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Index

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Introduction

This paper investigates whether the location of Italian ventures within a local innovation system (LIS) can drive their environmental, social, and governance (ESG) performance scores. In particular, we analyze the impact of the firms' geographical location on the total ESG score and its three sub-pillars.

A LIS can be defined as a set of localized networks of different actors (research institutes, universities, firms, and organizations) whose interaction creates a favorable setting for developing knowledge and innovation (Cooke et al., 1997; Doloreux, 2002).

Innovation in goods and services (and in their production processes) plays a crucial role in fostering economic growth (Antonelli, 2003; Pekkarinen & Harmaakorpi, 2006; Johnson, 2008). Therefore, on the one hand, for governments and institutions, it is crucial to create local ecosystems that can be attractive for innovation and support them with, among others, adequate education and training systems, appropriate financial institutions, and R&D infrastructures. On the other hand, it is recognized that firms' location in environments prone to innovation can improve their performance both at a local level and in the global economy.

Accounting for two main structural features of LIS (specifically the geographical proximity and the heterogeneity of the actors), we derive the indicators of innovation performance at the province level from several different sources: Geowebstarter database by Istituto Tagliacarne, National Institute of Statistics (ISTAT), Ministry of University and Research (MIUR), Ministry of Economic Development (MISE). The indicators capture distinct and relevant features of the innovation performance of a specific local area. They include patent and trademark intensity, the share of individuals with tertiary education, and the share of innovative start-ups or small and medium-sized enterprises.

Factor analysis is used to build up a summary measure of innovation performance, which accounts for all the previous indicators.

To investigate the association between the innovation performance of a local area and ESG factors of the firms located in that area, all the ventures situated in a province are given the measure of innovation performance of that province.

To retrieve ESG performance scores and financial indicators of the investigated companies (the Italian companies listed on the stock exchange), we use the Refinitiv Thomson Reuters Eikon database.

The acronym ESG stands for "Environmental, Social and Governance" and refers to the three relevant factors in measuring the sustainability of an investment: environmental factor (E), social factor (S) and governance factor (G).

More specifically, the environmental factors allow a company or government to contribute to climate change (climate change) through greenhouse gas emissions, together with waste management and energy. With renewed efforts to combat global warming, emission reduction and decarbonisation become more important (Boffo & Patalano, 2020)

The social aspects include human rights, labor standards in the supply chain, exposure to illegal child labor and other routine issues such as respecting health and safety in the workplace. A social score also increases if a company is well integrated with its local community and therefore has a "social license" to operate by consensus.

The governance factor refers to a set of rules or principles that pertain to the rights, responsibilities and elements between the various stakeholders in the governance (management) of the companies and, therefore, to all those that apply in meritocracy, to the diversity policies composition of the board of directors , the remuneration ethics of the main directors, the fight against corruption and the use of fair tax strategies. A well-defined corporate governance system can be used to balance or align interests among stakeholders and can function as a tool to support a company's long-term strategy.

The ESG factors appear increasingly important today, as they also allows investors to have a greater and deeper understanding of the sustainability of a company.

ESG principles are extra-financial parameters that are added to the "classic" economic parameters, thus increasing the information available to formulate an opinion on the company. For investors, the ESG criteria - or rather the ESG scores and ratings - also serve to assess their soundness in terms of investment. In fact, we speak of sustainable finance when, in addition to economic objectives, environmental and social ones are also taken into consideration.

Sustainability therefore becomes a strategic component and a guideline in business practices to generate collective well-being and reduce the impact on the planet. Consequently, the evaluation of a company must take into account both economic and social and environmental performance: this is the purpose of the ESG criteria and related indicators (ESG score and rating) (OECD 2021a; OECD 2021b)

ESG ratings are processed by agencies specialized in the collection and analysis of data on the sustainability aspects of business activities. ESG rating agencies, including MSCI, Morningstar, Sustainalytics, Refinitiv and many others, use assessment meters that can differ significantly from each other: therefore, even their respective ratings are not very overlapping.The data is collected from various sources based on public data, company documents,

data from supervisory authorities, trade associations, trade unions or on the reports of non-governmental organizations (OECD, 2022)

In general, companies with high ESG values are generally seen as better managed, more sustainable and future-oriented. There is a growing awareness among investors that these issues can be a determinant of a company's long-term financial performance. Incorporating ESG factors into the investment process and portfolio construction can help improve the risk / return profile in the long run (Gillian et al., 2021; Wong et al., 2021; Kim et al., 2019, Plumlee et al. 2015; Bouslah et al. 2013)

To our knowledge, this is the first paper that studies the relationship between the Local Innovation Systems and the ESG scores, thus contributing to two different streams of the literature.

Our analysis is made of three steps. The first one investigates the level of innovation of the Italian provinces over the period 2013-2019 by building up a measure of innovation performance based on several indicators. The second one analyzes the overall ESG score and the three sub-pillars of the investigated companies, whereas the last one analyzes the relationship between innovation and ESG factors.

The number of companies included in the analysis ranges from 36 in 2013 to 107 in 2020.

Our empirical evidence shows that in 2013, unlike in the subsequent years, the companies located in a more innovative province gained higher ESG scores. Our opinion is that, in the absence of binding guidelines referring to the firms' ESG disclosure, the geographical location had a relevant impact on the ESG performance of the companies, as only a small number complied with the ESG factors.

In contrast, in the years following 2013, when an ad hoc ESG regulation began to develop, the location in an innovative province no longer represented a significant factor in obtaining a high ESG score.

The paper is structured as follows. Section 1 describes the data sources and the variables used in the analysis. Section 2 quantifies the level of innovation of Italian provinces. The distribution of ESG factors across the selected companies is commented on in Section3. Section 4 reports the distribution of ESG scores by the degree of innovation at the local level, whereas Section 5 includes the results of nonparametric tests on the equality of the median yearly total return (YTR) of different subpopulations of firms, classified by values of both innovation performance and ESG scores. Conclusions are drawn in Section 6.

1.
Data sources and variables

1. Data sources and variables

This study uses two kinds of units of analysis: the listed companies based in Italy and the Italian provinces.

First, at the province level, corresponding to the third level of the NUTS (Nomenclature of territorial units for statistics) classification, we derive a summary measure of local innovation by exploiting the relationships among a set of indicators that are defined for every Italian province. Then we assign each company the innovation score based on the province where its headquarters are located.

Table 1 includes the indicators used for both units of analysis. The variables for the 107 Italian provinces refer to some characteristics of the main operating actors of the entrepreneurial and research ecosystem at a local level. They include patent and trademark intensity, intensity of research institutes, percentage of graduates, and share of large enterprises and innovative start-ups. They cover the years from 2013 to 2019.

The variables at the company level include ESG scores (the total score and the scores for the three distinct pillars, namely environmental, social, and governance) and the total return of the selected companies for the years from 2013 to 2020.

Table 1 - Variables

Name	Indicator	Description	Source	Available years
Province level				
patent	Patent intensity	Granted patents per 1 million inhabitants	Geowebstarter, Istituto Tagliacarne	2013-2019
trademark	Trademark intensity	Registered trademarks per 1,000 inhabitants	Geowebstarter, Istituto Tagliacarne	2013-2019
research	Intensity of public research institutes	Public research institutes per 1 million inhabitants	Ministry of University and Research (MIUR)	2013-2019
big_enterp	Large enterprises (250 employees or more)	Per100,000 active enterprises	Istat (Italian National Statistical Institute)	2013-2019
univ_degree	Individuals 25 to 39 years old with a university degree	Share amongst 25-39 years old	Istat (Italian National Statistical Institute)	2013-2019
innov_startups	Innovative start-ups or small and medium-sized enterprises (SMEs)	Per 100,000 enterprises	Ministry of Economic Development (MISE)/Movimprese	2013-2019
Company level				
ESG score	Overall ESG rating: overall score for a company's commitment to sustainable business practices		Eikon Refinitiv database	2013-2020
E Score	Environmental Pillar Score		Eikon Refinitiv database	2013-2020
S Score	Social Pillar Score		Eikon Refinitiv database	2013-2020
G Score	Corporate Governance Score		Eikon Refinitiv database	2013-2020
Sector	Activity sector		Eikon Refinitiv database	2013-2020
YTR	52 Week Total Return		Eikon Refinitiv database	2013-2020

2.
The degree of innovation across Italian provinces

2. The degree of innovation across Italian provinces

We measure the innovation performance of Italian provinces through several indicators. Each indicator accounts for a typical feature of the innovative climate of an area.

The main descriptive statistics of the chosen indicators for 2013-2019 are reported in Table 2.

Table 2 - Descriptive statistics – 2013-2019

indicator	year	mean	median	standard deviation	min	max	N
patent	2013	209.3	35.0	609.0	0.0	4650.9	107
	2014	156.9	25.4	448.1	0.0	3332.9	107
	2015	77.8	26.1	138.3	0.0	829.6	107
	2016	94.0	24.3	192.8	0.0	1331.8	107
	2017	298.8	25.0	1006.6	0.0	7809.6	107
	2018	220.8	23.8	680.5	0.0	5225.3	107
	2019	280.1	20.2	871.1	0.0	6462.5	107
trademark	2013	527.4	379.3	455.8	81.5	3669.8	107
	2014	514.6	404.5	428.3	112.2	3452.3	107
	2015	477.4	389.7	363.9	51.6	2712.7	107
	2016	249.6	182.2	250.7	30.6	2118.1	107
	2017	644.2	498.5	529.0	107.1	3993.2	107
	2018	978.7	768.7	758.1	284.4	5951.5	107
	2019	587.2	431.5	482.7	158.8	3889.2	107
research*	2013 to 2019	2.2	0.9	3.7	0.0	23.9	107
big_enterp	2013	6.0	5.3	3.8	0.0	20.4	107
	2014	6.0	5.5	4.0	0.0	20.8	107
	2015	6.1	5.7	4.1	0.0	21.7	107
	2016	6.2	5.6	4.2	0.0	22.5	107
	2017	6.4	5.7	4.4	0.0	23.5	107
	2018	6.6	5.5	4.5	0.0	23.8	107
	2019	7.0	5.6	4.8	0.0	24.4	107
univ_degree	2013	21.1	20.8	4.7	10.9	34.5	107
	2014	21.9	21.4	4.9	11.5	35.8	107
	2015	23.3	22.9	5.2	12.4	37.4	107
	2016	23.6	23.2	5.0	14.0	37.5	107
	2017	24.8	24.5	5.7	12.0	41.2	107
	2018	25.7	25.3	6.0	12.0	43.8	107
	2019	25.9	25.4	5.8	15.5	41.6	107
innov_startups	2013	0.6	0.0	2.0	0.0	11.9	107
	2014	4.3	0.0	9.8	0.0	46.2	107
	2015	20.9	15.0	21.5	0.0	103.4	107
	2016	47.8	39.1	36.4	0.0	174.4	107
	2017	92.4	85.8	60.5	7.5	331.6	107
	2018	142.6	128.4	86.1	17.9	498.5	107
	2019	209.3	192.9	119.1	18.4	711.9	107

*The intensity of public research institutes does not change over time

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The average values of both patent intensity and trademark intensity across Italian provinces show an oscillating trend, with troughs in 2015-2016 followed by increases in subsequent years (Figures 1 and 2).

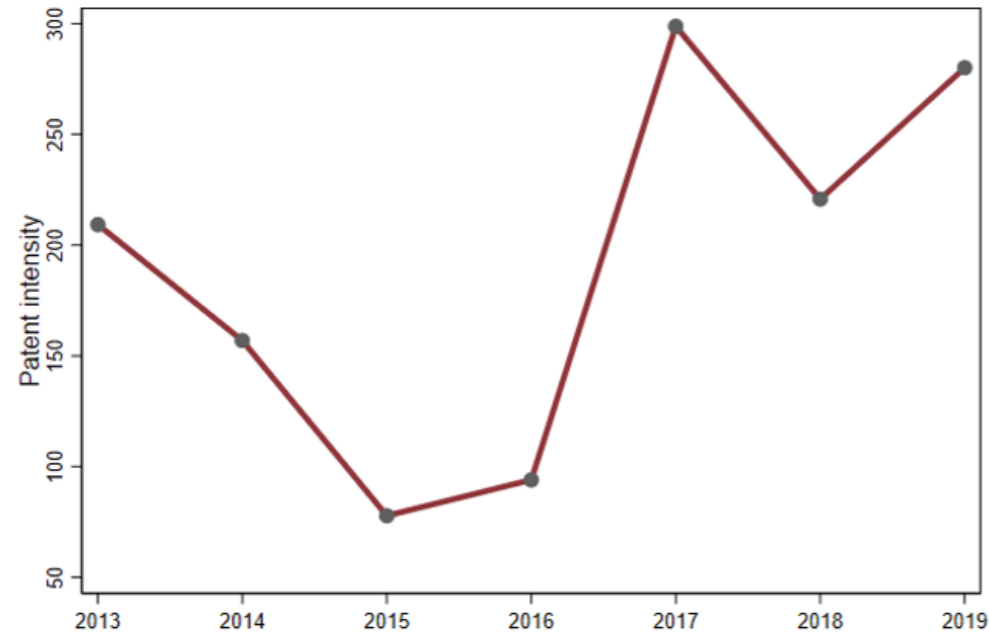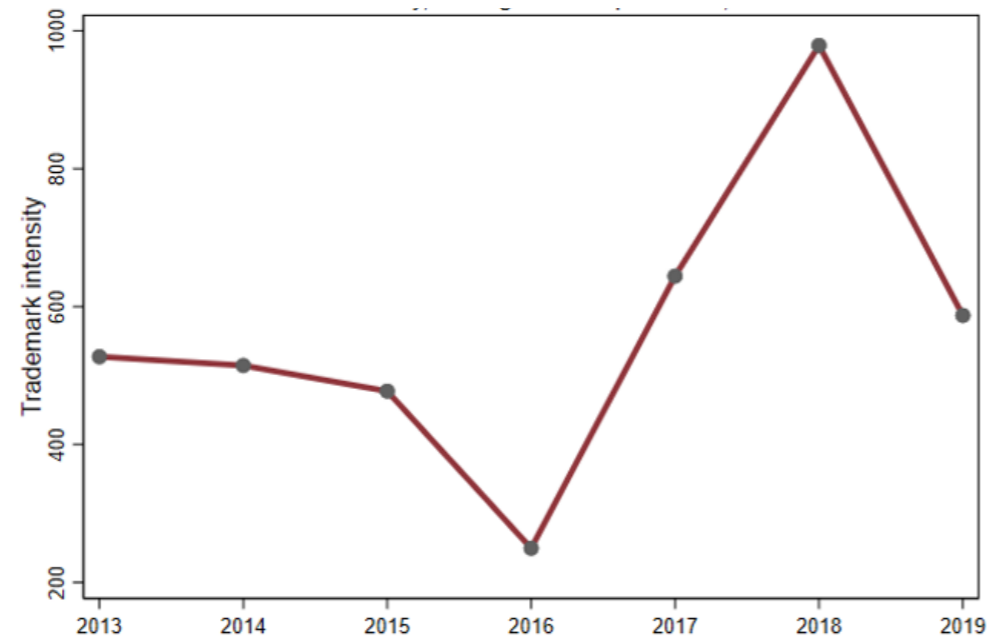Figure 1 – Average patent intensity across provinces. Years 2013-2019

Figure 2 – Average trademark intensity across provinces. Years 2013-2019

Large companies still represent a meager share of the total number of companies in the productive Italian ecosystem. The average proportion of large companies grows in the period under examination while remaining at a very low value (7 large enterprises out of 100,000 enterprises, Figure 3). In 2019, across all Italian provinces, the share ranged from a minimum of 0 to 24.4.

Figure 3 – Average share of large enterprises (250 employees or more) across provinces. Years 2013-2019
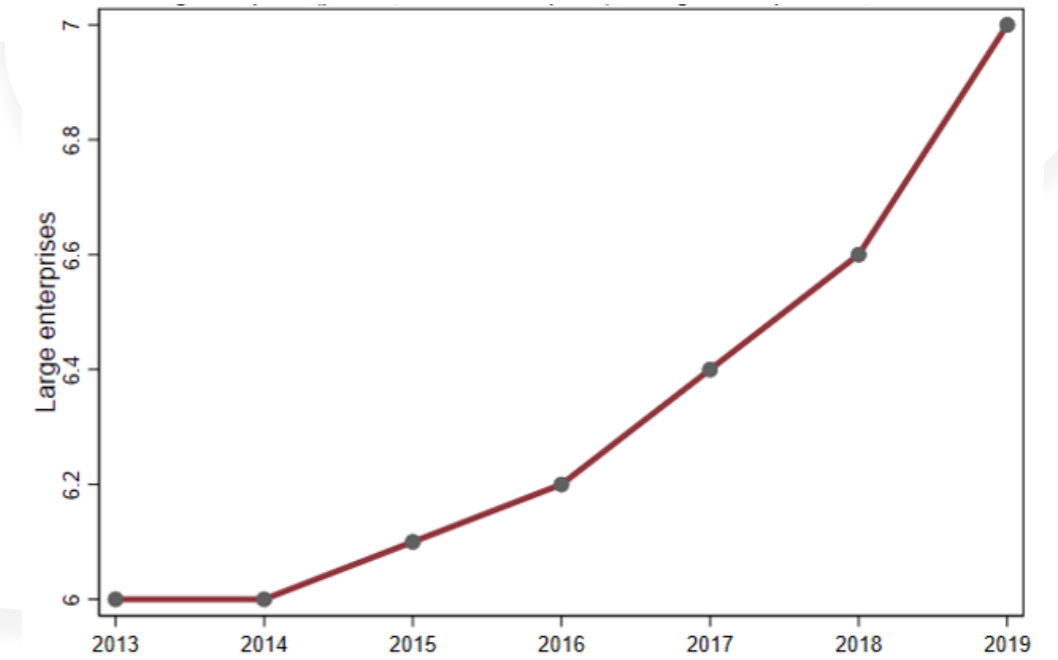
The proportion of individuals aged 25-39 with a tertiary degree out of the total number of individuals in the same age class, averaged across all Italian provinces, grows approximately constant from 21.1 percent in 2013 to 25.9 percent in 2019 (Figure 4).

Figure 4 – Average share of Individuals 25 to 39 years old with a university degree across provinces. Years 2013-2019
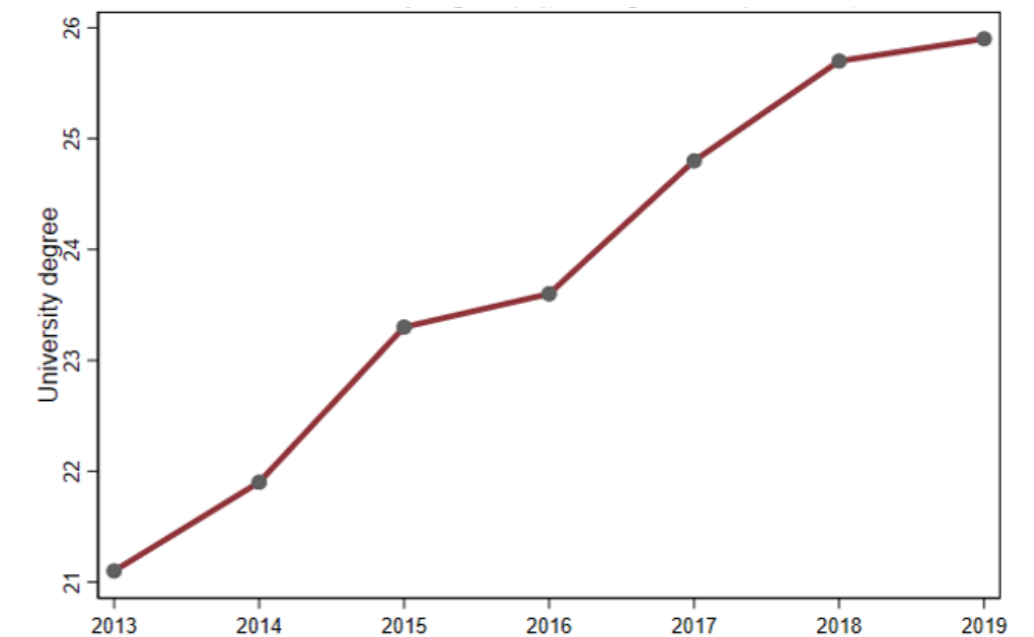
The share of innovative start-ups and SMEs out of the total number of enterprises follows exponential growth in the investigated period (Figure 5). Indeed, the particular section of the Business Register reserved for innovative start-ups was established by Decree-law No. 179/2012 and then extended to innovative small and medium-sized enterprises by Decree-law No. 3/2015. Therefore, in 2013 and 2014, the number of innovative start-ups was very low.

Figure 5 – Average share of innovative start-ups or innovative SMEs across provinces. Years 2013-2019
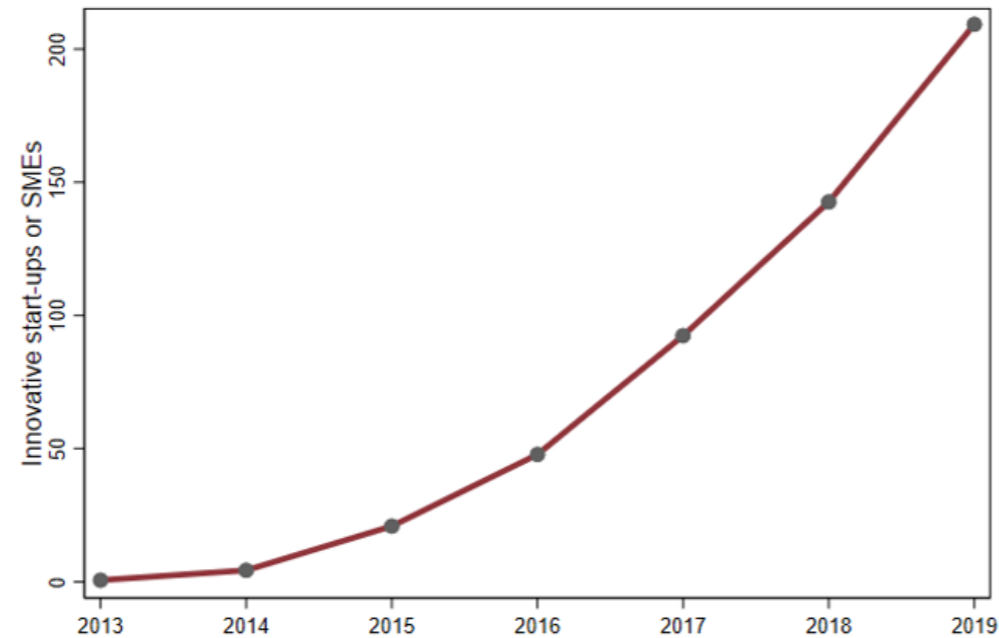
Every year, the observed indicators tend to be positively correlated, which means that the provinces that excel in a given indicator are generally also those that excel in other indicators. Factor analysis is a statistical method that exploits the correlation structure of the observed indicators to summarize them through potentially fewer unobserved (latent) factors while retaining most of the original variability.

To build a latent factor that accounts for the innovation performance of every province based on the observed indicators, we performed a factor analysis separately for each year, from 2013 to 2019, with the extraction of just one factor.

Table 3 displays the results of factor analysis, namely the percentage of variability retained by the factor and the factor loadings that account for the relationship of each variable to the underlying factor.

Table 3– Results of factor analysis – 1 factor extracted

	2013	2014	2015	2016	2017	2018	2019
Percentage of retained variability	0.9966	0.9712	0.9501	0.9595	0.9965	0.9780	0.9545
Factor loadings:							
patent	0.7976	0.7689	0.8235	0.8499	0.7464	0.7645	0.7553
trademark	0.8951	0.8355	0.8427	0.8756	0.8182	0.8252	0.8192
research	0.2903	0.3108	0.3639	0.3433	0.3512	0.3373	0.3718
big_enterp	0.6779	0.6959	0.6897	0.6542	0.6642	0.6756	0.6626
univ_degree	0.5832	0.6254	0.6809	0.6190	0.6631	0.6941	0.7288
innov_startups	-0.1573	-0.0156	0.2488	0.4498	0.5157	0.5266	0.6040

Every year, the percentage of variability retained by the first factor alone is very high (never less than 95%). This means that the extraction of a factor leads to a marginal reduction of the original indicators' variability.

Except for the indicator of innovative start-ups for the first two years, the factor loads positively on all indicators, which confirms that it can be interpreted as a summary measure of innovation.

Every year, the factor shows the strongest correlation with trademark and patent intensity, with loadings above 0.818 and 0.746, respectively. In 2019 the loadings of every item, but the intensity of public research institutes exceeded 0.60. Therefore we can conclude that the factor well explains these items.

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3. The ESG scores across Italian companies

From the Eikon Refinitiv database, we selected all the listed companies with headquarters in Italy (442 companies as of February 9, 2022). Then we excluded the companies with missing ESG scores in all years between 2013 and 2020.
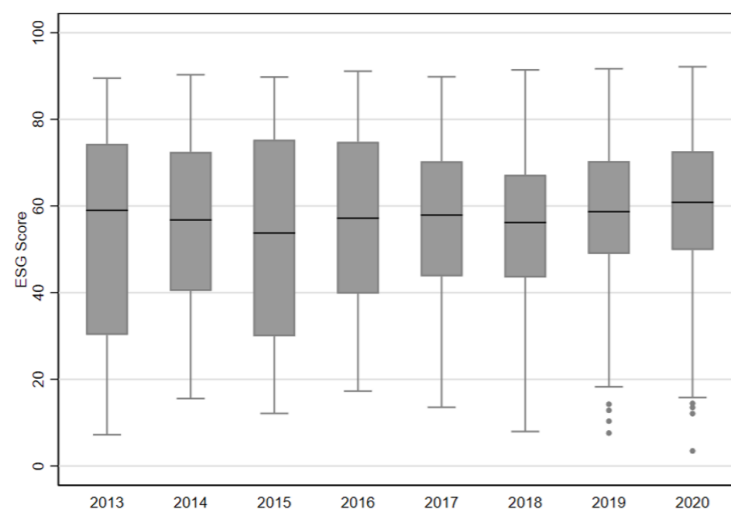
The ESG scores were available for just 36 companies in 2013. The number of companies with ESG scores rose to 107 in 2020.

The mean and standard deviation of the ESG score in the years from 2013 to 2020 are reported in Table 4. In the investigated period, as the number of companies with ESG scores increases, the average value slightly increases, and dispersion decreases. The evolution of the box plot of the ESG score in Figure 6 confirms the growing homogeneity of the scores: the interquartile range (IQR, which corresponds to the height of the boxes in the Figure) got halved from 44 points in 2013 to 22.7 in 2020. Conversely, the median values undergo only slight variations across the years, and they fluctuate around the score of 60.

Table 4 – Descriptive statistics of ESG score by year

year	ESG score		
	Mean	Std dev	Count
2013	53.19	24.66	36
2014	54.68	22.65	36
2015	53.64	23.55	39
2016	55.58	21.02	42
2017	57.05	18.48	54
2018	55.69	17.93	93
2019	57.21	18.44	100
2020	58.91	19.03	107

Figure 6 - Boxplot of ESG score by year

Table 5 - Descriptive statistics of the scores in Environmental, Social, and Governance pillars

| year	Environmental Pillar Score		Social Pillar Score		Governance Pillar Score	
	Mean	Std dev	Mean	Std dev	Mean	Std dev
2013	56.12	30.77	55.08	24.38	48.81	24.15
2014	56.32	30.27	58.45	23.41	49.72	22.20
2015	56.68	30.36	57.88	25.04	47.50	21.73
2016	58.83	26.43	60.89	22.22	48.13	21.86
2017	54.69	27.89	62.22	18.82	49.45	21.70
2018	49.43	25.61	63.00	19.59	49.13	21.29
2019	52.79	25.08	65.20	19.56	49.20	22.04
2020	55.57	25.21	67.18	19.81	49.34	22.76

Table 5 reports the statistics of the scores in the three distinct pillars (Environmental, Social, and Governance), whereas Figure 7 shows the corresponding distributions. The social score is the one with the highest increase on average, from 55.08 in 2013 to 67.18 in 2020. The average governance score remains constant, whereas the average environmental score first increases then decreases to return in 2020 approximately to the levels of 2013.

For the environmental and social score, over time, as more and more companies get the ESG score, the differences in the score tend to reduce. This trend is evidenced by the sharp decline in the standard deviation and the shrinking in the interquartile range. On the contrary, the corporate governance score does not show such a trend.

Figure 8 compares the distribution of ESG scores in their three pillars between financial and non-financial companies in 2013 and 2020. In 2013 financial companies scored much lower on average than non-financial companies in every pillar. The median scores across the three pillars ranged from 33.9 to 37.0 for financial companies and 57.2 to 70.0 for companies in a different sector. Nevertheless, in 2020 the ESG performances in the financial sector improved greatly, and the average scores approached those of the other companies.
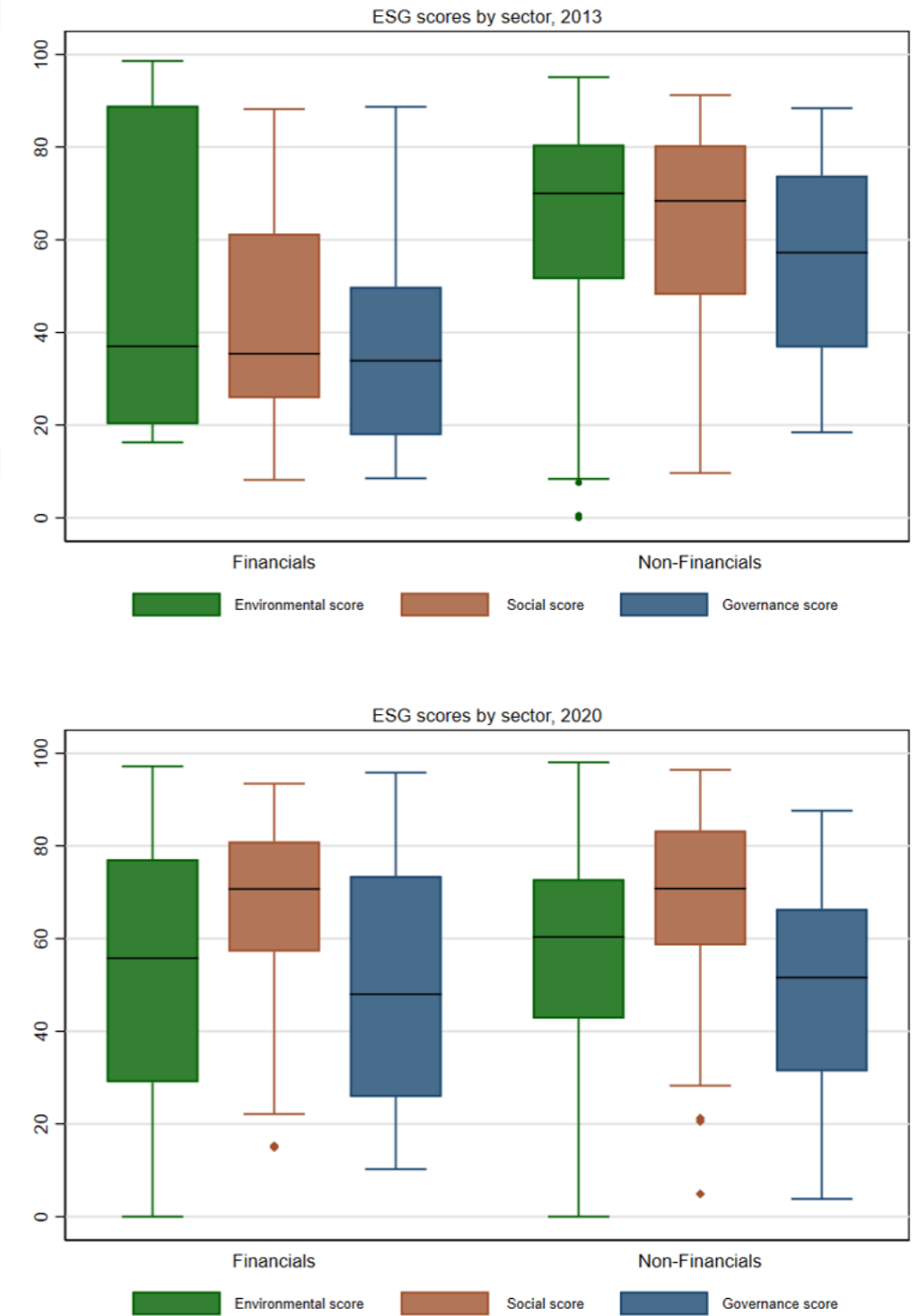
Figure 7 - Boxplot of environmental, social, and governance scores by year
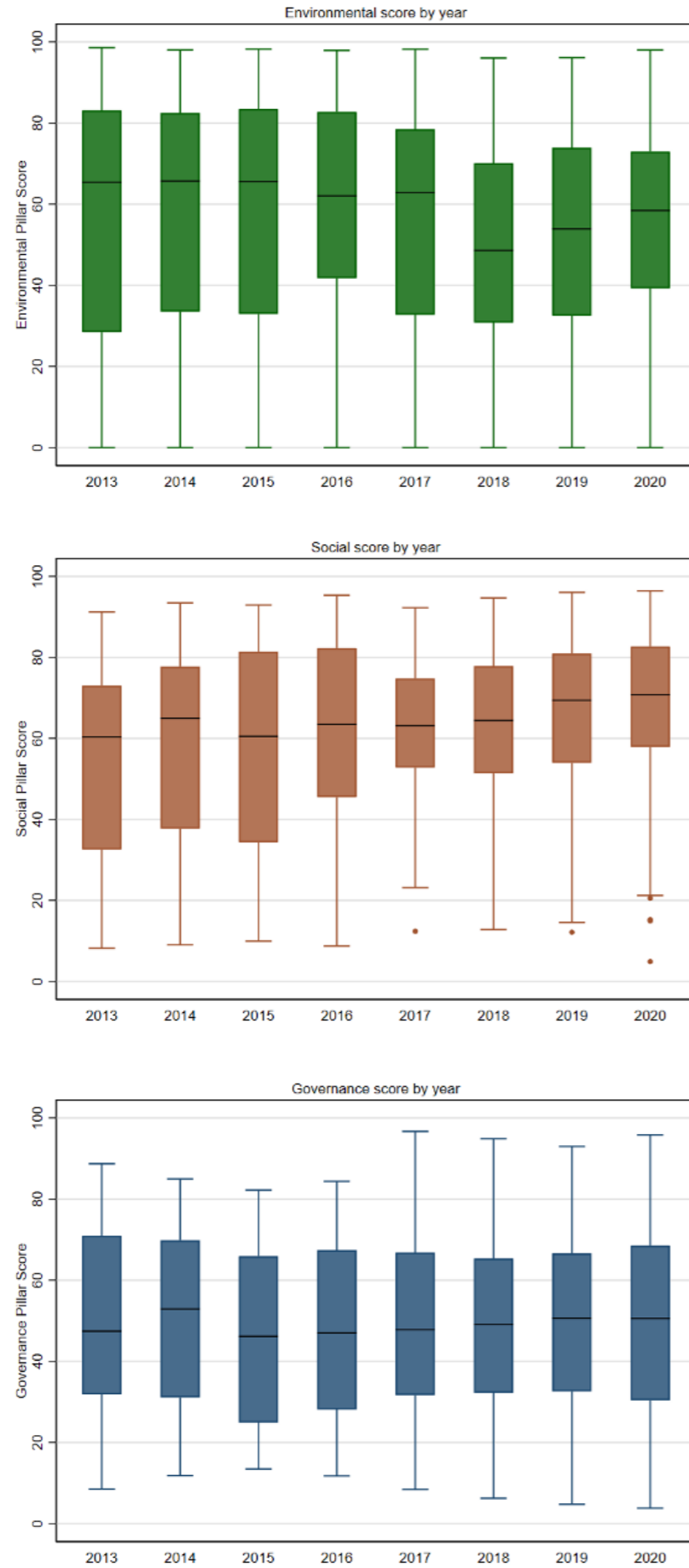
Figure 8 - Environmental, social, and governance scores for financial and non-financial companies.

Year 2013 (upper panel) and year 2020 (lower panel)

4. Degree of local innovation and ESG scores

We are interested in investigating whether the more innovative climate in a given area may impact ESG scores. We can expect that companies may benefit from the innovation performance of the area where they are based and from the relationships with the other innovation system actors to manage decision-making processes correctly, generate trust within the society and manage environmental risks.

To this end, we compare the score distributions between two groups of companies, the former with a value of the innovation score below the median and the latter with the innovation score above the median. Figure 9 reports the distributions of the score according to the three distinct pillars in 2013, 2016, and 2019.

In 2013, the companies in more innovative provinces scored higher than those in less innovative provinces in every quantile of the distribution of ESG scores. The exception is the median in the environmental score. In 2016 and 2019, the benefits of higher ESG scores for companies in more innovative contexts are less evident and mainly concern the social pillar.

Figure 9 – Distributions of ESG scores by the degree of innovation at the provincial level. Year 2013
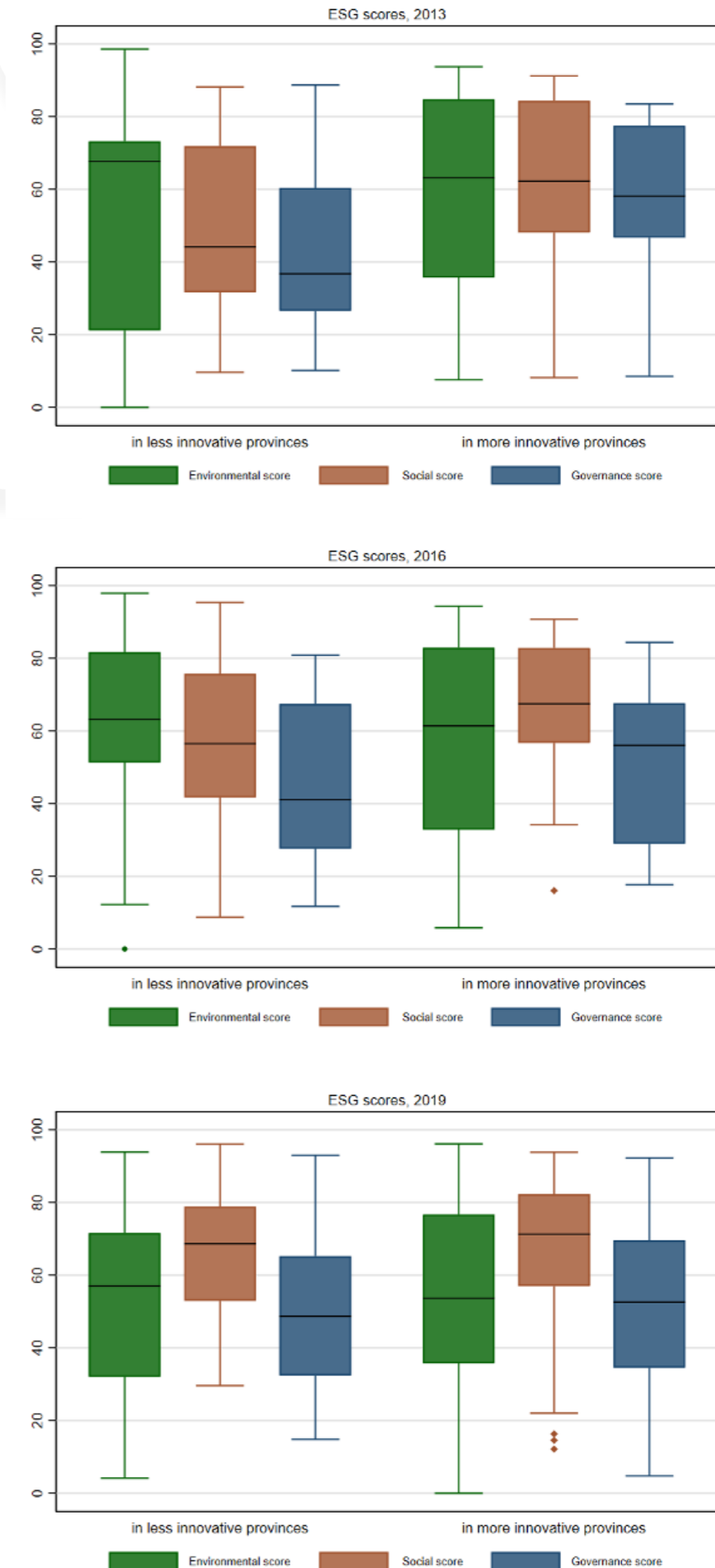
5.
**Degree
of local
innovation,
ESG scores,
and total
return**

5. Degree of local innovation, ESG scores, and total return

We performed nonparametric tests on the equality of different subpopulations' median yearly total return (YTR). The subsamples generate from the combination of the factors accounting for high/low values of ESG score and high/low values of innovation score (four subsamples). The null hypothesis is that the subsamples come from populations with the same median. Therefore, if the null hypothesis cannot be refused, we can conclude that neither the ESG score nor the degree of local innovation is a discriminating factor for the average performance of the companies. Conversely, rejecting the null hypothesis leads to the conclusion that the median annual return differs significantly in the four subpopulations. More precisely, the conclusion would be that there is at least one subpopulation with a median return significantly different from that of the others.

Table 6 – Testing the null hypothesis of an equal median yearly total return across subpopulations of societies that differ in ESG scores and innovation indicator. The reported figures represent the p-values of Fisher's exact test statistics

Score	Year						
	2013	2014	2015	2016	2017	2018	2019
ESG score	0.025	0.882	0.412	0.950	0.082	0.700	0.171
Environmental score	0.104	0.438	0.162	0.796	0.429	0.766	0.422
Social score	0.025	0.907	0.412	0.703	0.379	0.796	0.094
Governance score	0.132	0.906	0.115	0.726	0.042	0.841	0.491

Note: when the p-value <0.05, we conclude that at the significance level of 5%, the median yearly total return differs between societies cross-classified by the given score and the innovation indicator. When 0.05 < p-value < 0.10, we reach the same conclusion at the significance level of 10%. When the p-value > 0.10, we conclude that there is no statistically significant difference in the median yearly total return between groups of societies.

In 2013, the Fisher's exact test rejected the null hypothesis of equal median yearly return at a significance level of 0.05 (p-value=0.025, Table 6 and Figure 10). When the total ESG score is replaced by the scores of the three constituent pillars, we find that the score in the social dimension is the only element that drives the difference. Indeed, we cannot reject the hypothesis of equal median returns of societies cross-classified according to environmental score and innovation score and according to governance score and innovation score (the p-values of the corresponding test statistics are greater than 0.10). Conversely, we can reject the null hypothesis when the social score is used instead as a classification factor (p-value=0.025).

**5.
Degree
of local
innovation,
ESG scores,
and total
return**

In this case, the societies with high social scores and low innovation indicators seem to have an advantage over the other societies in terms of yearly median return (Figure 11).

Among the remaining years, only in 2017 did we find a significant difference in the yearly return of societies when ESG score and innovation indicator are used as classification factors (at the significance level of 10%). In this case, it is the governance score that makes the difference.
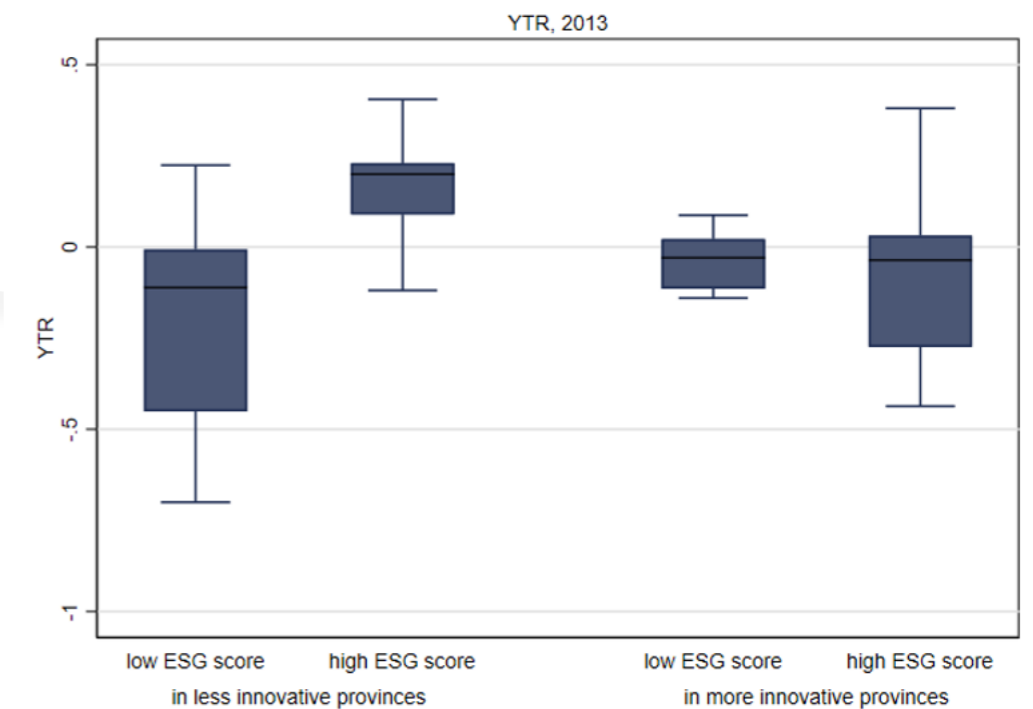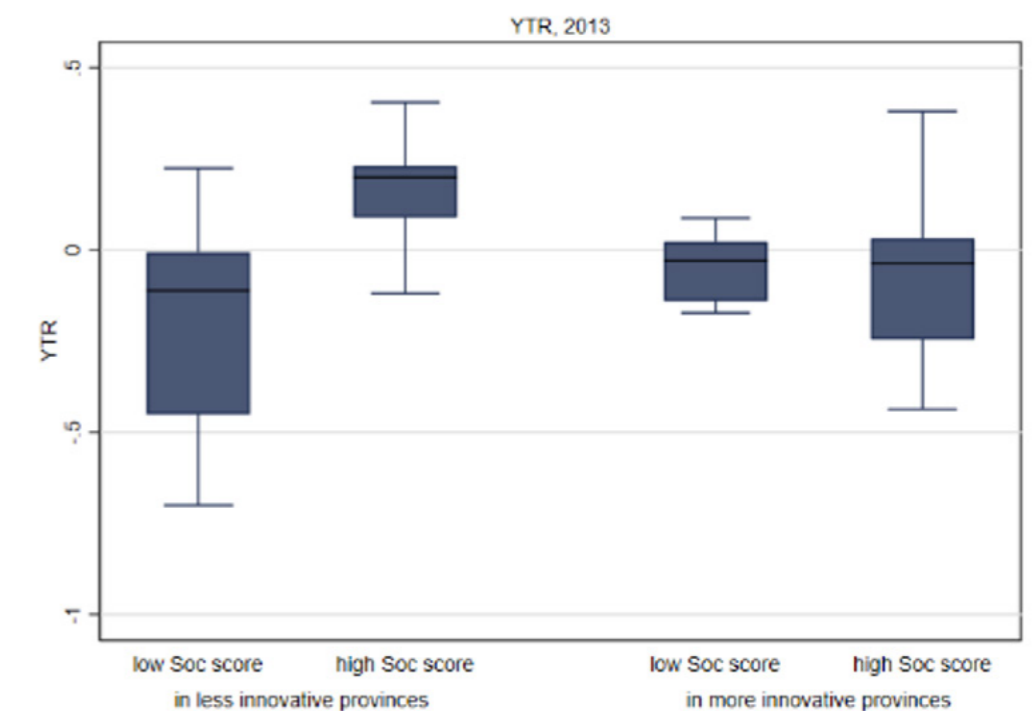

Figure 11 – Distributions of yearly total return by the degree of innovation at the provincial level and social score. Year 2013

6. Conclusions

This report studies the association between the innovation performance of Italian provinces and the ESG scores of Italian companies listed on the stock exchange. We derive a summary measure of innovation performance at the provincial level from a factor analysis that uses indicators referring to the patent and trademark intensity, education level, the share of innovative start-ups or small and medium-sized enterprises, the share of large enterprises, and the intensity of public research institutes. Extracting just one factor allows for an efficient dimensionality reduction with a minimum loss of information. As for the evolution of ESG scores in the investigated period, the companies have recorded an improvement, especially in the social score. Over time, as more companies comply with the ESG regulation, the differences in the score among companies tend to reduce for the environmental and social scores. For example, in 2013, financial companies scored much lower on average than non-financial companies in every pillar. In contrast, in 2020, their ESG performance improved greatly, and their average scores approached those of the latter. To investigate whether the innovative climate in a given area may impact the ESG scores of the listed companies in that area, we compare the score distributions of companies in less innovative areas with those in more innovative provinces. In 2013, the companies in more innovative provinces scored higher than those in less innovative provinces anywhere across the distribution of ESG scores, with the only exception being the environmental score's median. In the subsequent years, the benefits of higher ESG scores for companies in more innovative contexts are less evident and limited to the social pillar score. The final analysis first groups the firms by high/low values of ESG score and high/low values of innovation score and then proceeds by testing the equality of the median yearly total return (YTR) across the groups. In 2013 only, the null hypothesis of equal median yearly return was rejected, with the differences being driven by the score in the social dimension. In this case, the companies with high social scores and low innovation indicators seem to have an advantage over the other companies in terms of yearly median return. Ultimately this study gave only partial confirmation of the hypothesis that companies benefit from the innovation performance of the area where they are situated to achieve high ESG scores and high returns. The competitive advantage of being located in a province with a strong innovative vocation for achieving high ESG scores is evident only in the first years in which the ESG regulation was adopted, especially for the social pillar score. The assessment of the effects of joint levels of innovation performance and ESG score on the companies' return is more controversial as it seems that companies with low innovation performance and high social scores are rewarded with higher returns than other companies.

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