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Abstract

In the last few decades, the role of institutions has received renewed attention as a key factor to foster regional growth and innovative performance, raising researchers' interest in assessing the mechanisms through which the institutional framework could affect innovation. This paper, by focusing attention to the Emilia-Romagna context, empirically investigates the effects on innovative capacity related to higher institutional quality and to its dimensions. This region, in fact, provides – due to the performance achieved in the new economic scenario (EMU, globalisation, Industry 4.0) – a relevant testing ground to verify the extent to which the evolution of regional institutions has favoured the creation of a fertile ecosystem able to promote innovative capacity. The main findings reveal a positive role associated with two fundamental institutional components: the quality of public services (government effectiveness) and the degree of association and social cooperation (voice and accountability), which represent the most important institutional dimensions in this region.

Keywords: innovation, institutional quality, government effectiveness, voice and accountability, structural change

JEL classifications: O10, O43, R10, R11

1. Introduction

Since the seminal contributions of Lundvall (1992), Nelson (1993), Freeman (1995) and Edquist and Johnson (1997), the economic literature has emphasised the important role of institutions in the innovative performance of the National System of Innovation (NSI). In particular, this theoretical framework has highlighted the importance of formal institutions in incentivising and stimulating the process of new knowledge creation. Moreover, in the literature

about regional systems of innovation (RSI), the adoption of 'contextual perspectives' (Srholec, 2010) to explain the territorial dimension of innovation, as in the case of the innovative milieu (Aydalot, 1986; Camagni, 1991), has helped emphasise the role of formal and informal institutions, providing evidence of the importance of implicit rules and social capital and the role of collective services and local government (Malerba, 2005).

According to these strands of research, institutions, rules and incentives, acting as catalysts, affect the ability to create, transform and combine innovation inputs (human capital, R&D investments) into innovation outputs (Rodríguez-Pose, 1999; Crescenzi & Rodríguez-Pose, 2009). The different institutional characteristics of the national, regional and/or local system of innovation, in fact, seem to condition their capacity to assimilate innovation and technology, thus affecting economic development and the innovative performance of places and helping explain territorial disparities (d'Agostino & Scarlato, 2015, 2019). A possible explanation is related to 'the notion that it is the way that humans themselves decide to organize their societies that determines whether or not they prosper. Some ways of organizing societies encourage people to innovate, to take risks, to save for the future, to find better ways of doing things, to learn and educate themselves, solve problems of collective action and provide public goods' (Acemoglu, Johnson & Robinson, 2005, p. 397).

Notwithstanding this wide literature, it is only recently that the analysis aimed to evaluate the impact of institutional quality (IQ) on regional innovative capacity and economic growth has received a growing attention (Rodríguez-Pose & Di Cataldo, 2015; Rodríguez-Pose, 2013; Tebaldi & Elmslie, 2013).

The recognised importance of institutions as a key factor to foster regional growth and innovative performance has raised the interest of both researchers and practitioners in assessing whether not only the institutional framework but also its quality affect innovative performance.

Indeed, its beneficial effect on economic growth and social development could be observed only when the IQ is high (Holmberg, Rothstein & Nasiritousi, 2009).

Within this context, Emilia-Romagna, a highly important region in Northern Italy, provides an excellent testing ground to verify the extent to which the evolution of regional institutions has favoured the creation of a fertile ecosystem able to foster the innovative capacity of this region (Andreoni, 2018). In a regional economy such as Emilia-Romagna – which, even in the wake of the 2008 financial crisis and the 2012 earthquake, was able to preserve and improve its robust manufacturing base and which has a strong penchant to export and a higher propensity to innovate – institutions may favour the long-term capacity of the region to evolve and embrace both the challenges of Industry 4.0 and the new forms of globalisation brought by the 'unbundling' (Baldwin, 2013) of the productive process and the creation of the now-famous global value chain (GVC).

In sum, given the growing attention paid to the regional dynamics and importance of institutions to promote regional growth and innovation, this paper attempts to contribute to the literature by exploring if and to what extent institutions may represent an important source of innovation of the Emilia-Romagna region once we control for a number of more 'traditional' variables linked to innovation (productive structure, degree of openness, human capital, etc.).

The results highlight the favourable institutional environment for business and innovation that characterises Emilia-Romagna. The relevant presence of social capital (Degli Antoni, 2006; Sabatini, 2005)[1] rooted in this region, the existence of an institutional framework able to promote the development of the private sector by putting in place an industrial policy oriented towards knowledge-based investments (R&D, human capital, IT), and the quality of public and civil services represent important enablers of innovation that could allow one to understand the success of a socio-economic system known in the literature as 'Emilian Model'[2] and to anticipate its future development path (Bianchi & Labory, 2019a). This is particularly

important in light of the role played in Emilia-Romagna by manufacturing productions strongly connected to the peculiar characteristics of the fourth industrial revolution, first and foremost mechatronics. Finally, the region also excels in terms of its participation in the international markets – the first region in Italy for export per capita and, in 2018, the second region in Italy (surpassed only by Lombardy) for total export value.

The remainder of the paper is organised as follows. The next section presents the theoretical background, while the third section describes the structural characteristics, industrial specialisation, export capacity, and innovative performance of Emilia-Romagna. In the fourth section, attention is paid to Emilia-Romagna's institutional framework by emphasising the importance of the overall IQ and its components. The fifth section defines the empirical model and discusses the econometric results. Finally, in the last section, the main conclusions are provided.

2. Theoretical background

2.1 Institutions and institutional quality: Origins and developments

During the last few decades, the economic literature has been increasingly interested in the role played by institutions as an important source of economic growth (Acemoglu et al., 2005; Rodrik, Subramanian & Trebbi, 2004; Rodríguez-Pose, 2013). According to the broad definition of institutions proposed by North (1991), they represent the 'rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction' (p. 97). More specifically, they consist of both formal and informal rules with the former including norms, laws, statutes and regulations and the latter consisting of social norms, conventions and traditions.

Better institutions are commonly recognised as crucial determinants of economic growth and total factor productivity through their ability to affect firms' propensity to adopt

better technology and invest in the knowledge creation process (Aron, 2000). A developed institutional context, in fact, can help create 'the frameworks, regulations and markets that enable firms and other actors to engage in innovation. Structural reforms in education and training policies, in entrepreneurship policies, in product and labour markets, in public research institutions, and in policies to help develop networks and markets for knowledge can go a long way towards improving the environment for innovation' (OECD, 2010, p. 2).

Furthermore, the idea shared in the literature is that better formal and informal institutions can be considered sources of 'comparative advantage' (Levchenko, 2007) because of their ability to affect entrepreneurship, firms' productivity and innovation as well as their level of international participation through foreign direct investment (FDI) and trade (Sobel, 2008; Rodríguez-Pose & Di Cataldo, 2015; Crescenzi, Gagliardi & Percoco, 2013) and by favouring the accumulation of physical and human capital (Hall & Jones, 1999).

Institutions, in fact, according to Rodríguez-Pose (2013), 'matter as much, if not more, for economic development than long-established traditional factor-endowments, such as physical and human resource endowments, trade or technology transfers' (p. 1036). Yet 'while investment in infrastructure, education, or innovation tends to be – despite the richness and complexity of these factors – relatively easy to grasp, operationalize, and implement, the concept of institutions is more subjective, less clear, more controversial and, precisely for that reason, much more difficult to operationalize' (p. 1037). This reveals an important issue concerning the evaluation of institutions in terms of their quality and/or their effectiveness (Tebaldi & Elmslie, 2013), which can be considered crucial drivers of innovative performance and economic development (Sheppard, 2002).

In particular, the economic literature on the effects of the quality of institutions on the economic development has been enriched, during the last few decades, by two main research approaches (Bardhan, 2005). On the one hand, the historical analysis has tried to shed light on

the historical forces that could explain the institutional structure (Bardhan, 2005), and the relationship between politics and economy (Hall & Jones, 1999; Acemoglu, Johnson & Robinson, 2001; Rodrik et al., 2004). On the other hand, the quantitative approach has aimed at evaluating the IQ by adopting composite indicators (Kaufmann, Kraay & Mastruzzi, 2011; Charron, Dijkstra & Lapuente, 2014).

The first approach demonstrates the 'primacy of institutions' in economic growth (Rodrik et al., 2004) over geography (Gallup, Sachs & Mellinger, 1999), trade integration (Frankel & Romer, 1999), or other '*proximate* causes of growth' (Acemoglu et al., 2005, p. 388) such as physical and human capital accumulation, innovation, and productivity (Solow, 1956; Romer, 1986; Lucas, 1988; Mankiw, Romer & Weil, 1992). These factors, in fact, as emphasized by North and Thomas (1973), 'are not causes of growth; they *are* growth' (p. 2).

The historical approach, in other words, found in the institutions or in what Hall and Jones (1999) call 'social infrastructure' the fundamental determinant of economic growth (Acemoglu et al., 2005; Rodrik et al., 2004; Hall & Jones, 1999), emphasizing the importance of recognizing the historical identity of a nation, its cultural background, its overall perspectives, and its collective decisions. Institutions, in fact, are largely determined by society thus reflecting its characteristics and, as a consequence, 'the question of why some societies are much poorer than others is closely related to the question of why some societies have much "worse economic institutions" than others' (Acemoglu et al., 2005, p. 389).

The quantitative approach, instead, aims at opening the black-box of institutions and to extrapolate the exact characteristics – dimensions – that form and define institutions (Nifo, 2020). Institutions as a synthesis of several social, administrative, cultural and political indicators and of other meta-economic variables such as corruption, trial times, social and economic facilities, property rights etc. (Nifo, 2020). Within this literature strand, the academic attention of researcher and the increasing interest of international organizations (Word Bank,

United Nations) and policy makers about the primary importance of good institutions in explaining socio-economic differences across countries and regions, has led to an identification of the several dimensions of IQ and to a measurement of them through a set of variables which are able to capture the underlying concepts.

A pioneering achievement in the formulation and elaboration of IQ is the 'Worldwide Governance Indicators' (WGI, Kaufmann et al., 2011). The WGI, in particular, covers two hundred countries and territories and identifies six dimensions of governance (control of corruption, governance effectiveness, regulatory quality, rule of law, voice and accountability, political stability, and absence of terrorism) by exploiting several hundred individual variables. This dataset, widely recognised as one the most exhaustive and reliable measures of IQ, is frequently adopted by the literature on the economic effects of institutions on innovation and growth (Tebaldi & Elmslie, 2013; Clò, Florio & Rentocchini, 2020).

At regional level, instead, despite the growing attention on intranational dynamics, only recently was such attention directed at the problem of the quality of institutions (Rodríguez-Pose & Di Cataldo, 2015; Crescenzi et al., 2013; Agostino, Nifo, Trivieri & Vecchione, 2020; D'Ingiullo & Evangelista, 2020). Scant, in fact, are the evidence provided in literature aimed at evaluating the quality of local institutional arrangements at regional and subregional levels of analysis, and this is arguably because of a previous lack of data on institutions at this analysis level. Among these innovative contributions, the most important empirical attempt to create new data on IQ at the regional level was by Charron et al. (2014). The authors demonstrate that significant variations in terms of IQ among regions and subregions of a country could lead to biased estimation results in cross-country analysis. In other words, analysis at a national scale, overestimating low-performing regions and underestimating high-performing ones, could lead to partial, incomplete and in some cases wrong conclusions.

Finally, by adopting an intra-national perspective and focusing on the IQ of Italian regions (which is the key scope of our analysis), Nifo and Vecchione (2014), according to the strategy adopted by Kaufmann et al. (2011) for the WGI, provided five indicators of IQ (*voice and accountability*, *corruption*, *government effectiveness*, *regulatory quality*, and *rule of law*) and a synthetic index for all Italian regions and provinces (NUTS2 and NUTS3).[3]

2.2 Regional institutional quality and innovation

The difficulty in evaluating the effectiveness of institutions could explain the insufficient attention paid to institutional aspects by the RSI literature, which, in turn, has led to an incomplete definition of these systems because of the challenge of capturing the important element of RSI variety (Zukauskaite, 2018). As emphasised by a recent literature strand, in fact, the different and peculiar characteristics of regional institutions can be considered important determinants of regional disparities and innovation gap (Rodríguez-Pose, 2013). Regional institutions represent a strategic asset, hardly replicable, that helps achieve and preserve a certain competitive advantage and that allows for reinforcing resilience to environmental changes (Storper & Scott, 1995; Storper, 1997; Bathelt, Malmberg & Maskell, 2004). This can be related to the profound effects associated with clear and fixed formal and informal institutions that could generate a better definition of property rights and rule of law that reduce transaction costs and economic uncertainty (Aron, 2000).

From a policymaker perspective, the question concerning the impact of IQ on the economic performance of regions seems particularly relevant when different economies present large enough institutional differences that help explain disparities in terms of economic development and productivity (Nifo, 2020). Empirically, Rodríguez-Pose and Di Cataldo (2015), by using recently developed data on government quality, provide evidence of the important role of regional institutions in shaping the capacity of regions to innovate, also

demonstrating that in regions characterised by a weak institutional framework, an improvement in the quality of institutions could represent a crucial strategy to stimulate innovative capacity.

Furthermore, within the debate concerning the regional institutional framework, the economic literature has highlighted the key role of institutions in the development of industrial districts or clusters in eastern–northern and central–northern Italian regions such as Emilia-Romagna, Tuscany or Veneto (Rodríguez-Pose, 2013). The economic development of these geographically, culturally and historically identifiable areas where several small firms specialising in activities related to a specific industry coexist with an active community of people (Becattini, 1990), seems to have benefited from the favourable institutional factors rooted in these regions. Among these embryonic institutional factors, we found 'the specific shapes of the historic relations between the cities and their rural surroundings, the role of the extended family in the organisation of small independent farms, the scaffolding of small and medium-sized urban centres rich in craft and trade traditions not eroded by the first wave of industrialisation, and the influence of local political traditions' (Trigilia, 2009, p. 126). In the following years, the development of these virtuous institutional arrangements has helped create a fertile ecosystem that promotes the competitive and innovative capabilities of local-firm agglomerations which, in most cases, have exhibited better performance than that associated with vertically integrated hierarchical firms (Becattini & Coltorti, 2006), representing, *de facto*, the local socioeconomic development model and constituting the source of Italian industrial leadership (Lombardi & Magliocchi, 2016).

By keeping the attention on the Italian case and, in particular, on the institutional factors that could have helped explain the innovative performance of the Emilia-Romagna region, which is the key scope of the present paper, we can summarise the peculiar traits of the regional institutional ecosystem as follows: (i) the capacity of regional administrators to put in place effective policies to support regional development (such as knowledge-based investments and

sustainable-oriented public policies) (Mosconi, 2015, 2018); (ii) '[the] cultural homogeneity which lubricated social relations among economic actors, reinforced consensus and group loyalty among both entrepreneurs and employees, ensured the social ostracism of rule-violators, provided a common language to speed innovation and information exchange, and established the basis for trustful behaviour' (Rinaldi, 2005, p. 3); (iii) and the high number of both universities and national and European research organisations.

Therefore, given the renewed attention paid to institutions as a key determinant of regional innovative capacity, and in the light of the peculiar characteristics of the Emilia-Romagna region in terms of its robust manufacturing base, export vocation, innovation propensity and advanced institutional capital, the extent to which the institutional framework of this region played a role in explaining its innovative performance could be a significant question.

Empirical analyses at the regional level, in fact, could benefit from significant differences in socioeconomic and institutional characteristics among regions and subregions (Charron et al., 2014). Furthermore, the higher proximity between regional institutions and local actors and organisations translates into a greater effectiveness of these institutional arrangements with respect to national ones. Finally, by adopting an intranational perspective, it is possible to verify if and to what extent peculiar institutional features at the local level could explain differences in the process of knowledge creation and diffusion among regions and subregions and thus the varying innovative dynamics.

All in all, Emilia-Romagna appears a good case-study to investigate the role played by institutions in the broader context of the transition to the knowledge economy.

Economists and in general social scientist have documented the transition underway in advanced nations (regions) from an economy based on natural resources and physical inputs to one based on intellectual assets.

'The knowledge economy' – in Cristiano Antonelli's words – 'is characterized by the central role of the production and use of knowledge. Knowledge is both the central input and output of the economic activity (…) New information and communication technologies are the pillar of the knowledge economy (…) The traditional share of the manufacturing industry is replaced by the combination of advanced manufacturing cum KIBS (knowledge-intensive business-services)' (Antonelli, 2016, p. 338).

Amongst the relevant characteristics for the generation and use of knowledge, Antonelli highlights the following two: '(1) skilled labor intensity and low levels of fixed capital intensity; (2) high frequency of interaction: not only vertical interactions between bottom-up learning processes that enable the accumulation of competence and top-down technological applications of scientific knowledge, and between users and producers, *but also horizontal between public and academic research and corporate R&D activities.*' (Antonelli, 2016, p. 339) (emphasis added).

As a matter of fact, in Emilia-Romagna a 'European Data Valley' is developing (Bologna's based Cineca and the newly established European Centre for Medium-Range Weather Forecast are the two pillars). Again, advanced manufacturing remains a key activity (think of mechatronics and automotive, pharma and biomedical, etc.), and KIBS are getting stronger (Intesa Sanpaolo, 2020 has identified, among other things, a 'ICT technological pole, Bologna-Modena'). Finally, the cooperation between the four regional universities and the business community has achieved important goals (e.g., the Motorvehicle University of Emilia-Romagna, MUNER).

This is not to say that in Emilia-Romagna a full-fledged 'knowledge policy' already exits. As for the other most advanced Italian regions, the path towards the knowledge economy is still long. Nonetheless, in this region the process of 'endogenous innovation' (Antonelli, 2017) is working, at least to a certain extent – as we are going to show in the following sections.

3. The economic performance of Emilia-Romagna

3.1 A macroeconomic snapshot

In Central–Northern Italy, Emilia-Romagna represents one of the most dynamic regions which preserved robust manufacturing bases and reinforced their industrial specialisations through the emergence of new productions and the qualitative upgrade of many 'Made in Italy' productions. Neither the negative consequences of the 2008 financial crisis nor those of the 2012 earthquake were able to stop the development path of the Emilian Model. From 2007 to 2019, the growth rate of Emilia-Romagna has outpaced that of Italy as a whole.[4] The same performance can be seen in the best performing regions during the emergence of Italy's 'new' industrial triangle – i.e. Lombardy, Veneto and Emilia-Romagna (Di Vico, 2018).[5] It is possible to date the beginning of the transformation of the Emilian model during these years (i.e. between the first and second decades of the 21st century).[6]

After the seminal paper (Brusco, 1982), the Emilian model was 'revisited' 20 years later (Rinaldi, 2005): 'The improved performance of the region in the 1990s' – the argument goes – 'occurred in a context characterized by a restructuring of local industry and a change in the governance structure (. . .) Lead firms emerged, distant networks were formed (. . .)' (p. 262).

Taking into account these new developments, our basic idea was to shed light on the new structure of this regional economic system (particularly its manufacturing) as well as on the new firms' behaviour (Mosconi, 2011, 2012). It follows that this transformation is a multifaceted concept with many components (or tendencies). These tendencies – as we will explain in the following sections – toward firm growth in size, technological upgrade of production, excellent performance in export markets and a proactive role of regional industrial policy have been gaining ground since the beginning of the 21st century – the age of the euro.

With a present population of nearly 4.5 million residents (7.3% of the national population), Emilia-Romagna accounted for 9.2% of the national GDP in 2018, below the share of Lombardy (22.1%) and practically equal to the share of Veneto (9.24%) (i.e. the other two major industrialised economies). However, in 2018, the region still had one of the highest per capita incomes among the 20 Italian regions, equal to 36,289 euros (surpassed only by Lombardy and Trentino Alto-Adige, with GDPs per capita equal to 38,845 and 42,537 euros, respectively). Furthermore, considering the average annual GDP growth rate at power purchasing standards (PPS) during the period 2009–2018, Emilia-Romagna registered the highest growth rate (+2.1%) with respect to Italy (+1.4%), Veneto (+1.6%), and Lombardy (+2.0%), according to the latest data from the EUROSTAT.[7] This is particularly important in light of the capacity of this region to narrow the gap with other major industrial regions in terms of economic growth, overturning the lower growth dynamics obtained from 1981 to 1999 and becoming, during the last two decades, the Italian region with the highest GDP growth rate.

To complete this macroeconomic inspection, we must analyse the regional employment dynamics. In particular, despite the rapid increase of the unemployment rate to 10%, registered during the financial crisis of 2008, the region was able to overcome the dramatic consequences associated with this period of strong economic instability, worsened by the 2012 earthquake, becoming the second economy in Italy with the lowest rate of unemployment (5.9%, compared to the national rate of unemployment of more than 10%) and the highest rate of employment (69.6% against the national employment rate of 58.5%), surpassed only by Trentino Alto-Adige in both cases. In absolute terms, in the last two decades, employment has risen from 1,800,000 to over 2,000,000 people, completely in line with the target established by the EU since the Lisbon Strategy.

[Insert Table 1 here.]

3.2 Structural characteristics

Considering its industrial structure, Emilia-Romagna – since the contribution of Zamagni (1997) aimed to reconstruct the GDP per capita of Italian regions – appeared as a territory characterised by 'a widespread industrial attitude', and contrary to the *deindustrialisation* trend during the last few decades in the dynamic core regions of the upper- and middle-income economies, the manufacturing industries played and still play a crucial role for the Emilian economy. In 2017, the manufacturing sector accounted for 26.6% of value added, as highlighted in Table A1 in Appendix A, where the main structural indicators of Emilia-Romagna are reported. Moreover, with its 19 (out of 147) 'traditional' industrial districts (12.9%), its 508 (out of 3,593) medium-sized industrial enterprises (14.1%), and its three (out of 22) multinationals (13.6%), Emilia-Romagna represents one of the most important examples in Italian productive system where manufacturing firms, besides playing a leading role in the region, are concentrated in some powerful districts and clusters able to stimulate activities with higher knowledge and innovation intensity (e.g., automotive of Bologna and Modena, mechatronics of Reggio Emilia, biotechnology of Mirandola, packaging machinery of Bologna, pharmaceuticals of Parma, etc.).

However, trying to understand what happened to the Emilian Model by comparing the main macroeconomic variables of Emilia-Romagna with those of Italy would not provide enough reason to mention a transformation. Attention must be paid to deep changes in the productive structure and in firms' behaviour for at least ten years to face the many challenges imposed by, among others, the monetary union.

The most important changes can be summarised as follows. The first is an increasing capacity to move towards a path of gradual consolidation of firm size (a medium–large scale is essential to increase R&D investment and international participation). The second is a strategic capacity to undertake the paths opened up by new productive specialisations (IT, life science,

and green economy) without abandoning traditional 'Made in Italy' productions. The third is the increasing export capacity that characterised Emilia-Romagna's firms, which contribute, together with Lombardy and Veneto, to more than half of Italian exports. More importantly, by classifying these regions in terms of export, since 2018, Emilia-Romagna has occupied the second position of this special ranking (surpassed only by Lombardy), while it is ranked first in terms of export per capita. The sources of this extraordinary performance are different and can be found in the quality and design of many of Emilia-Romagna's products as well as in the capacity of regional entrepreneurs, workers, and technicians to recombine different technologies, such as in the case of mechatronics. This leads to the last important transformation that involves regional innovation capacity and technological progress during the fourth industrial revolution. In particular, as highlighted in the following paragraphs, the peculiarity of the mechatronics industry, as a result of the successful combination of mechanics and electronics, is that of being at the crossroads of several innovative models, each of which is characterised by its own distinctive features. Mechatronics represents an industry destined to be increasingly contaminated with the digital word by accentuating its scientific and technological profile along the Emilian Valley.

3.3 Firm size consolidation: The rise of lead firms

As shown in Table 2, by looking at the significant transformation of the region's industrial structure, we can observe that the total manufacturing employees showed a slight increase in the first decade (1991–2001) from 531,381 to 538,699 and a decreasing trend during the last twenty years, 448,036 in 2011 and 439,309 in 2017. The fall affected, to a greater extent, firms with less than ten employees (micro-firms); their labour force diminished by nearly 40%. Meanwhile, the decreasing dynamics of the immediate size of upper-class firms (from 10 to 49

employees), whose workforce (as a percentage of the total manufacturing labour force) has shown a reduction by more than 20% over the entire considered period, are less significant.

On the contrary, considering the manufacturing employment in firms with more than 50 employees, we can observe an increasing trend over the whole period (1991–2017), which was partially interrupted in 2011, when the labour force decreased from 225,124 in 2001 to 196,671 in 2011, most likely from the well-known drastic consequences of the 2008 financial crisis.

In addition, devoting attention to changes in firms' dimensions, it is important to highlight that Emilia-Romagna hosts the most robust segment of the Italian cooperative system, as pointed out by an empirical investigation by the Bank of Italy (Bentivogli & Viviano, 2012).[8] In this area, the cooperative system is often characterised by medium- and large-sized firms that have expanded their dimensions through internal growth paths (new investments) and, more commonly, through external growth paths (mergers and acquisitions).

In practice, the region's industry was restructured with an increasing role associated with bigger firms – namely, 'lead firms' (or 'focal firms') (Lazerson & Lorenzoni, 1999) – at the expense of smaller firms which are less capable of coping with challenges imposed by the global competition and swept away by competitive pressure. In effect, the rise of lead firms represented one of the most important changes in the structure of Emilia-Romagna's industrial districts in recent years (see, for instance, the process of internationalisation of the biomedical industrial district of Mirandola[9], as well as the concentration processes that occurred both within the ceramic tile industrial district of Sassuolo[10] and within the packaging machine industrial district of Bologna[11]. Lead firms, unlike 'traditional' district firms, aim to increase their size and diversify their product portfolios and 'tend to orchestrate a disproportionate amount of economic activity in terms of both quantity and quality. They provide the district with much of its propulsive and progressive character, benefiting from extensive external sources of information about changes in markets and technologies that they transmit to

subcontractors through relatively well-defined networks.' (Lazerson & Lorenzoni, 1999, p. 237).

Without these growing firms (bigger than traditional 'micro-firms', which account for 95.1% of Italian firms), undertaking the fundamental strategy for all successful businesses in 'Made in Italy' industries – strengthening 'upstream activities' (R&D, design, advertising, etc.) and 'downstream activities' (distribution, post-sales assistance, etc.) rather than purely productive processes (which can be partially de-localised) – would have been impossible. These activities consistently add value to the products of Emilia-Romagna, which, as we know, is the true keystone for competing successfully in the international markets. These activities basically have two characteristics: they are expensive (so size matters to spread fixed costs across a larger volume of production), and they require qualified human capital (thus, they offer opportunities to our talented youth).

[Insert Table 2 here.]

However, these changes in the industrial structure do not imply that this region has almost magically overcome the issue of firm size; the average size of 'local units' (*unità locali*) of business remains at four employees. Unfortunately, this represents a question that involves the entirety of Italian capitalism and that, notwithstanding many commonalities, clearly distinguishes our nation, the second largest manufacturer in Europe and one of the top ten worldwide, from Germany, the undisputed European manufacturing leader, ranked fourth in the world, Italy being seventh, according to Centro Studi Confindustria (2019).

Nevertheless, the previously discussed structural changes tell us at least two things: the path towards size consolidation in Emilia-Romagna has begun and is ongoing, and this process has found its most fertile ground precisely within many industrial districts and/or clusters,

where ‘industry localization’ (i.e. concentration of several firms in an industry in the same place) works according to the classic Marshallian economic analysis of the phenomenon. In fact, Alfred Marshall – in Paul Krugman’s terms (1991, p. 36-38) – ‘identified three distinct reasons for localization’ (*labour pooling, intermediate inputs, technological spillovers*)’, and these sources have generated agglomeration economies in many Emilian industrial districts and/or clusters since the 1960s and 1970s.

3.4 The industrial specialisation

As anticipated, Emilia-Romagna, characterised by a robust manufacturing base and a strong penchant for exporting, represents an ‘inspiring’ model in which structural change took on various forms that led to constantly increasing levels of value added. First, a qualitative upgrade can be found in many ‘Made in Italy’ productions (e.g. food, fashion). Second, we observed an authentic emergence of new production processes and products which are often the result of incremental innovation (e.g. mechatronics, wellness industries) or of more cutting-edge innovation (e.g. pharmaceuticals, biotech, life science, IT and big data). On closer inspection, the mechanical industry, in all its sophisticated specialisations, represents the core industry of Emilia-Romagna. The value added generated in 2016 by the two specialisations that belong to this industry (i.e. ‘Manufacture of computer, electronic, and optical products; manufacture of electrical equipment; manufacture of machinery and equipment n.e.c.’ and ‘Manufacture of transport equipment’[12]) was equal to 10.6 and 3.2 billion euros, respectively (see Table 3). In other words, what can be identified as advanced mechanics or mechatronics represents 41% of the manufacturing value added of the region.

This is particularly important in light of the growth dynamics of the manufacturing value added. As highlighted in Figure A1 in Appendix A, where the value added of each manufacturing industry in 1996 and the corresponding variation from 1996 to 2016 are

reported, we can observe the greater initial level associated with mechatronics (i.e. 'Electronic and electric devices'), where the value added has grown the most in terms of absolute value, followed by the food and metal industries. On the contrary, the textile, clothing, and leather industry registers a negative variation during this period, which indicates a value added in 2016 lower than that obtained at the beginning of the period.

[Insert Table 3 here.]

3.5 The export capacity

According to this industrial structure, Emilia-Romagna registered excellent performance in terms of export generated by previous economic activities or industrial specialisations. In 2018, as shown in Table 4, the exports related to advanced mechanics/mechatronics (i.e. 'Computer, electronic and optical products; electrical equipment'; 'Machinery and equipment n.e.c.'; and 'Transport equipment') was equal to 30.9 billion euros, which corresponds to a share of 48.7% of Emilia-Romagna's total export. The greater attention paid to these economic activities does not aim to hide the relevance of other industrial specialisations (e.g. food, fashion, home) but is exclusively related to the greater importance considered in modern economies by Industry 4.0 and to all the elements that concern the combination of machines and digitalisation that place mechatronics in a relatively advantageous position and push towards continuous investment in activities with higher knowledge intensity (R&D, human capital), where bigger firms represent a necessary precondition.

In other words, the selective restructuring of the local industry that has led to a reduction in the number of smaller manufacturing firms and their employment, the emergence of new hierarchies, the rise of lead firms, and the growth of strategic importance (both in terms of value added and export) associated with advanced mechanics in light of the current industrial

revolution, where we assist in the intermingling of machines and digitalisation, besides offering a picture of the industrial structure that prevails in Emilia-Romagna, allow us to understand the potential drivers of success of the Emilian Model and to anticipate its future development path.

[Insert Table 4 here.]

3.6 The innovative capacity

When attention is paid to the innovative capacity of this region, measured in terms of R&D expenditure and patent intensity, further elements of interest seem to emerge. In particular, as a ratio to GDP, total R&D expenditure in Emilia-Romagna accounted for 1.98% in 2017 and is higher than those of Italy (1.38%), Lombardy (1.28%), and Veneto (1.30%), as highlighted in Table 5.

Emilia-Romagna is one of the foremost regions in Italy in terms of innovative capacity. Concerning patent applications to the European Patent Office (EPO) per million inhabitants, the region shows constantly higher values than that associated with Italy and other most innovative Italian regions (see Table 5). In particular, according to the Regional Innovation Monitor Plus (European Commission, 2019),

> regional patent applications per million inhabitants were about 133, which is almost the double of the Italian average … and far above the one for Europe (112). Patents are coherent with regional industry specialisation concentrated on medium–high tech industries (like mechanical engineering and automotive) and more traditional industries like food, construction, and secondarily, fashion. Such industries, especially food and construction are, anyway, strong users of new applied technologies.

[Insert Table 5 here.]

Furthermore, Emilia-Romagna also presents a more resilient manufacturing base compared with the other Italian regions. According to Confindustria Emilia-Romagna and Prometeia (2020), 'industrial production from 2005 to 2017 increased on average by 4.2%, more than double the national figure'. In addition, as this section 3 highlights, the region has a national leadership on R&D investment (even if the R&D/GDP ratio is lower than that of the most innovative European regions) and on per capita exports, too. All these elements represent the main strengths of the regional economic context that should be considered and enhanced by future development strategies. However, although the progress made by the region is evident, so is the necessity to increase innovation activities (particularly in ICT), to widen R&D expenditure and investment in intangibles, and to reduce extreme financial fragility which characterises regional firms. These represent crucial aspects that must be taken into account to catch up with other developed European regions. Figure A2 in Appendix A clearly shows Emilia-Romagna's tardiness in terms of R&D investment with respect to Baden-Wüttemberg and Rhône-Alpes (i.e. the two other European regions with similar socio-economic and institutional characteristics as those of Emilia-Romagna).

3.7 Summing up

The economic performance of Emilia-Romagna, as evident from the review in this section, suggests that a profound structural change has been going on since the inception of the euro. This structural change, given the role played by Emilia-Romagna in the Italian economy as a whole (specifically in its manufacturing), is consistent with the more general dynamics of the Italian economy where firm size matters for both export performance[13] and productivity growth.[14]

It is worth recalling that Emilia-Romagna's industrial structure, alongside an increasing number of medium- and large-sized firms, is still characterised by the presence of many micro and small firms belonging to industrial districts (clusters) participating in global value chains. This subset of (micro and small) firms benefits from this structural feature in terms of its ability to innovate and compete in international markets.

4. Institutional framework, institutional quality dimensions, and innovation in Emilia-Romagna

During the last few decades, another characteristic has raised the interest of scholars to understand the success of the Emilian Model. As previously mentioned, the growing theoretical and empirical literature, besides emphasising the crucial role played by more traditional factors such as physical and human capital, has demonstrated the increasing importance of institutions as a source of economic development. This aspect, in particular, can be investigated by adopting an intra-national perspective and focusing on the IQ of Italian regions. To this end, this analysis relies on the dataset elaborated by Nifo and Vecchione (2014) for all Italian regions and provinces (NUTS2 and NUTS3).

Starting with an analysis of the overall IQ index, Table A2 in Appendix A shows the excellent results obtained in Emilia-Romagna in terms of government quality and effectiveness, which confirms once again the idea of an advanced institutional framework of this region. The realisation of industrial parks for small- and medium-sized firm settling as well as the real service policy implemented in Emilia-Romagna by local administrations to support and incentivise local firms to prompt innovation are only a few examples of this fertile institutional ecosystem (Rinaldi, 2005).

Preliminary evidence of the significant relationship between the institutional framework and innovative performance can be obtained by looking at the scatter plot that correlates the

average IQ over the period 2004–2011 and the log of patent intensity in 2011 of Italian provinces, as shown in Figure 1. The dots at the top of this graph represent provinces which registered better innovative capacity, while those on the right correspond to provinces with higher average IQ. The picture that emerges seems to highlight a significant and positive relationship between these two variables (the Pearson's *r* coefficient is equal to 0.81), confirming a strong correlation between the IQ and innovative performance of Italian provinces.

[Insert Figure 1 here.]

Upon closer inspection of the different dimensions of IQ, something of greater importance seems to emerge if, to give just a few examples, Emilia-Romagna is one of the top regions in Italy in terms of different institutional dimensions (i.e. social capital, the quality of public services, and the government's ability to promote the private sector) which are respectively captured by different institutional indicators (i.e. *voice and accountability*, *government effectiveness*, and *regulatory quality*).

Starting with the former, Emilia-Romagna, as largely emphasised in the economic literature, is characterised by a huge (and unique in Italy) presence of social capital rooted in the territory, which classifies the region in the first position in terms of one of the most important institutional dimensions (i.e. voice and accountability) (see Table A2). This dimension – capturing the citizen's ability to select their government as well as the freedom of expression, association, media, and press – is widely recognised as a proxy of social capital and civicness (Kaufmann et al., 2011), a fundamental determinant of human capital and innovation (Fountain, 1997; Crescenzi et al., 2013), entrepreneurship (Westlund & Bolton, 2003), and

economic development (Knack & Keefer, 1997; Sabatini, 2008), and a source of economic growth (Putnam, Leonardi & Nanetti, 1993; Zak & Knack, 2001; Degli Antoni, 2006). Social capital, understood as both a set of ethical norms of trust and cooperation and a network of reliable relationships, could play a crucial role to favour the socio-economic development of a region. The relevance of this institutional dimension is particularly evident when the relationship between patent intensity and voice and accountability is analysed. The strong correlation that appears in Figure A3 in Appendix A seems to corroborate the idea that a greater presence of social capital is associated with a stronger capacity to innovate. The extraordinary presence of social capital of this region is also confirmed when the ranking of Emilia-Romagna's provinces in terms of voice and accountability is considered. As reported in Table A3 in Appendix A, more than half of the provinces (i.e. Bologna, Rimini, Ferrara, Forlì-Cesena, and Ravenna) appear among the top ten provinces with the highest levels of social capital – all this including Modena, Parma, Piacenza, and Reggio-Emilia, which are classified among the top forty Italian provinces.

The region also excels in terms of another important institutional component: government effectiveness. Quoting Kaufmann et al. (2011), this dimension should capture 'the quality of public services, the quality of the civil services and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies' (p. 223), which seems to positively affect the innovativeness of a region (Jiao, Koo & Cui, 2015). In this regard, among the most important results obtained by Emilia-Romagna's regional administration, we can remark the Rete Politecnica ('Polytechnic Network') and its ITS (Istituti Tecnici Superiori) vocational schools, institutes that import the German model of 'Fachhochschule' to the region. Even in terms of applied research, the regional administration has made some important decisions, in particular the launch of the Tecnopoli-Rete Alta Tecnologia ('Technopoles —

High Technology Network'). In terms of public policy, Bianchi and Labory (2011) argued that in Emilia-Romagna,

> the emergence of new industries has been promoted by raising the innovation potential in the region as well as technology transfer by creating dense networking between research organisations and regional [industries] and training human capital to provide [the] new industry with adequate labour force and raise their capability to create relations with the rest of the world. (p. 443)

To complete the picture, the presence of universities in all the most important cities (Bologna, Ferrara, Modena-Reggio Emilia, Parma, and Piacenza, where we found two branches of extra-regional universities) as well as various important national and European research organisations – such as the European Centre for Medium-Range Weather Forecasts (ECMWF), the National Research Council (CNR), the National Agency for Energy, Environment, and Sustainable Innovation (ENEA), the National Institute for Nuclear Physics (INFN), and the National Institute of Astrophysics (INAF) (European Commission, 2019) – seems to prove the regional government's capacity to favour a positive environment that contributes to creating and improving a prolific innovative ecosystem in Emilia-Romagna. All this is considered along with the existence of an important data centre in Bologna (CINECA), which will host and manage one of the most powerful European supercomputers (Leonardo) that will constitute a strategic asset for many research institutes, universities, and firms.

The presence of an institutional framework able to promote the development of the private sector by putting in place an industrial policy oriented towards knowledge-based investments (R&D, human capital, IT) and that supports internationalisation is further corroborated by the excellent performance registered in Emilia-Romagna in terms of regulatory quality (see Tables A2 and A3). In particular, this IQ dimension conceptually captures the extent to which regional or provincial administrations were able to favour and to sustain the

business environment. The degree of openness of the economic system, business density and mortality, and entrepreneurial vitality, besides representing the mostly adopted indicators to measure this dimension, are also crucial factors that could positively affect innovative performance (D'Ingiullo & Evangelista, 2020). Economic openness, for instance, is considered an important dimension to promote innovation (Laursen & Salter, 2006; Rantisi, 2002), and as shown in Figure A4 in Appendix A, where the export per capita of Italian regions is reported, the extraordinary export capacity of Emilia-Romagna in both 2017 and 2018 is highlighted, confirming the leading position of this region in terms of one of the most important measures of openness (i.e. international trade). The extraordinary dynamism of this regional economy to international markets has two important implications. On the one hand, it is synonymous with being fully engaged in the flows of imports and exports, which suggests that Emilia-Romagna is a strategic crossroads for the country as a whole (Mosconi, 2012; 2018). On the other hand, its top status in the critical ranking of export per capita could be an extremely important source of innovation in this regional economy. Similarly, the thousands of innovative SMEs and start-ups as well as the increasing number of lead firms in most of Emilia-Romagna's districts contribute to creating a highly dynamic business environment characterised by greater entrepreneurial vitality and higher business density, which help to spread knowledge and to activate interdependencies among spatially close businesses (Boschma, 2005), beyond representing a strategic asset for the innovative milieu (Hansen, 1992).

Notable results are also obtained in Emilia-Romagna in terms of corruption, indicating a lower abuse of public office for illegal gains and private benefits obtained to the detriment of society (Golden & Picci, 2005; Nifo & Vecchione, 2014). The relationship of this dimension of institutions with the innovative capacity of a region is largely recognised. Corruption – by increasing transaction costs, introducing a higher level of uncertainty that discourages local entrepreneurships, and reducing the revenues of incumbent firms that simultaneously limit the

propensity to invest and to put in place innovative activities – negatively affects regional innovative capacity (Rose-Ackerman, 2001).

In contrast, some improvements seem to be necessary to guarantee a satisfactory level of rule of law (i.e. social development, measured in terms of crimes, violence, tax evasions, trial times, and the shadow economy). Greater deterrence in relation to crime as well as a proper definition of the instruments to protect intellectual property could guarantee 'a high level of appropriability for new inventions, techniques, and products introduced in the market' (Rodríguez-Pose & Di Cataldo, 2015, p. 676), positively encouraging investments and innovative activities (Daniele & Marani, 2010).

5. Econometric analysis

5.1 Data and Methodology

In this section, the relationship between governance quality and innovative capacity is analysed by adopting an econometric approach. In particular, attention is paid to the impact on innovation of IQ and its different dimensions (corruption, government effectiveness, regulatory quality, rule of law, voice and accountability). The province (NUTS3) represents the functional economic unit. The analysis is carried out by using patent intensity as a dependent variable, provided by the ISTAT in Development Policy Statistics (*Indicatori Territoriali per le Politiche di Sviluppo*), while data on IQ is included in the dataset of Nifo and Vecchione (2014). Each specification also controls for the level of GDP per capita, the productive structure given by the share of employees in the manufacturing sector, the export capacity (measured as total export over GDP), and the human capital (calculated as the share of tertiary-educated individuals). Except for the GDP per capita which is provided by the EUROSTAT, all the other control variables are collected by the ISTAT in Development Policy Statistics, and in the economic literature focused on the causes of innovation and growth these variables are considered crucial

determinants of innovation. We also include the initial level of innovation in the model to consider the extent to which the innovation disparities narrow or widen. In line with these considerations, the model is formulated as follows:

$$Y_{i,T-t} = \alpha + \beta_1 Y_{i,t} + \beta_2 I_{i,t} + \sum_{n=1}^{N} \gamma_n X_{ni,t} + \varepsilon_{i,t}, \quad (1)$$

where $Y_{i,T-t}$ is the dependent variable and captures the growth of patent intensity from 2004 to 2011, while $Y_{i,t}$ is the natural log of patent intensity in 2004 and is included to verify if and to what extent a convergence process is occurring. $I_{i,t}$ indicates the six dimensions of IQ in 2004. Finally, $X_{ni,t}$ represents the set of control variables included in the regressions. In particular, among the regressors, the natural log of GDP per capita is used to capture the extent to which more developed and wealthy places present a better capacity to innovate (Hudson & Minea, 2013). We also control for the provincial productive structure by including in the model the percentage of total employment in the manufacturing sector. According to the consolidated development economics literature, the role of manufacturing as an engine of innovation is well established (Rodríguez-Pose & Di Cataldo, 2015). A largely adopted input of innovation that must be included among the regressors is the level of education of the resident population, which may affect innovation dynamics and the relationship between IQ and innovation growth. The several beneficial consequences associated with a greater human capital base are largely confirmed in the knowledge production function (KPF) literature (Crescenzi, Rodríguez-Pose & Storper, 2007; Rodríguez-Pose & Di Cataldo, 2015). Therefore, the stock of provincial human capital, proxied by the share of tertiary-educated individuals as a percentage of total population, is included among the regressors. Finally, we include the ratio between total export and GDP as a proxy for export intensity. It largely recognises the crucial role associated with the international openness of a province for its innovation and economic performance in general

(Gambardella, Mariani & Torrisi, 2009). In Table A4 in Appendix A, the descriptive statistics of the variables used in the econometric analysis are reported.

5.2 Estimation Results

In Tables 6, the estimation results are reported. In particular, the negative and statistically significant beta parameter of the initial level of patent intensity indicates an overall convergence process during the period 2004–2011. In other words, less innovative provinces have been able to catch up with more innovative ones, narrowing the gap over the considered period. With respect to the control variables, the coefficient associated with the GDP per capita is positive and significant, suggesting that more developed provinces, which present a higher level of income per capita, also register better innovation growth. Moreover, the coefficient associated with the share of tertiary-educated individuals is positive and significant, indicating that a higher human capital base represents a crucial factor able to foster provincial innovation. Furthermore, the crucial role of the manufacturing sector is confirmed by the positive and statistically significant coefficient related to this variable, which implies that a greater share of this industry represents an important engine of provincial innovation. Finally, in line with the economic literature, provinces which present a higher propensity to export have also shown better innovative performance.

In light of the abovementioned peculiar economic features of Emilia-Romagna, these econometric findings seem to corroborate the idea that the structural characteristics of the region constitute the foundations of its economic development and contribute, together with Lombardy and Veneto, to towing the economy of the whole country. In particular, the strong manufacturing base mainly oriented towards mechatronics and characterised by a process of gradual consolidation of firm size, excellent export propensity, the greater capacity to favour the process of human capital formation, and the ability to attract and to retain tertiary-educated

individuals seem to be, among others, important sources of innovation underpinning the economic success of Emilia-Romagna.

Concerning our variables of interest, the positive effect of the overall IQ, which is consistent with the findings of other studies (Rodríguez-Pose & Di Cataldo, 2015), is confirmed by the positive and statistically significant coefficient associated with this variable, demonstrating that IQ represents an important determinant of a province's innovative capacity. As a consequence, the developed institutional framework which strongly characterised Emilia-Romagna could have contributed to improving firms' innovation capacity because of the presence of a fertile institutional ecosystem. These results are reinforced once the IQ index is disentangled into its five dimensions, confirming our expectation regarding the leading position and competitive advantage of Emilia-Romagna. The main findings reveal that the quality of public services (government effectiveness) and the degree of association and social cooperation (voice and accountability), which are the most important institutional dimensions in Emilia-Romagna, represent the main channels through which institutions positively affect the innovative performance.

[Insert Tables 6 here.]

5.3 Endogeneity issue: Addressing reverse causality

The econometric model presents several sources of bias that must be accounted for. First, the endogeneity issue, given the reverse causality between the dependent variable and the IQ regressors, could create a systematic distortion. To this end, we perform tests to determine whether IQ should be considered as endogenous or not. In detail, we implement Wooldridge's (1995) test, which suggests that our variables of interest can be treated as exogenous. The results for each IQ dimension are reported in Table 6. However, in order to improve the robustness of

our estimates, we take into account the endogeneity issue due to the reverse causality between institutions and innovation by adopting an instrumental variable estimation approach based on a two-stage least square procedure (2SLS). The purpose is to obtain an exogenous variation in IQ, and the economic literature provides several solutions on exclusion restrictions that can be relied on. As highlighted by Rodríguez-Pose and Di Cataldo (2015), past literacy rate can be considered a suitable instrumental variable, as it 'represents an important source of variation for the cultural traits and level of social capital of European regions [and] . . . an exogenous determinant of current government quality' (p. 691). Furthermore, we complement this instrument with the regional voter participation rate at national and European elections (number of voters as a proportion of the total electorate). As indicated by Miles (2015), 'systems in which the arbitrating institutions (courts, bureaucracy, and civil service) govern fairly (control corruption, provide the rule of law) are associated with higher levels of voter turnout' (p. 371). At the same time, people who belong to contexts characterised by better IQ might be mainly motivated to participate in elections to help improve the system where they live, thus creating a self-enforcing virtuous circle.

The high correlations between the instruments and the several measures of IQ seem to provide a preliminary validity of our choice. However, although evidence concerning the correlation is rather comforting, we have to statistically justify the relevance and orthogonality of the external instruments. Therefore, in Table 7, we report the underidentification test, which helps evaluate if the correlation between the excluded instruments and endogenous variables is high enough and thus informs the relevance of the instruments. Yet it is important to remark that in the presence of heteroskedasticity, which occurs when the i.i.d. assumption is no longer valid as in our case, we have to look at the LM and Wald versions of the Kleibergen and Paap (2006) rk statistics instead of Anderson LM and Cragg–Donald Wald statistics. The several tests seem to reject the null hypothesis, confirming that the models are correctly identified.

Moreover, we test the validity of our instruments by relying on Hansen's (1982) J-test for overidentifying restrictions when the standard errors are robust to heteroskedasticity. In this case, the validity of the instrumental variables is confirmed by the fact that the null hypothesis cannot be rejected at 10%.

The results reported in Table 7 reveal an interesting overall scenario when we control for the endogeneity issue. The main findings, in fact, besides confirming a positive and statistically significant effect associated with government effectiveness and voice and accountability, seem to indicate an important role played by an additional institutional variable. In particular, as indicated by the positive and statistically significant coefficient associated with rule of law, the capacity to reduce criminality rate, level of tax evasion and shadow economy positively encourage the creation of a favourable environment for the innovative capacity. As to what concerns the control variables, the results remain substantially unchanged, and the level of GDP per capita as well as the manufacturing employment, the export capacity, and the human capital still play crucial roles in explaining innovative performance.

[insert here Table 7]

5.4 Spatial issue: Addressing spatial dependence

The potential spill-over effects among spatially related provinces could represent another notable source of bias. The innovative capacity of a province could affect the innovative performance of the neighbouring provinces, raising the necessity to account for spatial dependence. Thus, in Table 6, we also report Moran's I tests for spatial autocorrelation in pooled residuals using a row-standardised spatial weight matrix of 103 Italian provinces. The results highlight the substantial presence of spatial dependence in the data. Hence, according to the literature, a possible approach to introduce spatial effects is to include a spatially lagged dependent variable. In this way, the spatial autoregressive model (SAR) has the following form:

$$Y_{i,T-t} = \alpha + \rho \sum_{j=1}^{R} \omega_{ij} Y_{i,T-t} + \beta_1 Y_{i,t} + \beta_2 I_{i,t} + \gamma_n \sum_{n=1}^{N} X_{ni,t} + \varepsilon_{i,t}, \quad (2)$$

where ω_{ij} is set to the inverse of the distance between the centroids of province *i* and *j* and represents an element that belong to the row-standardised spatial weights matrix Ω.

A second frequently adopted approach is the spatial error model (SEM), which is used to handle spatial dependence because of omitted variables or errors in measurement by including a spatially auto-correlated error term of the following form:

$$\varepsilon_{i,t} = \lambda \sum_{j=1}^{R} \omega_{ij} \varepsilon_{jt} + \nu_{it}. \quad (3)$$

Therefore, Equation (1) will be modified as follows:

$$Y_{i,T-t} = \alpha + \beta_1 Y_{i,t} + \beta_2 I_{i,t} + \gamma_n \sum_{n=1}^{N} X_{ni,t} + \lambda \sum_{j=1}^{R} \omega_{ij} \varepsilon_{jt} + \nu_{it}. \quad (4)$$

Finally, spatial dependence could be addressed by introducing in the model both a spatially lagged dependent variable and a spatial error component (spatial autoregressive error model) and estimating the following equation:

$$Y_{i,T-t} = \alpha + \rho \sum_{j=1}^{R} \omega_{ij} Y_{i,T-t} + \beta_1 Y_{i,t} + \beta_2 I_{i,t} + \gamma_n \sum_{n=1}^{N} X_{ni,t} + \lambda \sum_{j=1}^{R} \omega_{ij} \varepsilon_{jt} + \nu_{it}. \quad (5)$$

As a result, to verify if and to what extent the quality of government and its components can support the innovative system and to confirm the robustness of the results, the analysis is carried out by estimating all the previously explained spatial econometric models.

Tables 8-10 confirm the results previously obtained: the estimated coefficient of IQ index remains positive and statistically significant in all the specifications demonstrating how well-

functioning institutions tends to favour knowledge creation and innovation. Furthermore, we find that, to a greater extent, the positive effects of institutions seem to involve two important dimensions: the amount of social capital and the presence of social and economic facilities. The coefficients associated to voice and accountability and to government effectiveness, in fact, indicate the positive link between these components and the capacity to innovate. Moreover, Tables 8 and 9 provide evidence of a positive effect on innovation related to low levels of corruption. According to the strategy adopted by Nifo and Vecchione (2014), in fact, high values of this index indicate an overall better scenario, while low values such as those registered in Campania, Sicily, and Calabria, which occupy the last positions of the ranking reported in Table A2 in Appendix A, are synonymous of a worse performance in terms of corruption.

Of the control variables, we find that a higher trade openness towards exports, a wider manufacturing base, a greater human capital endowment, and a higher level of economic development prove to be, almost in all the specifications, important determinants of innovation.

Translating these results into the Emilia-Romagna context, the main findings seem to reveal that all the previously described structural characteristics including several institutional infrastructures are playing an important role in shaping the innovation performance of this region.

6. Conclusions

Statistics on size, population, and GDP identify Emilia-Romagna as a medium (perhaps medium–large) region at both the Italian and the EU levels. However, certain special features come to the fore upon closer examination, qualities that turn it into a fairly significant case in 'regional' studies. These features, as we have shown in this study, include the quality of its administrative institutions, its ranking among European regions, its structural economic characteristics, and the public policies carried out by its regional government. While the Emilian model has been a subject of study in the international economic literature for many

years, the same cannot be said for all the other regions of Northern Italy that have similar economic performances.

Its economic structure certainly plays a major role. Horst Siebert (2005), the long-time economic advisor to Chancellor Kohl, described Germany in the introduction to his book, which doubles well as a description of the Emilia-Romagna economy:

> Germany is an open economy with a strong industrial base, producing about a third of its gross domestic product for export. It is also an economy in which social protection and the state play dominant roles. (p.1-2)

Stylised fact #1: the importance of manufacturing (in its limited definition, excluding construction) on the creation of regional value added is higher than 25% in Emilia-Romagna. This is called the 'manufacturing multiplier' (Mosconi, 2015), i.e. the strong contribution that manufacturing can make to an economic system as a whole when considering that an important part of the tertiary sector depends specifically on the demand that comes from the industry (e.g. transport and logistics, banking and insurance, marketing and advertising).

Stylised fact #2: the relationship between export and GDP is around 40% in Emilia-Romagna, proof of the high level of openness in this regional economy. As we make our final conclusions, we cannot stop there – and not only for reasons of comparative analysis. In fact, if the two abovementioned stylised facts (manufacturing base, exports) bring the economic structure of the region close to that of Germany, others show Emilia-Romagna to be lagging compared to the leading regions of the EU. The most important of these is investment in R&D.

Stylised fact #3: the ratio of R&D/GDP is an exceptional 5% in Baden-Württemburg and no higher than 2% in Emilia-Romagna. This is adequate in terms of national Italian averages (Italy as a whole, we should remember, invests 1.3% of its GDP in R&D) and is, in part, due to the institutional framework that has been created there. The ways by which an

ecosystem of innovation and research can be strengthened represent, in our opinion, one of the most promising directions of research to be developed in this strand of economic literature.

This is certainly not the only method, however, especially considering the 'new normal' in Italy, Europe, and the world in 2020 ever since the explosion and spread of the COVID-19 virus and everything that it has brought in terms of economic consequences and human tragedy. One question has become preeminent in the international economic debate that has accompanied the end of the first stage of the pandemic (health emergency, lockdown, etc.): what will the globalisation of tomorrow look like? In other terms, how will this be a different globalisation from that which the world knew between the end of the 20th century and the beginning of the 21st?

This general question touches Emilia-Romagna directly, specifically because of the two structural characteristics that we have often mentioned in this work. Because of these, many of the region's manufacturing firms are part of the GVC to varying degrees, but these GVCs will most likely change in the post-coronavirus world. In Italy, many scholars (e.g. Francesco Giavazzi, Stefano Manzocchi, Romano Prodi) have put forth their hypotheses in the direction of a *regional-scale globalisation*. Will it work?

In Richard Baldwin's seminal work (2016), we learned the difference between the 'first unbundling' and 'second unbundling' of the global economy and thus, in his own words, between 'old' and 'new globalisation'. In 2016, he published *The Great Convergence* (meaning the convergence between the G7 nations and newly industrialised nations, starting with China), which had the significant subtitle of *Information Technology and the New Globalisation*. Today, after the double shock to the system (on the sides of both supply and demand) that the spread of the virus has given to the manufacturing world, Baldwin's thoughts (2020) are now focused on 'supply chain contagion waves'. In one of his first new analyses, he pointed out,

> The key point is that GVC is far more regionalised than trade in final goods. Indeed, there are no major linkages between the three industrial giants [Deutschland, China, the United States] – at least at this level of abstraction. This [suggests] that supply chain contagion will be mostly regional, not global. (Baldwin, 2020)

Afterwards, he analysed what he calls 'total dependency, i.e. exposure, of one nation's supply side (production) to the production of other [nations]', stating,

> The first fact that jumps out [from the figure] is China's dominance when it comes to imported manufacturing intermediates. China really is the workshop of the world – it is central to the entire global network of trade and production. Manufacturing inputs from China make up over 3.6% of every major nation's manufacturing output . . . Plainly, the COVID [shutdown] of Chinese manufacturing will clearly have a big impact on manufacturing sectors globally. (Baldwin, 2020)

The economy of Emilia-Romagna is deeply invested in both the phenomena described by Baldwin (2020) and those in other recent works (Baldwin & Tomiura, 2020). In particular, if the 'regionalisation of supply chain trade' is a clear empirical fact, a study of the changes within the GVCs where Emilia-Romagna firms have a role could be a promising direction for future research.

Stylised fact #4: the high quality of Emilia-Romagna institutions, besides representing one of the strengths of the region, seems to have acted as a 'social filter' or 'catalyst' that intercepts the deep economic and social transformations during the last two decades (manufacturing transformation, servitisation of manufacturing firms, digitalisation process and globalisation) by favouring the creation of a prolific regional ecosystem that increases regional resilience and stimulates innovative process. Our analysis shows a regional economy that is

fully part of both European and international trade, primarily because of the innovative nature of its manufacturing firms.

Furthermore, the strong social cohesion characterising the Emilia-Romagna region could have played two additional important roles. On the one hand, it seems to have helped reinforce the effects of policy interventions by easing the adaptation of the regional system. On the other hand, the presence of a well-rooted social capital could have limited the negative effects of social fragmentation that often arises with industrial revolutions and structural changes (Bianchi & Labory, 2019b). In sum, this regional economic system has the necessary grounding and stability to face the most recent changes.

Notes

1. The common characteristic of these analyses is an assessment of the relationship between 'social capital' and the quality of economic development in Italy (Sabatini, 2005), and – more in details – in its regions and provinces (Degli Antoni, 2006). In the former, 'social capital is measured through synthetic indicators representing strong family ties, weak informal ties, voluntary organization, and political participation'. In the latter, the two proxies are (i) the data drawn from the *World Values Surveys* ('most people can be trusted'), and (ii) the 'quantity and quality of associational life and related social norms'.
2. This concept was introduced to international debate because of Brusco's (1982) contribution.
3. The five dimensions have been elaborated by aggregating 24 elementary indices.
4. In the figures released by Unioncamere Emilia-Romagna (2020), the base year (2000) has an index value equal to 100: in the years between 2007 and 2019 (the last year before the pandemic), Emilia-Romagna's economy has shown a satisfactory growth rate (111.5) while Italy lagged behind (104.5).
5. Annual GDP growth rates (Banca d'Italia, 2020): Emilia-Romagna 1.7% (2016), 2.3% (2017), 1.8% (2018); Veneto 1.8% (2016); 2.2% (2017), 1.3% (2018); Lombardia 1.9% (2016), 2.1% (2017), 0.6% (2018).
6. On this transformation (the so-called, 'metamorphosis'), an extensive empirical evidence has been provided by a University of Parma research project (Mosconi, 2008, 2011, 2012, 2018).
7. https://ec.europa.eu/eurostat/data/database
8. Considering the results of a survey, the Bank of Italy (Bentivogli & Viviano, 2012, p. 14) wrote that 'Emilia-Romagna was the first Italian region by incidence of cooperative employment on total non-agricultural jobs (9.7% against 4.6% of the national average) and by average size of cooperative firms (34.8 employees, more than double the national average' (our translation).
9. Fumagalli, Mosconi, Saruis and Tomasello (2018).
10. Prodi and Frattini (2018).
11. Andreoni, Frattini and Prodi (2017).
12. This is the definition proposed by the EUROSTAT in the NACE Rev. 2.
13. In a medium-term analysis (1999-2016), the Directorate General for Economics of the Bank of Italy (Bugamelli et al., 2017, pp 5-6) argues that the relatively unsatisfactory performance of Italian aggregate exports between 1999 and 2007 was 'the result of the interplay between three factors. The first is the significant appreciation of the real effective exchange rate for Italy (…) The second factor is the initial specialization in productions that were particularly exposed to the increasing competition of low-wage countries (China in particular) on world

exports (…) The third factor, which is intertwined with the previous two, is the size distribution of Italian firms and in particular the large number of small exporters, which struggled to: i) defend their exports in the face of the exchange rate appreciation; ii) keep pace with external demand; iii) successfully face competition from low-wage countries.' Over the next six-year period, the authors point out that 'Italian exports have significantly supported GDP growth and have outpaced the demand stemming from destination market'. Thus, the question becomes: 'To what extent do these facts signal a successful structural adjustment? On this, our evidence is mixed. On the one hand, cyclical or temporary factors may have been at play (…) On the other hand, the specialization of Italy's exports shifted towards sectors (vehicles and pharmaceuticals) that are less exposed to competitive pressure stemming from Chinese producers, and towards productions that are particularly effective in activating domestic value added (food and beverages). Moreover, the selection process triggered by the exceptional difficulties encountered by micro and small firms both before and during the global financial crisis might have structurally strengthened the population of Italian exporters, making it more resilient to negative shocks and more capable of taking advantage of new opportunities.' (Bugamelli et al., 2017, p. 5-6).

14. Another recent analysis of the Directorate General for Economics of the Bank of Italy focusses on productivity growth in the medium-long term (since the second half of the 1990s). 'In explaining the underperformance of Italy's aggregate productivity' – according to Bugamelli et al. (2018, p. 5-6) – the heterogeneity across firms within each sector is a crucial element, relatively more important than the heterogeneity across sectors. This is the consequence of a very polarized productive system. On the one hand, there are many micro and small enterprises, which are on average old, have a limited attitude to innovation, to the adoption of advanced technology and to internationalization, are ineffective in their management skills and practices and have a vulnerable financial structure (…) Such a large share of micro and small firms curbs aggregate productivity growth not only via a composition effect, 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). On the other hand, there is a small set of firms, mostly medium- and large-sized, whose efficiency, performance and strategies (in terms of innovation, technology and exports) are comparable to the most successful European competitors (…) It is these firms that are currently supporting growth. However, these high-performance firms' average size and share of value added are smaller in Italy than in other countries.'

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Table 1: Main macroeconomic variables

	Italy			Emilia-Romagna		
	2008	2018	Var. %	2008	2018	Var. %
GDP	1,567,853 € mln	1,765,421 € mln	12.6	138,088 € mln	161,705 € mln	17.1
Export	369,015 € mln	465,325 € mln	26.1	47,528 € mln	63,762 € mln	34.2
Value added	1,409,139 € mln	1,583,357 € mln	12.4	124,500 € mln	144,850 € mln	16.3
Employment rate	58.6%	58.5%	-0.2	70.2%	69.6%	-0.9
Unemployment rate	6.7%	10.6%	58.2	3.2%	5.9%	84.4

Sources: Our elaborations. Indicatori territoriali per le politiche di sviluppo. Istat (2020).

Table 2: Employees in manufacturing sector by size of the firm in Emilia-Romagna and in Italy.

EMILIA-ROMAGNA **SIZE OF THE FIRM**	**1991**		**2001**		**2011**		**2017**	
	n.	**%**	**n.**	**%**	**n.**	**%**	**n.**	**%**
0-9	143,621	27.0	126,040	23.4	97,980	21.9	86,853	19.8
10-49	180,771	34.0	187,535	34.8	153,385	34.2	141,100	32.1
50-249	130,762	24.6	139,751	26.0	128,100	28.6	130,276	29.7
250 and over	76,227	14.4	85,373	15.8	68,571	15.3	81,080	18.5
Total	531,381	100.0	538,699	100.0	448,036	100.0	439,309	100.0
ITALY **SIZE OF THE FIRM**	**1991**		**2001**		**2011**		**2017**	
	n.	**%**	**n.**	**%**	**n.**	**%**	**n.**	**%**
0-9	n.a.	n.a.	1,152,165	24.0	1,023,943	26.4	846,943	23.0
10-49	n.a.	n.a.	1,531,083	31.8	1,269,917	32.7	1,124,921	30.5
50-249	n.a.	n.a.	1,029,159	21.4	958,977	24.7	835,034	22.7
250 and over	n.a.	n.a.	1,098,267	22.8	628,214	16.2	877,681	23.8
Total	n.a.	n.a.	4,810,674	100.0	3,881,051	100.0	3,684,579	100.0

Sources: Our elaborations. Istat (1991; 2001; 2011; 2020)

Table 3: Manufacturing value added by economic activity (NACE Rev. 2)

	1996		2006		2016	
ECONOMIC ACTIVITY (NACE REV. 2)	€ MLN	%	€ MLN	%	€ MLN	%
Food [a]	2,231.6	10.6	3,031.8	10.7	4,204.9	12.5
Textiles, clothing, and leather [b]	1,990.0	9.5	1,942.4	6.8	1,735.5	5.2
Wood, paper, and printing [c]	1,378.7	6.6	1,712.1	6.0	1,247.6	3.7
Chemicals, pharmaceutical, coke, and petrol [d]	1,622.4	7.7	1,731.4	6.1	2,403.4	7.1
Rubber and plastics [e]	2,975.8	14.2	3,711.6	13.1	3,805.5	11.3
Metallurgy, and metal products [f]	2,855.8	13.6	4,223.7	14.8	4,242.9	12.6
Computer; optical, electronic, and electric devices [g]	5,510.5	26.3	8,373.7	29.4	10,653.6	31.6
Transport [h]	1,150.6	5.5	1,900.0	6.7	3,263.7	9.7
Furniture [i]	1,253.2	6.0	1,824.9	6.4	2,124.5	6.3
MANUFACTURING INDUSTRY	*20,968.6*	*100*	*28,451.6*	*100*	*33,681.6*	*100*

Sources: Our elaborations. Istat (2010; 2020)
Note:
[a] Manufacture of food products, beverages and tobacco products.
[b] Manufacture of textile, apparel, leather and related products.
[c] Manufacture of wood and paper products, and printing.
[d] Manufacture of coke, and refined petroleum products; manufacture of chemicals and chemical products; manufacture of pharmaceuticals.
[e] Manufacture of rubber and plastics products, and other non-metallic mineral products.
[f] Manufacture of basic metals and fabricated metal products, except machinery and equipment.
[g] Manufacture of computer, electronic and optical products; manufacture of electrical equipment; manufacture of machinery and equipment n.e.c.
[h] Manufacture of transport equipment.
[i] Manufacture of furniture; other manufacturing, and repair and installation of machinery and equipment.

Table 4: Manufacturing export by economic activity (NACE Rev. 2)

ECONOMIC ACTIVITY (NACE REV. 2)	2011			2018		
	Value (€ mln)	%	Var.	Value (€ mln)	%	Var.
Food [a]	4,013	8.4	12.1	5,595	8.8	5.2
Textiles, clothing, and leather [b]	5,025	10.5	16.0	7,038	11.1	6.9
Wood, furniture, paper, and printing [c]	505	1.0	4.6	492	0.8	4.5
Chemicals, pharmaceutical, coke, and petrol [d]	3,847	8.0	10.0	4,740	7.4	6.3
Rubber and plastics [e]	4,756	9.9	2.8	5,917	9.3	-1.5
Metallurgy, and metal products [f]	3,725	7.8	11.1	4,916	7.8	7.8
Computer; optical, electronic, and electric devices [g]	3,434	7.2	3.4	5,086	8.0	7.2
Machinery and equipment n.e.c. [h]	14,726	30.7	20.9	18,562	29.3	4.9
Transport [i]	5,231	10.9	19.8	7,248	11.4	7.2
Other manufacturing	1,494	3.1	6.9	2,062	3.3	8.4
MANUFACTURING INDUSTRY	*46,756*	*97.5*	*13.7*	*61,656*	*97.2*	*5.4*

Sources: Our elaborations. Istat (2012; 2019)
Note:
[a] Food products, beverages and tobacco products.
[b] Textile, apparel, leather and related products.
[c] Wood and paper products, and printing.
[d] Coke, and refined petroleum products; chemical products; pharmaceutical products.
[e] Rubber and plastics products, and other non-metallic mineral products.
[f] Basic metals and fabricated metal products, except machinery and equipment.
[g] Computer, electronic and optical products; electrical equipment;
[g] Machinery and equipment n.e.c.
[h] Transport equipment.
[i] Products of other manufacturing activities.

Table 5: Total R&D expenditure over GDP and patent intensity, by region

Total R&D expenditure over GDP		*Patent intensity*	
Region	2017	Region	2012
Emilia-Romagna	1.98	Emilia-Romagna	132.9
Lombardy	1.28	Lombardy	93.3
Veneto	1.30	Veneto	101.5
Italy	1.38	Italy	58.8

Source: Our elaborations. Indicatori territoriali per le politiche di sviluppo. Istat (2020).

Table 6: Robust ordinary least squares estimation results.

Variable	Ordinary least squares					
	(1)	(2)	(3)	(4)	(5)	(6)
$lnpatent_{i,t}$	-0.7110***	-0.6384***	-0.7097***	-0.6372***	-0.6253***	-0.6661***
	(0.1082)	(0.1008)	(0.1061)	(0.1037)	(0.1033)	(0.1099)
ln(GDP)	1.6943***	1.7877***	2.0957***	2.3479***	2.2071***	2.0605***
	(0.4797)	(0.5371)	(0.5133)	(0.4955)	(0.5344)	(0.4923)
Manufact. employment	3.3856***	4.5736***	4.2059***	3.6958***	3.7991***	3.6827***
	(1.2882)	(1.4059)	(1.217)	(1.3545)	(1.2761)	(1.3168)
Export	0.0064**	0.0063**	0.0069**	0.0061*	0.0068**	0.0068**
	(0.003)	(0.0031)	(0.0032)	(0.0033)	(0.0033)	(0.0032)
Graduates	0.0440*	0.0331	0.0421*	0.0451**	0.0454**	0.0514**
	(0.0223)	(0.0242)	(0.0221)	(0.0222)	(0.0219)	(0.022)
IQI	1.5047**					
	(0.6508)					
Voice and accountability		1.0541*				
		(0.6287)				
Government effectiveness			1.3672***			
			(0.4292)			
Rule of law				0.2836		
				(0.3967)		
Regulatory quality					0.2916	
					(0.4318)	
Corruption						0.9084
						(0.716)
Constant	-17.0179***	-17.8409***	-20.6643***	-23.1607***	-21.8199***	-20.8143***
	(4.5358)	(5.0451)	(4.8863)	(4.7679)	(5.0876)	(4.6241)
N	103	103	103	103	103	103
R^2	0.42	0.40	0.41	0.38	0.38	0.40
Wooldridge's test (*p-value*)	2.01 (*0.159*)	4.06 (*0.047*)	1.88 (*0.174*)	4.08 (*0.046*)	4.75 (*0.032*)	3.49 (*0.065*)
Moran's I test (*p-value*)	2.17 (*0.015*)	1.96 (*0.025*)	1.51 (*0.065*)	2.43 (*0.008*)	2.25 (*0.012*)	2.39 (*0.008*)

Source: Our elaborations. EUROSTAT (2020), ISTAT (2020), and Nifo and Vecchione (2014) data.
Note: *statistically significant at the 10%; **statistically significant at 5%. *** statistically significant at 1%. Standard errors robust to the heteroskedasticity are given in parenthesis.

Table 7: Robust two-stage least squares estimation results.

Dependent Variable:	Two-stage least squares					
Patent growth rate	(7)	(8)	(9)	(10)	(11)	(12)
$lnpatent_{i,t}$	-0.8229***	-0.6749***	-0.8073***	-0.7379***	-0.6403***	-0.6884***
	(0.1403)	(0.1076)	(0.1479)	(0.148)	(0.1051)	(0.109)
ln(GDP)	0.7446	-0.8209	1.7459***	1.8744***	2.7546***	1.8626***
	(0.782)	(1.5906)	(0.581)	(0.6085)	(0.977)	(0.5722)
Manufact. employment	2.5868*	7.2543***	4.5027***	-0.0971	4.3159***	3.5094***
	(1.4613)	(2.2832)	(1.3514)	(3.0041)	(1.4895)	(1.3206)
Export	0.0064**	0.0060*	0.0074**	0.0027	0.0054	0.0071**
	(0.0029)	(0.0034)	(0.0034)	(0.0051)	(0.0037)	(0.0033)
Graduates	0.0437*	-0.0155	0.0395*	0.0580*	0.0417*	0.0558**
	(0.0239)	(0.0451)	(0.0225)	(0.0339)	(0.0223)	(0.0237)
IQI	3.5843**					
	(1.6387)					
Voice and accountability		5.6861**				
		(2.7889)				
Government effectiveness			3.0416*			
			(1.7349)			
Rule of law				4.2998*		
				(2.4739)		
Regulatory quality					-0.6246	
					(1.3281)	
Corruption						1.4685
						(1.1338)
Constant	-8.1987	6.5817	-17.3149***	-19.7862***	-26.7815***	-19.2207***
	(7.1725)	(14.8747)	(5.4049)	(5.4990)	(9.0405)	(5.0684)
N	103	103	103	103	103	103
R^2	0.34	0.29	0.36	0.38	0.35	0.39
Under-identification test (*p-value*)	21.261 (*0.000*)	7.152 (*0.028*)	7.516 (*0.057*)	8.5 (*0.036*)	9.692 (*0.021*)	19.483 (*0.000*)
Hansen's J test (*p-value*)	2.588 (0.274)	1.782 (*0.182*)	3.467 (*0.176*)	1.452 (*0.483*)	4.039 (*0.132*)	4.401 (*0.110*)

Source: Our elaborations. EUROSTAT (2020), ISTAT (2020), and Nifo and Vecchione (2014) data.
Note: *statistically significant at the 10%; **statistically significant at 5%. *** statistically significant at 1%. Standard errors robust to the heteroskedasticity are given in parenthesis.

Table 8: Robust spatial autoregressive (SAR) estimation results.

Variable	SAR					
	(13)	(14)	(15)	(16)	(17)	(18)
$lnpatent_{i,t}$	-0.6936***	-0.6265***	-0.6931***	-0.6248***	-0.6147***	-0.6514***
	(0.0885)	(0.0851)	(0.0897)	(0.0862)	(0.0859)	(0.0871)
Rho	0.1708	0.1788	0.1861*	0.2023*	0.2004*	0.1889*
	(0.1079)	(0.1091)	(0.1085)	(0.1090)	(0.1087)	(0.1081)
ln(GDP)	1.6950***	1.8279***	2.0482***	2.2765***	2.1727***	2.0247***
	(0.4525)	(0.5048)	(0.4015)	(0.3956)	(0.4709)	(0.4239)
Manufact. employment	3.2341***	4.2501***	3.9647***	3.4768***	3.5957***	3.4855***
	(1.0587)	(1.1164)	(1.0501)	(1.1288)	(1.0967)	(1.0668)
Export	0.0064**	0.0063**	0.0068**	0.0061**	0.0067**	0.0068**
	(0.003)	(0.0029)	(0.0029)	(0.0029)	(0.003)	(0.003)
Graduates	0.0406*	0.0315	0.0385	0.041*	0.0411*	0.0469*
	(0.0238)	(0.0248)	(0.0238)	(0.0245)	(0.0245)	(0.0245)
IQI	1.3653**					
	(0.5445)					
Voice and accountability		2.1998***				
		(0.4749)				
Government effectiveness			1.2669**			
			(0.5549)			
Rule of law				0.2584		
				(0.3961)		
Regulatory quality					0.2256	
					(0.4373)	
Corruption						0.8128*
						(0.4891)
Constant	-16.8856***	-18.0763***	-20.0766***	-22.3252***	-21.3281***	-20.2864***
	(4.2014)	(4.7054)	(3.7477)	(3.6763)	(4.3475)	(3.8672)
N	103	103	103	103	103	103

Source: Our elaborations. EUROSTAT (2020), ISTAT (2020), and Nifo and Vecchione (2014) data.
Note: *statistically significant at the 10%; **statistically significant at 5%. *** statistically significant at 1%. Standard errors robust to the heteroskedasticity are given in parenthesis.

Table 9: Robust spatial error model (SEM) estimation results.

Variable	SEM					
	(19)	(20)	(21)	(22)	(23)	(24)
$lnpatent_{i,t}$	-0.6917***	-0.6174***	-0.6769***	-0.6164***	-0.6002***	-0.6461***
	(0.0897)	(0.0861)	(0.0909)	(0.0874)	(0.0867)	(0.0879)
Lambda	0.1963	0.1837	0.1430	0.2347*	0.2165*	0.2310*
	(0.1276)	(0.1285)	(0.1312)	(0.1247)	(0.1261)	(0.1250)
ln(GDP)	1.6296***	1.7983***	2.0763***	2.2664***	2.1454***	2.0346***
	(0.4742)	(0.5284)	(0.4203)	(0.4166)	(0.4922)	(0.4320)
Manufact. employment	3.0979***	4.2127***	3.8805***	3.1824***	3.4075***	3.2579***
	(1.0743)	(1.1459)	(1.0765)	(1.1455)	(1.1193)	(1.0852)
Export	0.0063**	0.0060**	0.0066**	0.0059**	0.0066**	0.0068**
	(0.0028)	(0.0029)	(0.0029)	(0.0029)	(0.003)	(0.0029)
Graduates	0.0463*	0.0334	0.0403	0.0473*	0.0456*	0.0524**
	(0.025)	(0.0263)	(0.0251)	(0.0262)	(0.0261)	(0.026)
IQI	1.5604***					
	(0.5758)					
Voice and accountability		2.2744***				
		(0.4967)				
Government effectiveness			1.2376**			
			(0.5953)			
Rule of law				0.4423		
				(0.4383)		
Regulatory quality					0.3028	
					(0.4603)	
Corruption						0.9672**
						(0.4889)
Constant	-16.4465***	-17.9014***	-20.4551***	-22.4349***	-21.2149***	-20.5977***
	(4.4072)	(4.94)	(3.929)	(3.8779)	(4.5473)	(3.9631)
N	103	103	103	103	103	103

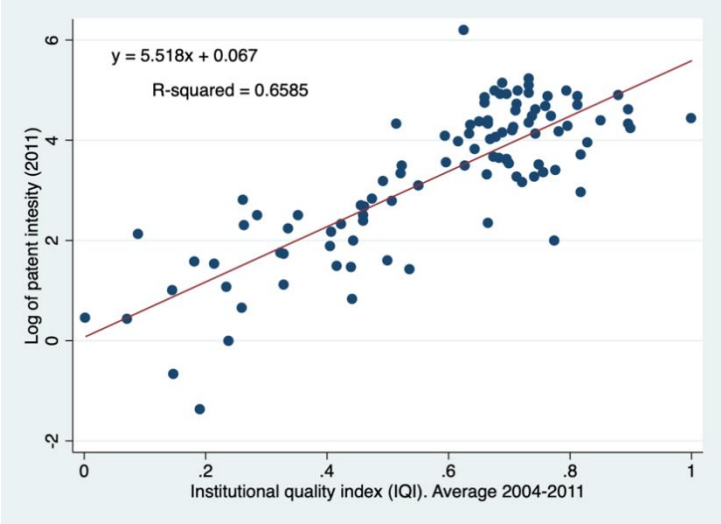
Source: Our elaborations. EUROSTAT (2020), ISTAT (2020), and Nifo and Vecchione (2014) data.
Note: *statistically significant at the 10%; **statistically significant at 5%. *** statistically significant at 1%. Standard errors robust to the heteroskedasticity are given in parenthesis.

Table 10: Robust spatial autoregressive error model (SARAR) estimation results.

Variable	SARAR					
	(25)	(26)	(27)	(28)	(29)	(30)
$lnpatent_{i,t}$	-0.6855***	-0.6087***	-0.6742***	-0.6067***	-0.5981***	-0.6486***
	(0.0908)	(0.0868)	(0.0908)	(0.0881)	(0.0873)	(0.0882)
Rho	0.2404	0.3346**	0.4293***	0.3444**	0.3579**	0.2206
	(0.1768)	(0.1592)	(0.1247)	(0.1666)	(0.1594)	(0.1918)
Lambda	-0.1083	-0.2599	-0.4806**	-0.2363	-0.2653	-0.0476
	(0.2457)	(0.2398)	(0.2082)	(0.2483)	(0.2425)	(0.2549)
ln(GDP)	1.7067***	1.7715***	1.8487***	2.1934***	2.0929***	2.015***
	(0.4383)	(0.467)	(0.3554)	(0.3858)	(0.4460)	(0.4228)
Manufact. employment	3.2623***	4.1423***	3.9320***	3.5871***	3.5995***	3.5085***
	(1.051)	(1.1068)	(0.9843)	(1.0994)	(1.0679)	(1.0656)
Export	0.0063**	0.0064**	0.0065**	0.006**	0.0064**	0.0067**
	(0.0029)	(0.0029)	(0.0028)	(0.003)	(0.003)	(0.003)
Graduates	0.037	0.0269	0.0323	0.0347	0.0343	0.0454*
	(0.0235)	(0.0227)	(0.0196)	(0.0228)	(0.0226)	(0.0247)
IQI	1.2627**					
	(0.552)					
Voice and accountability		1.9196***				
		(0.5316)				
Government effectiveness			1.2919***			
			(0.4403)			
Rule of law				0.1107		
				(0.3575)		
Regulatory quality					0.1595	
					(0.4023)	
Corruption						0.7788
						(0.5047)
Constant	-16.9079***	-17.4135***	-17.9938***	-21.3698***	-20.4164***	-20.1489***
	(4.0706)	(4.3553)	(3.3396)	(3.6296)	(4.152)	(3.8758)
N	103	103	103	103	103	103

Source: Our elaborations. EUROSTAT (2020), ISTAT (2020), and Nifo and Vecchione (2014) data.
Note: *statistically significant at the 10%; **statistically significant at 5%. *** statistically significant at 1%. Standard errors robust to the heteroskedasticity are given in parenthesis.

Figure 1


y = 5.518x + 0.067
R-squared = 0.6585
Log of patent intesity (2011)
-2
0
2
4
6
0
.2
.4
.6
.8
1
Institutional quality index (IQI). Average 2004-2011

Appendix A

Table A1 – The economy of Emilia-Romagna: main structural indicators

Value added by economic activity (NACE rev.2) and GDP in 2017 **(Banca d'Italia, 2019)**		
Agriculture, forestry and fishing		2.5%
Industry		30.9%
	of which:	
	Manufacturing	*26.6%*
	Construction	*4.3%*
Services		66.7%
Total value added		€140,934 million
GDP		€157,216 million
GDP *per capita*		€ 35,324 (124.0 Italy=100)
International trade in 2018 **(Banca d'Italia, 2019)**		
Exports		€63,427 million
Imports		€36,375 million
Degree of openness (exports + imports over GDP)		63.5%
R&D expenditure and patent intensity **(Istat, 2019)**		
Total R&D expenditure over GDP		1.98 (Italy=1.38)
Patent intensity (Patent applications per million of inhabitants)		132.9 (Italy=58.8)
Industrial districts **(Istat, 2015; Intesa Sanpaolo, 2018)**		
Istat, *I distretti industriali – 9° Censimento dell'industria 2011*		13 out of 141 (9.2%)
Intesa Sanpaolo, *Monitor dei distretti*		19 out of 157 «traditional» (12.1%)
Intesa Sanpaolo, *Monitor dei distretti*		3 out of 24 «technological poles»
Exports:		
	E-R's «traditional» industrial districts	€17.46 bn of €123.77 bn Italy (14.1%)
E-R's IDs with better economic performance (Index: 0-100)		2 out 20 best performant Italian IDs
	Mechatronics RE	77.9
	Packaging BO	68.1
Purchases' average distance:		
	E-R's industrial district enterprises	70 km
E-R's industrial districts with lower purchases' average distance:		2 out of 10 best performant Italian IDs
	Packaging BO	67 Km
	Mechatronics RE	79 Km
Share of E-R's champion enterprises		10.2%

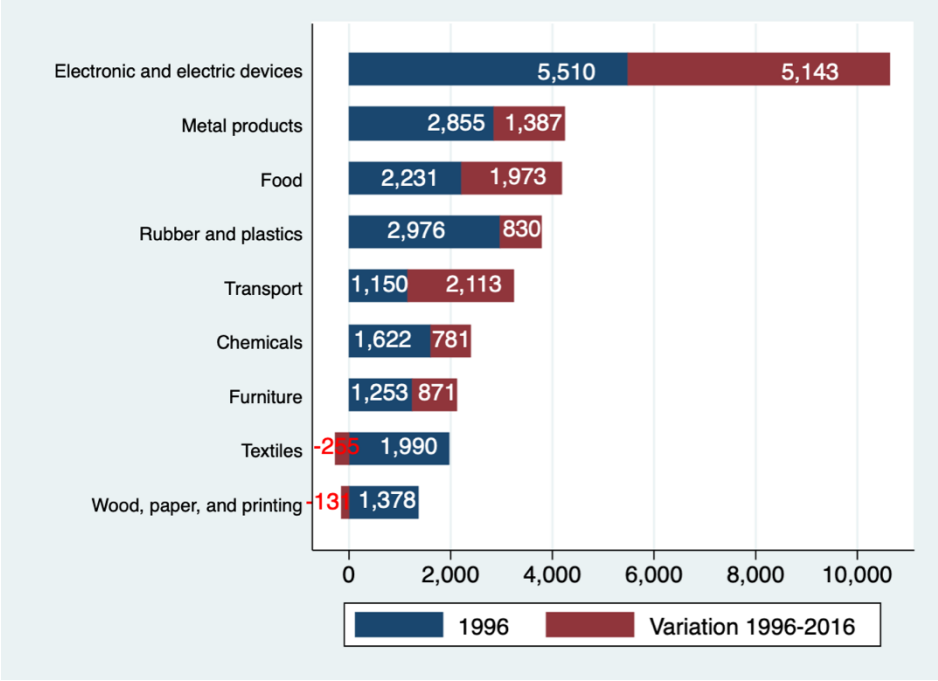
E-R's industrial district with higher share of champions:	2 out of 10 best performant Italian IDs
Ceramic machinery MO RE	19%
Agricultural machinery MO RE	17%

Table A1 (continued)

"Champion" enterprises in 2017 **(Il Corriere della Sera, 2019)**	
Emilia-Romagna's champion enterprises:	
Number	85 (14.2%)
Revenues	7,322.28 million (16.8%)
Employees	25,621 (16%)
Profits	776.95 million (17%)
Medium-sized enterprises in 2017 **(Mediobanca-Unioncamere, 2020)**	
Medium-sized industrial enterprises	508 out of 3,593 (14.1%)
Emilia-Romagna's share over total Italy:	
Revenues	15.2%
Exports	13.8%
Value added	15.0%
Multinationals in 2017 **(R&S Mediobanca, 2019)**	
Aggregate data of multinational enterprises	3 out of 22 (13.6%)
Leading Italian companies in 2017 **(R&S Mediobanca, 2019)**	
Manufacturing enterprises	161 out of 1167 (13.8%)
Emilia-Romagna's share over total Italy:	
Revenues	12.5%
Value Added	12.7%

Remark: Basic statistics for Emilia-Romagna (as a percentage of Italy): Population (7,3%); Land Area (7,4%); GDP (8,9%).
Sources: Our elaborations. Banca d'Italia (2019), Intesa Sanpaolo (2018), Istat (2015; 2019), Mediobanca-Unioncamere (2020), R&S Mediobanca (2019a, 2019b).

Figure A1 – Value added in 1996 and variation 1996-2016 (€ mln)



Sources: Our elaborations. Istat (2010; 2020)

Table A2: Regions' ranking by different dimensions of institutional quality in 2012

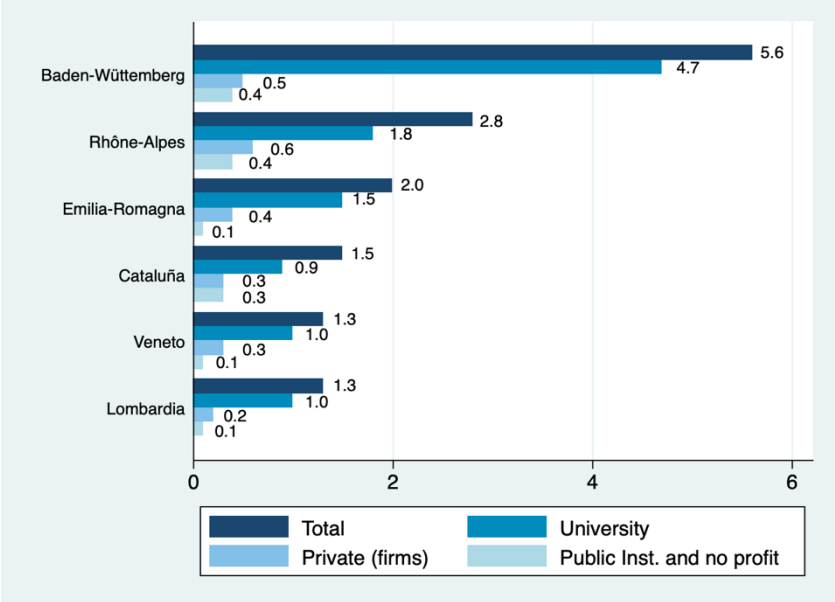
Institutional quality index (IQI)		*Voice and accountability*		*Government effectiveness*	
Region	(0 to 1)	Region	(0 to 1)	Region	(0 to 1)
Tuscany	0.88554	Emilia-Romagna	0.72088	Friuli-Venezia Giulia	0.72063
Trentino-Alto Adige	0.86434	Valle d'Aosta	0.70340	Emilia-Romagna	0.62078
Umbria	0.75044	Lazio	0.65816	Veneto	0.60557
Valle d'Aosta	0.74688	Lombardy	0.64333	Trentino-Alto Adige	0.59932
Veneto	0.73505	Liguria	0.63595	Tuscany	0.58872
Marche	0.73313	Tuscany	0.61534	Marche	0.58342
Friuli-Venezia Giulia	0.72727	Trentino-Alto Adige	0.56734	Lombardy	0.57238
Emilia-Romagna	0.72711	Veneto	0.55814	Umbria	0.55265
Abruzzo	0.72529	Piedmont	0.52334	Piedmont	0.53270
Lombardy	0.71226	Friuli-Venezia Giulia	0.50085	Liguria	0.51137
Piedmont	0.70990	Marche	0.49605	Abruzzo	0.41802
Lazio	0.67919	Sardinia	0.49524	Valle d'Aosta	0.41287
Liguria	0.54709	Umbria	0.48705	Campania	0.40088
Sardinia	0.45398	Abruzzo	0.46229	Sardinia	0.37398
Puglia	0.41974	Molise	0.44527	Lazio	0.33280
Basilicata	0.41724	Basilicata	0.40085	Puglia	0.31649
Campania	0.36160	Puglia	0.30770	Basilicata	0.26569
Molise	0.25636	Sicily	0.22327	Calabria	0.20663
Sicily	0.22906	Campania	0.17714	Sicily	0.18299
Calabria	0.09224	Calabria	0.15309	Molise	0.07498

Table A2 (Continued)

Regulatory quality		*Rule of law*		*Corruption*	
Region	(0 to 1)	Region	(0 to 1)	Region	(0 to 1)
Lazio	0.74515	Trentino-Alto Adige	0.82329	Umbria	0.98929
Tuscany	0.72930	Tuscany	0.82028	Veneto	0.95554
Valle d'Aosta	0.70963	Abruzzo	0.80490	Trentino-Alto Adige	0.95278
Emilia-Romagna	0.66628	Valle d'Aosta	0.77727	Tuscany	0.93584
Marche	0.63307	Umbria	0.68255	Piedmont	0.92914
Abruzzo	0.59976	Lazio	0.68073	Emilia-Romagna	0.91720
Piedmont	0.58034	Marche	0.62955	Marche	0.90491
Trentino-Alto Adige	0.57503	Piedmont	0.62734	Abruzzo	0.88921
Lombardy	0.57423	Veneto	0.58524	Lazio	0.87750
Umbria	0.57127	Campania	0.58329	Lombardy	0.84874
Liguria	0.56607	Lombardy	0.56531	Friuli-Venezia Giulia	0.84393
Sardinia	0.56100	Friuli-Venezia Giulia	0.54227	Basilicata	0.82741
Veneto	0.55058	Puglia	0.53728	Sardinia	0.81875
Friuli-Venezia Giulia	0.46479	Basilicata	0.48849	Molise	0.81394
Molise	0.44480	Emilia-Romagna	0.46550	Liguria	0.78189
Basilicata	0.34210	Sicily	0.40833	Puglia	0.77780
Sicily	0.24354	Sardinia	0.35906	Valle d'Aosta	0.69295
Campania	0.23424	Liguria	0.34430	Calabria	0.67948
Calabria	0.20563	Molise	0.33417	Sicily	0.57253
Puglia	0.19742	Calabria	0.13630	Campania	0.22033

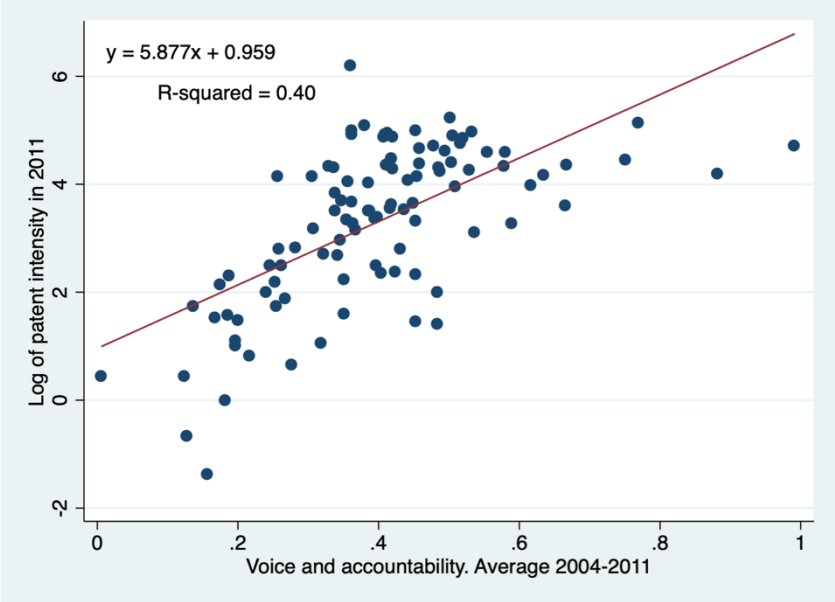
Source: Our elaborations. Nifo and Vecchione (2014) data.

Figure A2 – Intramural R&D expenditure as a share of GDP in 2017



Source: Confindustria Emilia-Romagna and Prometeia (2020)

Figure A3 – Relationship between voice and accountability and the log of patent intensity



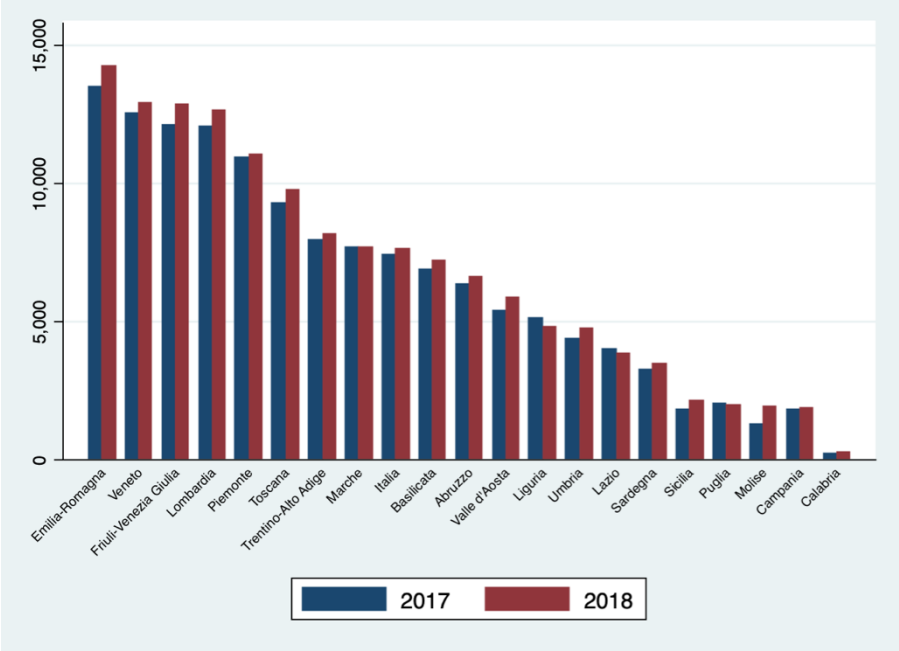
Source: Our elaborations. Istat (2019) and Nifo and Vecchione (2014) data.

Table A3: Ranking of Emilia-Romagna's provinces by different dimensions of institutional quality in 2012

Institutional quality index (IQI)		*Voice and accountability*		*Government effectiveness*	
Region	Ranking (score)	Region	Ranking (score)	Region	Ranking (score)
Ravenna	12 (0.81346)	Rimini	1 (1.00000)	Ravenna	5 (0.75440)
Forlì Cesena	19 (0.77191)	Bologna	4 (0.90824)	Rimini	7 (0.67831)
Rimini	21 (0.76452)	Ferrara	5 (0.74649)	Parma	15 (0.62905)
Piacenza	27 (0.74349)	Forlì Cesena	7 (0.73292)	Bologna	16 (0.62386)
Parma	42 (0.71561)	Ravenna	9 (0.72502)	Modena	18 (0.61675)
Reggio nell'Emilia	43 (0.71257)	Reggio nell'Emilia	12 (0.65341)	Reggio nell'Emilia	22 (0.59153)
Ferrara	44 (0.70617)	Piacenza	17 (0.61324)	Forlì Cesena	24 (0.58758)
Modena	45 (0.70354)	Modena	36 (0.52246)	Ferrara	30 (0.56902)
Bologna	51 (0.69496)	Parma	38 (0.51851)	Piacenza	40 (0.52497)
Regulatory quality		*Rule of law*		*Corruption*	
Region	Ranking (score)	Region	Ranking (score)	Region	Ranking (score)
Rimini	9 (0.76511)	Piacenza	55 (0.61165)	Piacenza	21 (0.94161)
Piacenza	10 (0.75065)	Forlì Cesena	58 (0.58161)	Reggio nell'Emilia	24 (0.93780)
Reggio nell'Emilia	13 (0.71462)	Ferrara	67 (0.51807)	Parma	28 (0.93306)
Modena	14 (0.71326)	Parma	68 (0.51774)	Rimini	35 (0.91997)
Ravenna	16 (0.70870)	Modena	70 (0.50693)	Forlì Cesena	37 (0.91698)
Parma	18 (0.69661)	Ravenna	76 (0.48450)	Ravenna	38 (0.91677)
Forlì Cesena	28 (0.64182)	Reggio nell'Emilia	77 (0.48014)	Modena	39 (0.91667)
Bologna	35 (0.60205)	Bologna	93 (0.33648)	Bologna	48 (0.89904)
Ferrara	60 (0.46765)	Rimini	94 (0.32527)	Ferrara	49 (0.89760)

Source: Our elaborations. Nifo and Vecchione (2014) data.

Figure A4 – Regional export *per capita* (2017 and 2018)



Source: Our elaborations. Indicatori territoriali per le politiche di sviluppo, Istat (2020) data.

Table A4: Summary statistics.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Patent intensity growth rate	103	-0.251	0.799	-3.527	1.768
Log of patent intensity	103	3.543	1.304	0.380	5.734
Institutional quality index (IQI)	103	0.594	0.228	0	1
Voice and accountability	103	0.411	0.183	0	1
Government effectiveness	103	0.269	0.158	0	1
Rule of law	103	0.599	0.196	0	1
Regulatory quality	103	0.515	0.218	0	1
Corruption	103	0.768	0.191	0	1
Log of GDP *per capita*	103	9.997	0.258	9.465	10.612
Manufacturing employment	103	0.200	0.082	0.066	0.390
Graduates	103	13.317	2.926	8.40	20.50
Export	103	29.860	21.009	0.445	92.425

Source: Our elaborations. EUROSTAT (2020), ISTAT (2020) and Nifo and Vecchione (2014) data.