock-in and the consequent decline. However, the local institutional contexts reveal different degrees of change. A persistence of traditional informal regulation characterizes the Borgamanero case, while in Lecco, local governance actors seek a new path of development to address the challenges of the fourth industrial revolution.

Both cases may aspire to reach the situation described by quadrant 5 (Table 3), representing the best possible outcomes. In this situation, congruent productive and institutional change in local economies will generate a territorial environment particularly favourable to versatile integration processes. This, in turn, will facilitate the faster adoption of 4.0 technologies and better integrate them into the local context and consequently promote innovative local capacity-building.

However, to achieve this change, the two districts will need to follow two different paths. In the case of Borgomanero, the main challenge is to create a more formal and

institutionalized model of local governance able to create a shared view of development among relevant local economic agents and provide congruent collective goods for competitiveness. In the metalworking district, the successful economic change is related to how much effective and inclusive local governance intervention will be.

Different risks also characterize these two different paths. In the case of Lecco, the major threats are represented by the possibility that the local change will result in the situations described by quadrants 3 and 6 (Table 25). These situations are generated by a mismatch between new local institutions, public goods for competitiveness and the local production systems. In the case of quadrant 3, the misalignment is total, and, consequently, new local institutions fail to trigger an adjustment of local enterprises. In the scenario described in quadrant 6, on the other hand, new institutions effectively underpin local productive changes.

Only some local enterprises will be able to exploit the new opportunities offered by local governance, however. This will vary according to differences in internal knowledge, technical and financial resources and lead to a separation of the local economies into two segments. One will be better equipped to take advantage of the contextual externalities, and the other will be left behind, faced with increasing challenges to profit from the new institutional environments.

In the Borgomanero tap and valves district, with its absence of a formal governance body, the possible risks cover all negative outcomes, as shown in Table 25. Nevertheless, the more concrete likely adverse outcomes are those described in quadrants 4 and 2 (Table 25). In the first case (quadrant 4), the district fails to create a governance platform able to define common projects, thus creating voluntaristic forms of local social capital. Despite this, informal social relations and the cooperative culture of traditional areas may partially compensate for the lack of adequate local governance. However, this outcome will lead to a slow change of productive territorial landscape and a high risk of erosion and obsolescence of the local knowledge base.

The possible outcomes described by quadrant 2 express the exact opposite situation, where even if the districts do manage to display a more institutionalized and formal

local governance, new actions and intuitive fail to produce significant effects in fostering local industry's technological and organizational adjustment. This outcome will be particularly harmful, resulting in a stagnation of local economies and, consequently, a decline that undermines territorial industrial resilience.

6.5 CONCLUSION

This chapter's qualitative analysis has shed light on an important aspect of industrial districts' relations and the Fourth Industrial Revolution. First, the Italian 4.0 policy appears to have played a significant role in fostering the adoption of Industry 4.0 in the two cases. However, it was possible due to the contribution of local government actors and territorial social externalities, which traditionally characterized industrial districts. In this view, the central policy provides resources that are activated because of specific territorial dynamics. These dynamics can be traced back to the importance of different institutional levels in focusing on and adjusting to the local context of the general technological trajectory discussed in Chapter Four. However, despite the possibility of determining relevant local adjustments, which are both internal (e.g. acquisition of new technological competencies) and external (e.g. adjustment of local productive networks and service providers' involvement), significant challenges still exist. On the one hand, industrial districts present advantages, which can facilitate digital transformation, particularly in the initial introduction and testing phases. These advantages can be linked to clusterization dynamics such as the knowledge spillover mechanisms, agglomeration economies and externalities. Alternatively, they can be connected to particular social factors as favourable, stabler and less uncertain environments of trust and cooperation. On the other hand, the mechanisms that generated systems' external economies of social matrix, supporting industrial districts incremental technological adaptation and local economic adaptability, are no longer sufficient to ensure a successful and versatile integration process. Indeed, involuntary forms of local social capital, on which semi-automatic socioeconomic district reproduction is based, are challenged by radical technological changes. These limitations have

two implications. First, the possibility of specialized local clusters participating in the Fourth Industrial Revolution's technological trajectory is related to collective and public efforts by institutional bodies at every level, namely, international (EU policy), national, regional, and local (Bellandi, Chiaminade, & Plechero, 2020). Second, these efforts cannot be effective without the simultaneous activation of local resources and new forms of territorial embeddedness and rerouting. Indeed, to take part in the Fourth Industrial Revolution, local economies, as discussed in Chapter Four, must accomplish the following processes:

a) acquisition of at least part of the established paradigm's technological cluster, b) adaptation to the local context's production and problem-solving activities and c) development of innovation capabilities with a certain degree of integration concerning the paradigm's technological trajectories (Dosi, 1982).

As shown in this chapter, the Italian national 4.0 policy on local governance and territorial social externalities has fostered the first of these steps. However, the fieldwork revealed significant challenges in the realization of the two other processes. Difficulties in the relationship between manufacturing SMEs and ICT firms, the need to introduce a new knowledge base at the firm and local levels, and the modification of the division of labour in local value chains, are all factors that introduce challenges in the traditional model of versatile integration. Despite these, as shown in Chapter Three, industrial districts have already embraced a path of territorial manufacturing servitization in post grate recession periods. This process in industrial districts is based on strengthening the productive relationships between ICT service and manufacturing firms and, in the long run, can lead to the higher local embeddedness of ICT firms in industrial districts' social dynamics. These service providers' local embeddedness would partially solve both economic interaction problems with manufacturing SMEs and integrate Industry 4.0's abstract and codified knowledge at the local level. However, a local adjustment that is successful in facing the challenges brought about by the Fourth Industrial Revolution appears difficult to achieve without comprehensive and robust action by formal and institutionalized local governance, which can identify a new local

development path. A path of development that is inclusive of new and relevant economic actors, such as KIBS enterprises, and more traditional ones, such as small manufacturing family firms, creates relevant public goods for competitiveness, such as the formation of new skills in the labour force and effective technology transfer agency. The complexity of Industry 4.0 requires a combination of traditional mechanisms with innovative ones within industrial districts, characterized by the emergence of new players, activities and resources.

7 CONCLUSION

This thesis aims to understand the changes that industrial Italian industrial districts have experienced since their economic recovery from the 2008 Recession or the Great Recession and how they are facing the new challenges linked to the Fourth Industrial Revolution. Consequently, it is unavoidable to explore how the diffusion of the Industry 4.0 technological paradigm has affected specialised manufacturing clusters. The starting point to shed light on this issue is to address the relevance of industrial districts in the Italian economy nowadays. A study on manufacturing territorial clusters of SMEs questioned whether this peculiar local economic model may still represent a valid path of local development and, more generally, clarified the role of manufacturing activities in Western developed countries. The results of this study show that manufacturing, in general, and industrial districts, in particular, continue to be remarkable sources of both jobs and economic dynamism, especially in relation to export sectors. However, although the role of industrial districts in the Italian economy has been established, they have undergone remarkable changes during the 2008 Great Recession recovery period. These changes involve both territorial articulation and reforms in internal structure. Indeed, the results obtained redefine the traditional regional borders of the industrial district model, which has moved its fulcrum from southern Third Italy (Emilia Romagna and Tuscany) towards Lombardy. Moreover, the economic landscape of Italian districts nowadays appears to differentiate into two models. The first one remains linked to traditional made in Italy sectors and displays an employment structure still based on micro and small firm occupations, which characterise central regions. By contrast, in northern regions (namely, Lombardy and Veneto), a new model focused on metalworking sectors and on the greater importance of occupation in medium-size firms is emerging. Despite regional differences, this transformation in occupational structure represents a general process involving industrial districts as a whole. However, the loss of employment in microenterprises in favour of growth in medium- and large-sized companies is

only an aspect of a more complex industrial district's economic adjustment. The analysis conducted in the third chapter shows how local economies have undertaken a more radical transformation process related to territorial manufacturing servitisation processes (Lafuente, Vaillant, & Vendrell, 2019). At the local level, this transformation sees the replacement of manufacturing micro and small enterprises with KIBS sectors. However, it should be noted that the most interesting result obtained concerns the way in which these processes of territorial manufacturing servitisation assume different dynamics and forms according to the territorial context involved. In fact, if in local economic systems, metalworking companies have benefits in being placed with companies in KIBSs but not with ICT companies, the exact opposite occurs in districts. The fact that manufacturing companies benefit from the local presence of a network of small ICT companies but not from other advanced services is consistent with the case study results. The districts offer an answer to many of the needs of companies usually satisfied by KIBSs through social dynamics different from those of the market. However, the fieldwork shows how important it is for districts to integrate ICT companies into local production networks in order to compensate for the lack of internal resources of manufacturing SMEs. These territorial dynamics are the basis of the greater ability of district companies to adhere to the Italian 4.0 plan, which is an important indicator of the absorptive capacity of new technologies linked to the Fourth Industrial Revolution by these local economies. Despite districts' greater ability to adopt Industry 4.0 technologies, the comparison of the two cases has revealed that difficulties in activating true and proper versatile integration processes, especially without formal local government support, remain for industrial districts. Indeed, the semi-automatic integration processes linked to district dynamics do not seem to be able to guarantee the autonomous integration of the principles and abstract knowledge of new technological paradigms.

These findings contribute in many ways to both the local development field of study and to the enquiry on 4.0 industry technological changes.

7.1 NEW INSIGHTS INTO AND OLD CONFIRMATIONS ABOUT LOCAL DEVELOPMENT

The thesis uses recent data to propose a broad empirical analysis of the panorama of Italian industrial districts. Therefore, this is a useful analysis to account for the structural changes affecting the Italian district system as a whole. However, this work's contribution is not limited to re-proposing an analysis of a new, updated database. As far as we know, this is the first study to provide an empirical confirmation of territorial manufacturing servitisation processes.

The hypotheses of territorial manufacturing servitisation formulated by Sforzi and Boix (2019) were tested together with other endogenous local development factors identified in the literature, such as production specialisation and the degree of related variety (Boschma & Frenken, 2009). This analysis highlights important new elements, such as the different effects of specialisation and a variety of resources on firms of different sizes or the role played by KIBSs in the dynamism of local economies. Moreover, the fact that even controlling for all these factors operating within the districts entails a remarkable competitive advantage underlines the importance of the contributions of a sociological approach. Indeed, it provides a profound interpretation of socio-institutional dynamics to understand local development phenomena. In other words, the study of local economies cannot be reduced to a mere analysis of sectoral structure variables. Lastly, this work demonstrated the effectiveness of multilevel regression models in the study of territorial economies. This type of analysis has two advantages. The first concerns the possibility of disentangling the effects determined by the characteristics of individual firms from those that have a true contextual nature. The second is that it allows us to understand the different effects of these contextual variables according to enterprise characteristics.

7.1.1 New perspectives on Industry 4.0 adoption

This thesis focuses on the largely neglected geographical dimension and meso-level analysis of Industry 4.0. Thanks to an original dataset, it was possible to perform one of the first quantitative studies regarding the terrestrial articulation of Industry 4.0 adoption. It should be emphasized that the observation was indirect, in fact, to remedy the lack of data, the adherence by companies to the policy that incentive the investment in enabling technologies was used as an indicator of the spread of industry 4.0. This solution is satisfying as, on the one hand, it represents a good indicator of technological diffusion. On the other hand, it allows us to show how the different local realities show different abilities to seize central policies' opportunities. However, the contribution of this work is not limited to a quantitative analysis, which demarcates a phenomenon's boundaries. The thesis proposes a mixed-methods approach that integrates quantitative variable-oriented and qualitative case-oriented approaches on the basis of sequential logic (Johnson, Onwuegbuzie, & Turner, 2007). The collection and elaboration of quantitative data represent the basis for a deeper qualitative analysis that concerns less codified variables and complex local dynamics. Indeed, the comparative case study allowed us to provide an answer to the hypotheses generated by the quantitative findings, making it possible to better identify the social mechanisms at the base of the greater absorptive capacity of the district context. This empirical step has also made it possible to identify the opportunities and challenges that the Fourth Industrial Revolution poses to specialised SME clusters and how the spread of Industry 4.0 may change the classical productive relations that characterise industrial districts. To sum up, this work contributes to the emerging debate on Industry 4.0 in three main aspects. First, it queries how the introduction of Industry 4.0 involves Italian territorial realities in different ways. Second, it provides important insights into which territorial relations have fostered the spread of this technology in the industrial district context. Finally, it shows how the introduction of such technologies has blurred the typical distinction between high-technology and specialised manufacturing clusters.

7.2 RESEARCH LIMITATIONS AND IMPLICATIONS FOR FURTHER RESEARCH

All studies have limitations and pose new questions that are mainly left unresolved, and this thesis is no exception. The present study's first and most significant limitation is a direct consequence of a precise theoretical, empirical, and metrological positioning. Indeed we focused on the endogenous factors of local economies' development. Consequently, this work does not address relevant issues linked to extraterritorial relations and exogenous local development drivers. Several studies have shown that external resources play a major role in the process of economic adjustment and as sources of valuable knowledge (Belussi, 2015; De Marchi, Di Maria, & Gereffi, 2017; De Marchi, Gareffi, & Grandinetti, 2017). As our findings have highlighted that Industry 4.0 brings new difficulties in integrating local contextual knowledge into the external technical one, investigating the role of external relations and extraterritorial links in these processes is a particularly promising research line. A second major limitation that characterises this study is related to the lack of data and the poor data quality. Because of difficulties in retrieving data, it was impossible to perform a longitudinal analysis, which is a helpful method for identifying local economies' evolutive trajectory. Many scholars have claimed the importance of using this kind of analysis for local development studies to understand better the successful and unsuccessful path of local socio-economic transformation (Asheim, Smith, & Oughton, 2011; Boschma & Frenken, 2006; Martin & Sunley, 2006). Moreover, the lack of detailed data has made a more accurate exploration of Industry 4.0 implementation impossible. The availability of more precise data would allow further investigations into how different firms in terms of sector, dimension and location may follow a different path of implementation, involving different Industry 4.0 enabling technologies.
The findings of this research introduce four relevant new lines of enquiries:

Changes in the configuration of local production networks

Both the territorial servitisation process and the implementation of Industry 4.0 technologies are leading to local productive network reshaping. Deepening our knowledge of the interplay between manufacturing SMEs, ICT firms and other KIBSs at the local level would be helpful to investigate further the evolution of the local relations between these actors. A study based on network analysis would be especially beneficial to understand how economic and technological changes affect the composition and the integrating principles of local value chains.

Local embeddedness of ICT firms

The research findings have clarified the increasing importance of ICT firms in industrial districts' economic dynamism. However, at the same time, the market relations between ICT firms and manufacturing SMEs appear particularly problematic. Indeed, the cognitive distance between such two firm categories creates significant information asymmetries, making it difficult for small manufacturing firms to effectively take advantage of ICT market opportunities. The possibility of regulating the economic interaction and coordination between actors through social mechanisms is one of the pillars of a sociological understanding of local economies. Following this perspective, a higher level of local ICT firms' territorial embeddedness can solve the problematic relations between them and SMEs. A research effort to understand how local social aspects, such as local institutions, generalised local trust and reputational mechanisms, affect ICT market relations and behaviours would be essential to territorial servitisation and Industry 4.0 diffusion studies.

The importance of medium-sized enterprises in industrial districts

This research clarifies that medium-sized enterprises have started to increasingly become relevant actors in district realities not only in employment terms. They appear more able to take advantage of local externalities. At the same time, their performance is affected more by territorial sectoral-related variety than by simple specialisation. These findings have two significant implications for studies of industrial districts. First, it would be appropriate to rethink the standard

quantitative method for identifying industrial districts. It is possible that industrial districts, or at least some of them, will experience in the near future a significant shift in employment structure from being micro-firms to being medium- and large-sized firms. The identification strategy commonly used classifies districts as only local economic systems whose main activity (more than 50%) is carried out by micro and small enterprises, and there is the risk that this method will soon be obsolete. The problem is not only methodological but also theoretical. Whether an industrial district, in which most of the jobs come from medium-sized firms, loses its characterisation from a qualitative point of view is also worth examining. The second relevant implication is the role that medium-sized firms play in local governance, both directly or by influencing other relevant local actors' actions, such as by creating new local goods for competitiveness. Indeed, studying how local governments, business association trade unions and local smaller firms are affected by the local presence of medium/large enterprises can significantly reshape the theoretical understanding of industrial districts.

Relationship between local economies and regional innovation policy

One of the most relevant results of this work is determining how local governments and local collective actors played a relevant role in fostering district firms' participation in the 4.0 Italian policy. In a certain way, the central state's actions provide resources for local actions. Following this reasoning, a similar dynamic between local economies and regional industrial and innovation policies is conceivable. Moreover, as the regional and local levels are more socially, economically and politically close, it is possible to imagine the greater capacity of relevant local production systems to influence regional policies. Thus, we can expect valuable feedback to define and implement regional interventions that will strengthen innovation and the local economy. Examining these kinds of relations across different levels of governance would be an important contribution to the field of regional innovation systems (Asheim & Coenan, 2006).

To conclude, more research efforts in the directions discussed would provide vital knowledge to formulate more conscious and inclusive innovation policies. A deeper understanding of these territorial socio-economic dynamics will help define and implement public intervention at all territorial levels. These contributions are precious in a historical time like the one we are currently in, which is characterised by disruptive technological changes.

APPENDIX A

Quantitative strategy for the identification of industrial districts on ISTAT ASIA 2017 data, consequential steps

Step 1 Identification of predominantly manufacturing LLSs

For each of the 610 local labour systems (LLSs) the LQ employment index is calculated for each of the economic activities that compose the productive sectors of industry and services:

Productive sectors	NACE code
Agriculture	01, 02, 03
Mining industry	05 -09
Manufacturing industry	10 -33, 383, 581
Construction	412, 42, 43
Business services	61, 521, 582, 62, 631, 64, 662, 663, 69 - 73, 741, 743, 749, 773, 78, 80, 821, 941, 9511
Consumer Services	411, 55, 56, 591, 59203, 60, 68, 742, 772, 79, 811, 90, 92, 932, 96 -99
Social services	37, 381, 382, 39, 65, 75, 85 -88, 91, 931, 949
Traditional services	35, 36, 45, 463, 464, 467, 469, 47, 491-493, 495, 50, 51, 53, 61 , 774, 822, 84, 942

For LLSs that have index values higher than 1 in manufacturing or business services or consumer services, the sector of prevalence is calculated in order to verify which of the three aggregations of economic activities prevails at the level of SLL:

$$\left[(LLS_{emp,nace}/ITA_{emp,nace}) - (LLS_{emp,tot}/ITA_{emp,tot})\right] * ITA_{emp,nace}$$

Were:

$LLS_{emp,\ nance}$ = employees of a single economic activity in a local labour system

$ITA_{emp,nace}$ = employees of a single economic activity in Italy

$LLS_{emp,tot}$ = Total employment in a local labour system

$ITA_{emp,tot}$ = Total employment in Italy

The highest value (basic employment) in one of the economic activities (manufacturing, business and consumer services) indicates sector prevalence. When in an LLS this value corresponds to the manufacturing industry, the LLS is considered mainly manufacturing.

Through this procedure, it is possible to identify 230 predominantly manufacturing LLS.

Step 2 Identification of predominantly manufacturing SLLs of SMEs

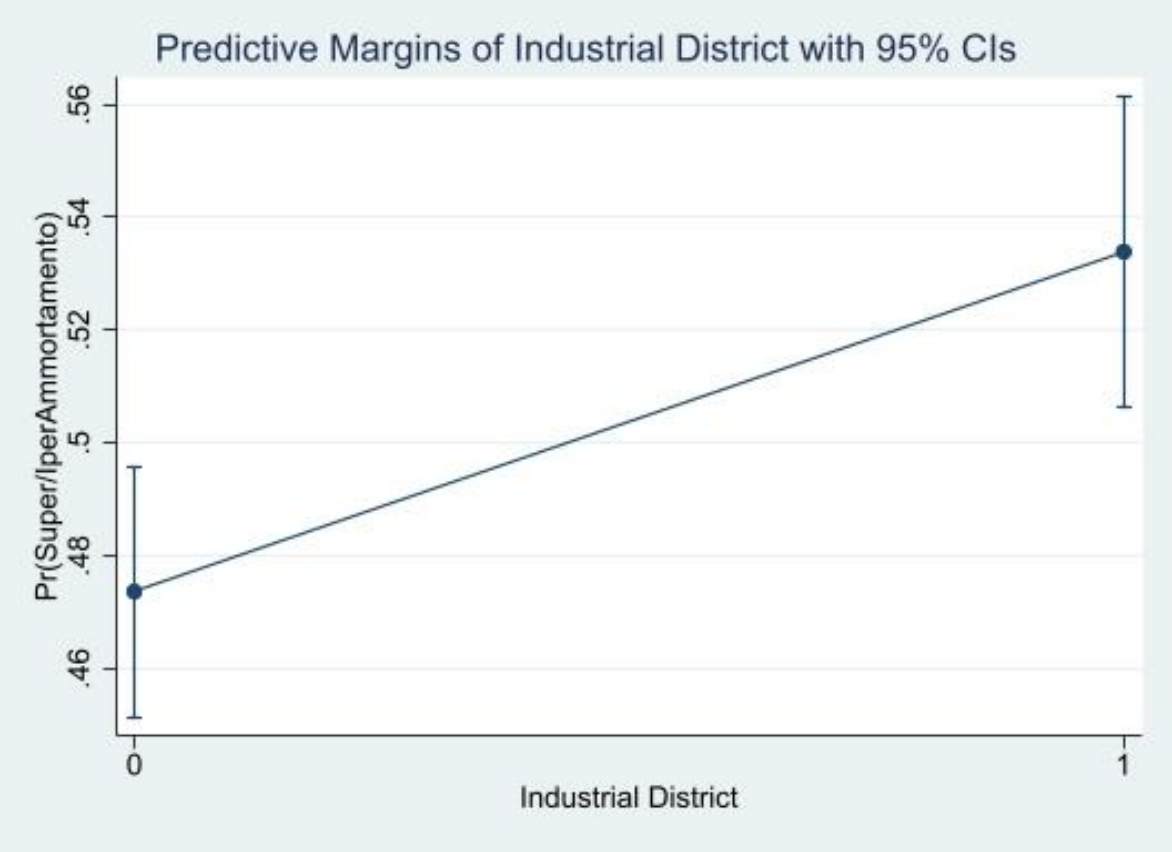
For each of the 610 local labour systems (LLSs) the LQ employment index is calculated for each enterprises' dimensional class, micro (0-9 employees), small (10-49) employees, Medium (50-249 employees) and Large (250+ employees). The highest value in one of the three classes of employees (micro, small and medium) defines a predominantly manufacturing LLS of small and medium-sized enterprises (SMEs). In Italy, there are 167 predominantly manufacturing LLSs of SMEs and 63 predominantly manufacturing LLSs of large enterprises.

Step 3 identification of industrial district

In this thesis are considered industrial districts 167 predominantly manufacturing LLSs of SMEs, already identified as industrial districts in the 2011 census. Following this method, it was possible to identify 122 industrial districts in 2017.

APPENDIX B

As an additional robustness check, we have predicted margins for industrial district variable to control if there is an overlap of confidence intervals



Give the characteristics of the model is not important to evaluate the overall model fits but only the increase of Likelihood obtained by adding the dichotomous variable Industrial district, the only variable of interest not included in the Coarsened exact matching procedure (CEM command on Stata) (Blackwell, Iacus, & King, 2009). To do this, two logistic binomial regression models are estimated, one whit all the variables selected (full model) and one with the same variables except industrial district (control model). This gives the possibility to use the Likelihood-ratio test to control if the addiction of the industrial district variable increases the overall Likelihood significantly.

	Full model b/se	Control model b/se
Super/Iper Ammortamento		
Metalworking = 0	0.0000	0.0000
	(.)	(.)
Metalworking = 1	0.0134	0.0142
	(0.0718)	(0.0716)
EBITDA euros	0.0000	0.0000
	(0.0000)	(0.0000)
N. employees 2017	-0.0002	-0.0002
	(0.0006)	(0.0006)
Average R&D expenditure 2012-17	-0.0000	-0.0000
	(0.0000)	(0.0000)
Average increase of assets 2012-17	-0.0000*	-0.0000*
	(0.0000)	(0.0000)
North West	0.0000	0.0000
	(.)	(.)
North East	0.0845	0.0996
	(0.0844)	(0.0841)
Center	0.0516	0.0584
	(0.1065)	(0.1063)
South	0.0638	-0.0050
	(0.1212)	(0.1192)
Islands	-0.3594*	-0.4603**
	(0.2171)	(0.2149)
Industrial district = 0	0.0000	
	(.)	
Industrial district = 1	0.2426***	
	(0.0741)	
Constant	-0.1500*	-0.0496
	(0.0780)	(0.0716)
Observations	3282	3282
r2		
chi2	27.48	16.74
p	0.00219	0.0530
r2_p	0.00604	0.00368

Likelihood-ratio test LR chi2(1) = 10.74

(Assumption: control model nested in full model) Prob > chi2 = 0.0010

APPENDIX D

Respondents summary:

interwied ID number	Location	typology of organization	Dymension
1	Borgomanero	Entrprise	medium
2	Borgomanero	Entrprise	Medium
3	Borgomanero	Entrprise	Medium
4	Borgomanero	Entrprise	small
5	Borgomanero	Entrprise	small
6	Borgomanero	Entrprise	medium
7	Borgomanero	Entrprise	small
8	Borgomanero	Busuness oraganization	-
9	Borgomanero	Busuness oraganization	-
10	Lecco	Entrprise	medium
11	Lecco	Entrprise	small
12	Lecco	Entrprise	medium
13	Lecco	Entrprise	small
14	Lecco	Entrprise	small
15	Lecco	Entrprise	medium
16	Lecco	Entrprise	small
17	Lecco	Busuness oraganization	-
18	Lecco	Busuness oraganization	-

Interview guide

Numbers identify main questions that are always asked; bullet points identify accessory questions asked if necessary and function as a main topic trace for the interviewer.

1) Mi parli dell'andamento della sua azienda in questi ultimi anni.

2) Invece per quanto riguarda in generale le altre aziende del territorio?

3) Oggi sono più importanti i rapporti con aziende locali o estere?

4) Operare in questo territorio vi dà dai vantaggi competitivi?

- La forza lavoro qualificata proviene dal territorio?
- Operare in questo territorio facilita in qualche modo lo sviluppo di nuovi prodotti o l'introduzione di nuove tecnologie? Ad esempio con l'interazione con altri imprenditori locali e il sostegno da parte delle associazioni
- Operare in questo territorio secondo lei fornisce accesso a informazioni utili per quanto riguarda nuove opportunità di mercato (in particolare riguardo i mercati esteri)?

5) Che tipo di rapporto ha con le altre imprese della zona?

- Che rapporto ha con i fornitori locali?
- Che rapporto ha con le aziende di cui è fornitore?
- Intrattiene rapporti con gli imprenditori locali con cui non a relazioni commerciali?
- Per quanto riguarda servizi avanzati e aziende high-tech come cambia la relazione rispetto alle aziende del settore manifatturiero? Queste aziende con cui è in relazione dove sono situate?

6) Invece con le imprese non del territorio ha rapporti significativi oltre al semplice compra-vendita?

- Le aziende che non sono del territorio e con cui intrattenete rapporti, che tipo di aziende sono?

7) Cosa significa secondo lei industria 4.0?

8) Cosa significa industria 4.0 per la sua impresa?
- Che tipo di tecnologie sono state introdotte?

9) Come siete arrivati alla decisione di investire in 4.0?
- Che ruolo hanno ricoperto gli sgravi fiscali?
- L'adozione è avvenuta a seguito dell'introduzione da parte di altre imprese con cui ha rapporti strategici di lunga durata? Sono imprese del territorio?
- Che ruolo hanno ricoperto gli sgravi fiscali?
- Ha ricevuto informazioni da parte di associazioni datoriali?

10) In che modo vi siete preparati all'investimento per quanto riguarda le risorse interne? Ad esempio assunzione di nuovi profili, investimenti in formazione…ecc ecc.

11) Come è cambiata l'organizzazione dopo l'investimento? Ad esempio nuove funzioni e mansioni.
- Sono state reperite all'interno o all'esterno del territorio?

12) Vi siete appoggiati a risorse esterne per la fase di definizione e implementazione dell'investimento?
- Sono risorse del territorio o esterne al territorio?
- Dove avete raccolto le informazioni e come avete individuate le tecnologie
- Siete stati aiutati da risorse esterne nella fase di implementazione

13) A seguito dell'investimento avete stretto rapporti continuativi con aziende di beni e servizi di tipo differente rispetto al passato?

- Sono aziende sterne o interne al territorio?
- In questa domanda verranno segnalate le imprese che producono i macchinari, interessante è stabilire se si tratta di nuove reti strategiche

14) L'implementazione di queste tecnologie come ha cambiato l'organizzazione interna dell'impresa (in temini di organizzazione della produzione, di rapporti di lavoro, ecc.)?

15) Siete membri di un'associazione territoriale?

16) Questa associazioni ha giocato un qualche tipo di ruolo nella vostra scelta di investire?

17) Mi parli del vostro rapporto con i sindacati
- I sindacati sono interni o locali?

18) Il sindacato interno in che modo ha accolto l'introduzione delle nuove tecnologie?

19) Le amministrazioni locali di Comune e Provincia offrono qualche tipo di sostengo alla diffusione di queste tecnologie?

20) Accanto ai più tradizionali rapporti produttivi secondo lei è diventato più importante stringere rapporti con Università, centri di ricerca o più in generale con diffusori tecnologici?

21) Come giudica gli interventi del governo in materia di 4.0?

22) La regione Piemonte/Lombardia sta secondo lei in qualche modo incentivando la diffusione di queste nuove tecnologie?

English translation:

1) Tell me about your company's performance in recent years.

2) And, more in general, what about other companies in the area?

3) Which are more important these days: relationships with local or foreign companies?

4) Does operating in this territory give you competitive advantages?

- Does the qualified workforce come from the area?
- Does operating in this territory facilitate in any way the development of new products or the introduction of new technologies? For example, through interaction with other local entrepreneurs and support from associations.
- In your opinion, does operating in this territory provide access to useful information regarding new market opportunities (in particular foreign markets)?

5) What kind of relationship do you have with the other companies in the area?

- What is your relationship with local suppliers?
- What is your relationship with the companies you supply?
- Do you have relations with local entrepreneurs with whom you don't have business relations?
- With regard to advanced services and high-tech companies, how does the relationship change if related to companies in the manufacturing sector? Where are the companies that you have a relationship with located?

6) And, do you have significant relations with companies outside the area besides simply selling and purchasing?

- The companies you deal with that are based outside your area, what kind of companies are they?

7) What do you think Industry 4.0 means?

8) What does Industry mean for your company?
- What kind of technologies has 4.0 introduced?

9) How did you come to the decision to invest in 4.0?
- What role did tax breaks play?
- Did the adoption take place following the introduction by other companies with which you have long-standing strategic relationships? Are these companies local companies?
- Have you received information from employers' associations?

10) How did you prepare for the investment in internal resources? For example, recruitment of new profiles, investment in training... etc. etc.

11) How has the organisation changed since the investment? For example, new functions and tasks.
- Were they found within or outside the territory?

12) Did you rely on external resources for the definition and during the implementation?
- Are they local or external resources?
- Where did you collect the information and how did you identify the technologies?
- During implementation, were you supported by external resources?

13) Following the investment, have you established ongoing relations with companies dealing with different types of goods and services than those that you dealt with in past?

- Are these companies within or outside your area?
- In this question, the companies that produce the machinery will be mentioned: it would be interesting to establish whether they are new strategic networks.

14) How has the implementation of these technologies changed the internal organisation of the company (in terms of production organisation, labour relations, etc.)?

15) Are you a member of a territorial association?

16) Has this association played any kind of role in your choice to invest?

17) Tell me about your relationship with the trade unions.
- Are the unions internal or local?

18) How has the internal trade union welcomed the introduction of new technologies?

19) Do the local administrations of municipalities and provinces offer any kind of support to the dissemination of these technologies?

20) Along with the more traditional manufacturing relationships, do you think it has become more important to establish relationships with universities, research centres or more generally with technological diffusers?

21) What do you think of the government's actions regarding 4.0?

22) In your opinion, is the Piedmont/Lombardy region somehow encouraging the spread of these new technologies?

Original extracts from interviews:

1 "Noi sfruttando le politiche abbiamo preso macchinari e strumenti utili per l'industria 4.0 di domani, perché anche se oggi non sfruttiamo al cento per cento domani vogliamo avere la possibilità di farlo. È chiaro che questo all'inizio ha un costo maggiore…siamo partiti dalla fine a da un pezzo dell'inizio" (of internal productions chain). Enterprise 5 Borgomanero small

2 "È da anni che la tecnologia va in questa direzione, sono quasi 10 anni che tutta la fase di protopizzazione la facciamo tutta internamente, abbiamo investito in stampanti 3D e programmi di simulazione. Progettazione, Protopizzazione, mock-up è tutto fatto internamente. Poi se abbiamo bisogno di macchinari speciali o di nozioni specifiche collaboriamo con altri". Enterprise 1 Borgomanero medium

3 "In un certo senso tutti i macchinari degli ultimi anni sono già in quell'ottica, poi il discorso di creare il circuito e l'interconnessione complessiva è un altro discorso…Poi l'ufficio tecnico è già collegato al gestionale, come si chiama l'ultima versione??...va beh comunque abbiamo già integrato le fasi di magazzino". Enterprise 1 Borgomanero medium

4 "Noi non abbiamo mai fatto il passo più lungo della gamba, gli incentivi sono stati decisivi non solo nel decidere di investire in industria 4.0, ma soprattutto ci hanno portato a un investimento su scala maggiore…
Siamo associati e qualsiasi cosa facciamo…ehm…L'approccio della nostra azienda è semplice quando dobbiamo fare le cose noi abbiamo un binario il nostro professionista e la nostra associazione di categoria…
Con le poche aziende con cui abbiamo strette relazioni ci siamo confrontati, la crescita per confronto è sempre importante" Enterprise 3 Borgomanero medium

5 “Io uso LINUX, io sono un appassionato di tecnologia quindi sto attento a cosa la tecnologia a da offrire” Enterprise 12 Lecco small

6 “Noi ci siamo mossi in anticipo rispetto agli incentivi e abbiamo comunque avuto supporto da parte della nostra associazione” Enterprise 5 Borgomanero small

7 Interviewer: “Avete ricevuto avuto aiuto nella fase di definizione e impetrazione dell’investimento da parte di altre imprese della zona o da associazioni di categoria?”
Respondent: “No noi siamo stati tra i primi, e quindi al contrario è l’associazione che ha mandato da noi persone, quattro o cinque soprattutto qualche anno fa.” Enterprise 12 Lecco small

8 “Noi abbiamo bisogno di raccogliere i dati, cerchiamo di non perdere nulla, di essere il più efficienti possibile ma è difficile”. Enterprise 3 Borgomanero small

9 “La semplificazione e l’automazione di alcuni processi che prima erano molto manuali lo stesso numero diciamo così che prima era riportato in giro per quattro cinque software e relative divisioni, perché serviva a vari processi. Aver automatizzato la raccolta e la distribuzione dei dati durante tutto il processo di produzione e fatturazione da dei vantaggi incredibili, non puoi capire cosa significhi per l’efficienza. Io non vendo la fatica dei miei lavoratori ma il prodotto finito e il valore aggiunto gli operari lo creano quando lavorano sulle macchine non quando scrivono sui fogliettini” Enterpise Lecco 11 Medium

9 “Quello che notiamo è che le piccole medie imprese spesso approcciano dei lavori senza sapere quanto gli è costato un prodotto, o prendo commesse senza sapere quanto guadagneranno… La piccola impresa piemontese prende

piccoli lotti complessi che gli altri non riescono o non vogliono fare, in questo l'additive manufacturing potrebbe aiutare. Riassumendo i due punti principali in cui la 4.0 possa aiutare. Va be sì il cloud e la cyber security, ma lì c'è anche un discorso di infrastrutture in molte aree non c'è copertura internet. Nelle piccole imprese il monitoraggio dei dati e creare simulazioni digitali è importate per le piccole commesse perché riesci a capire se stai nei costi oppure no, perché va bene vendere a sotto costo per far girare i macchinari ma devi esserne consapevole". Association 8 Borgomanero

10 "I ragazzi sono anche venuti il sabato e la domenica mattina per fare prove e famigliarizzare con le macchine, insomma quando non avevano da fare ci giocavano po'" Enterprise 6 Borgomanero medium

11 "Nel nostro caso più che learning by doing si tratta di fare formazione by doing" Enterprise Borgomanero 3 medium

12 "Sulla carta industria 4.0 è una grande occasione per tutte le aziende il problema è che per fare questo bisogna partire dalla scuola, e cioè cominciare a mettere nella testa delle persone che l'industria 4.0 zero ha bisogno di: punto uno una serie di ingegneri meccanici, punto due una serie di ingegneri a livellodi gestione, punto tre da persone che cominciano da subito a lavorare in un'ottica 4.0… Per fare industria 4.0 bisogna partire dalle competenze allora da lì l'industria 4.0 si può creare ma senza quello è difficile" Enterprise 2 Borgomanero medium

13 "A me conviene assumere qualcuno che conosca la tecnologia e ragioni già in ottica 4.0 e poi insegnargli il lavoro che facciamo noi piuttosto che il contrario. Perché, perché sapere industria 4.0 non vuol dire saper fare un lavoro o usare una macchina vuol dire avere una visione di insieme e una conoscenza alta della tecnologia" Enterprise 10 Lecco medium

14 “La fregatura più grossa che oggi uno prende nel mondo del lavoro è proprio sul tema informatico in generale, perché ti compri un software gestionale che ti costa una fucilata e se sbagli fornitore sei finito, non hai fatto un buon investimento hai buttato via dei soldi e che non sono pochi. Poi oggi fai fatica a distinguere la webagency dalla softwarehouse. Soggetti che sono venuti qui e sembravano bravissimi perché la contavano su ci hanno fregato” Eterprise 13, medium dymension Lecco.

15 “Le aziende ICT farebbero parte di un processo virtuoso nel momento in cui chi si occupa di quel ambito fornisca alle imprese quello di cui hanno bisogno e non quello che gli vogliono vendere questo vuol dire far parte di un distretto. Questo vuol dire selezionare le imprese (ICT) sul mercato cosa che magari che non riesce a fare la singola impresa ma si può fare come sistema. Come nel caso delle relazioni con l’estero servendo degli interpreti cha traducono da una lingua all’altra per fare un determinato lavoro, con il l’ICT è la stessa cosa dobbiamo trovare e creare qualcuno che sappia mettere in contatto questi due mondi, perché questo è l’anello più debole in questo momento” Buisness associetion 1 Lecco

16 “Quindi con l’occasione del 4.0 abbiamo deciso di svecchiare il parco macchine. Questo ci ha data maggiore flessibilità produttiva e progettuale… Facciamo una premessa ancora noi su una commessa cerchiamo di produrre internamente i particolari più complicati, secondo i nostri limiti produttivi. Seconda scelta il numero di particolari il più alto possibili. Sapere di poter fare più cose ci dà più libertà sapendo che non avremo bisogno di tanti fornitori, con sui fare diciamo così un po’ di guerra sul quanto produrre, quando il costo e così via, cedendo il controllo delle tempistiche e della qualità”. Enterprise Lecco 15 medium

17 "Abbiamo preso lavori conto terzi grazie alle nuove macchine aumentando l'offerta, ma sempre in un discorso di nicchia se c'è qualcosa che crea problemi per i piazzamenti o i materiali noi ci proponiamo, ci facciamo del male". Enterprise Lecco 11 small

18 "Una volta che un'azienda ci dice ok facciamolo noi andiamo a cercare nel nostro database tutte le aziende che si sono rivolte a noi per presentarci a noi i loro servizi e i loro prodotti e che sappiamo perché hanno lavorato con aziende similari a quelle in cui si vuole attivare l'investimento, per andargli ad offrire un prodotto tagliato su misura per loro e quindi si organizzano non so tre quattro colloqui con aziende.
Nella selezione di questi possibili partener seguite una logica territoriale?
No non proprio, posso avere una azienda a sud di Cuneo ma ritengo che il migliore fornitore sia ad Ivrea io gli propongo quello, diciamo che il territorio interviene in un secondo momento se devo scegliere scelgo quella più vicina". Association 9 Borgomanero

19 "Dieci anni fa abbiamo creato una struttura che si occupasse di sviluppare i mercati esteri, quindi abbiamo degli export manager delle figure che sono per noi degli account che affianchiamo alle aziende su un modello di attività che erogavano i privati ma che noi abbiamo reso una struttura interna all'associazione….molte aziende non avevano neanche il sito interne, ma neanche una pagina in Acrobat con la descrizione dei servizi, se andava bene avevano dei cataloghi cartacei che non serviano a niente se non quando andavi a una fiera o vanno da un cliente ma normalmente sono tutti dedicati al lavoro non escono mai dalla fabbrica… Noi abbiamo fatto questo tipo di supporto e avuto un successo spaventoso imprevedibile perché lo forniamo a dei costi che dico sono fuori. Questo è apprezzatissimo dalle aziende e quindi un sostegno molto pratico e molto operativo e poi ci ha consentito di sviluppare altre attività sottostanti. A questo tipo di attività abbiamo poi affinato dei supporti

perché nel mentre lavoravamo con le aziende per questo tipo di necessità subentravano altre richieste per esempio la contrattualistica internazionale problematiche doganali…" Business association 17 Lecco

20 "Noi abbiamo l'obbligo di anticipare i bisogni delle imprese, perché , perché tutto quello che abbiamo creato sulla base delle esigenze delle imprese va bene funziona…Questo non esclude, anzi è il nostro principale dovere essere un passo avanti a queste necessita anzi in diversi ambiti in deversi momenti e in diverse situazioni abbiamo anche sperimentato. Lo abbiamo provato a fare, ad esempio con le dinamiche legate alle 'estero…ma ora ancora di più riguardo all'ambito tecnologico, prima in maniera più scoordinata, adesso in maniera coordinata" Business association 18 Lecco

21 "Le liste degli istituti tecnici sono non dico bloccate ma quasi, qui c'è la gara ad accaparrarci i ragazzi diplomati neolaureati e poi francamente fa più appeal un'azienda più strutturate. Ho avuto contatti con delle persone ma preferiscono lavorare in situazione più strutturate. Enterprise 16 Lecco small Adesso in maniera coordinata abbiamo proposto degli incontri dove vengono poche aziende, perché i temi trattati non dico che sono l'avanguardia ma forse anticipano un po' troppo i tempi e quindi non destano un interesse di massa, ma con le aziende che vengano si cerca di innescare dei processi delle curiosità su cui poi magari innestare dei progetti". Associetion Lecco 17

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