Regional disparities and industrial structure: territorial capital and productivity in Italian firms

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Abstract.[1]

We investigate the role of Territorial Capital (TC) on the productivity of Italian firms, constructing indicators for eight dimensions of TC in a first attempt to capture a wide variety of regional resources. When imposing homogeneous TC effects on all firms, we find that technological, social, institutional, financial and infrastructure capital drive productivity. However, only technological and artistic capital contribute to reduce regional disparities. Across industries, financial capital and infrastructure increase productivity in companies operating in a wide range of sectors. Industrial policies should consider sectoral heterogeneity and North-South differences to effectively boost productivity performance.

Keywords: *Territorial Capital, Regional Resources, Total Factor Productivity, Regional disparities, Firm productivity*.

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1. Introduction

Understanding the sources of firms' productivity performance is a major economic and political challenge which has attracted a noticeable research effort over the years (Griliches, 1998; O'Mahony and Vecchi, 2009, Marrocu et al., 2012). The literature shows that drivers of productivity can be found not only within the firm's boundaries[2] but also outside the firm as part of the environment where the firm is located. This paper focuses on these external variables and aims to evaluate the impact of territorial capital (TC) on firms' productivity performance.

The OECD (2001) defines TC as "the stock of assets which form the basis for endogenous development in each city and region". This concept embraces different ideas frequently studied in the field of economic geography, such as social capital and institutions, and stresses the importance of the *co-existence* of these assets as a defining characteristic of different territories. Substantial work has attempted to identify different forms of TC, providing substance to a fairly nebulous concept (Camagni, 2008; Jabareen, 2008; Thorsby, 1999; Isaksson, 2007; Servillo et al., 2012; Perucca, 2014; Fratesi and Perucca, 2019). However, existing contributions have mainly focused on a limited set of territorial resources (Shah, 1992; Black and Lynch, 1996; Cook et al., 2005; Marrocu et al., 2012; Lasagni et al., 2015), which only partially captures the complexity and variety of TC. Most related studies have investigated the contribution of TC to regional macro performance (e.g. Camagni and Capello, 2013; Perucca, 2014; Fratesi and Perucca, 2019), while its role in promoting productivity at the firm level is still unclear. In addition, the assumption of homogenous effects of TC on performance across very diverse regions and industries remains mostly unchallenged.

This paper addresses these issues, starting with the identification of a range of TC assets which covers a much wider spectrum of territorial resources than those found in existing studies. We then evaluate the impact of TC on firm-level productivity. Our study focuses on Italy, a country where the

[2] These include, for example, inputs of labour and capital, investments in Research and Development (R&D) and managerial practices (Bloom and Van Reenen, 2006; Syverson, 2011).

cultural and historical background has contributed to the emergence of wide regional disparities (Tabellini, 2010). This provides a perfect ground for testing the presence of heterogeneous effects of TC on productivity across regions. In particular, we address the question of whether different endowments of TC contribute to the persistence of regional disparities or whether they support the catching-up process of the Southern regions. Finally, we also assess the role of TC in firms operating across different industries, including manufacturing and services. This extends the existing evidence for Italy which has exclusively focused on manufacturing (Cingano and Schivardi, 2004; Marrocu et al., 2012; Aiello et al., 2014; Lasagni et al., 2015). Given that two-thirds of GDP is accounted for by services, our analysis is, to our knowledge, the first to fully account for the Italian industry structure.[3]

Our analysis uses data for a large sample of firms, extracted from the AIDA database, linked to information on regional variables from public datasets. While TC is often investigated at the provincial level (Fratesi and Perucca 2019; Perucca, 2014; Camagni et al., 2011), focusing on regions has the advantage of providing a wider range of indicators over a longer time period. Moreover, Italian regions are characterised by a good degree of administrative and economic control (Marrocu et al., 2012) as well as homogeneity from an historical, cultural and socio-economic perspective, which makes the regional dimension particularly relevant. For each dimension of TC, we identify two alternative proxies, as well as constructing summary indicators using factor analysis. Our analytical framework is based on the derivation of a measure of Total Factor Productivity (TFP) using the Levinsohn and Petrin (2003) methodology to account for the endogeneity of factor inputs. We then analyse the impact of the different types of TC on TFP, over the 2004-2012 period.

Our analysis leads to the identification of eight components of TC. Results for our benchmark model show that five of them (technological, social, institutional, financial and infrastructure capital) matter for firms' productivity. The remaining three (human capital, natural and artistic capital) do not play a significant role when we impose homogeneous coefficient across all firms. When we relax this

[3] http://www.economywatch.com/world_economy/italy/industry-sector-industries.html, accessed on April 5th, 2018.

assumption and we distinguish between the Northern regions and the rest of Italy, we find that, together with artistic capital, technological capital is positively associated with productivity performance in the Centre and Southern regions, contributing to the catching up process towards the North of the country. Other components, such as human, social, financial and infrastructure capital positively affect performance only in firms located in the North. At the sector level, although the size of the effect varies, we find that industry performance is mainly driven by regional financial resources, infrastructure, institutional and human capital. Except for the food and accommodation industry, natural capital is the only component of TC to be either insignificant or negatively related to productivity. Environmental regulations, which often impose constraints on economic activities, are likely to be the reason for this outcome (Dechezleprêtre and Sato, 2014; Greenstone et al., 2012)

In the next section we discuss the literature on TC and productivity and set our main hypotheses. We then present our analytical framework (section 3) and our data (section 4). Section 5 reports our results while section 6 concludes the paper.

2. Territorial capital and productivity performance

Among the different forms of territorial capital, there is general agreement on the role of *human capital*. Firms operating in regions with a high proportion of educated workers have access to a pool of diverse skills which can boost productivity via the generation of new ideas and the diffusion of knowledge (Backman, 2014; Marrocu and Paci, 2012). Related to skills, and in particular to the ability to create and innovate, *technological capital*, is also considered important in promoting productivity performance (Florida, 2003; 2005; Piergiovanni et al., 2012). Marrocu and Paci (2012) provide a clear definition of both human capital (labour forces with degree over population) and technological capital (10 years patent stock over 1,000 population) at the regional level. Their results show that both proxies are positively related to productivity in 4 European countries, although the effect is lower in Italy compared to France, Spain and the UK. This suggests that there might be some other features

in the Italian context that prevent companies from taking advantage of the returns from technological and human capital, an issue that deserves further investigation.

Other definitions of TC, such as *social*, *institutional* and *financial capital*, are often considered to be positively associated to productivity performance, both at the macro and the firm level (Cook et al., 2005; Guiso et al. 2009; Lasagni et al., 2015). Pro-social behaviour, such as a collaborative culture, low levels of corruption and high property-rights protection, creates a favourable environment for entrepreneurship and enhances productivity (Fazio and Piacentino 2010, and Nerozzi et al., 2004; North, 1981). A good institutional framework promotes trust, reduces transaction costs and stimulates the efficient use of resources, leading to higher productivity performance (Rodríguez-Pose, 2013; Lasagni et al., 2015). The role of financial capital, while unquestioned at the macro level (Rajan and Zingales, 1998), has been more difficult to identify at the subnational level and only counts a limited number of studies. An important contribution is Guiso et al. (2009), who find that the development of local financial resources is relevant for small and young firms, while large companies can find resources outside their region. Moretti (2014) provides evidence for Italian provinces and shows that access to finance promotes productivity in the Northern and Central regions where institutions are stronger, but not in the Southern regions. These results suggest that the role of financial capital depends on both firms' characteristics and institutional factors within a country; however, few studies so far have accounted for both factors within the same analytical framework.

The literature also considers other components of TC, such as *infrastructure capital*, *natural* and *artistic capital*. For infrastructure, although the relation to productivity is well established in the macroeconomic literature, (Isaksson, 2007; Crafts, 2009), its role at the regional level has often been overlooked in empirical analyses (Crescenzi et al., 2016). Even more challenging is the evaluation of the role of natural capital - natural assets not directly created by human activities (Jabareen, 2008). In fact, regulations on the use of natural resources, although beneficial to the environment, can be a hindrance to productivity performance (Dechezleprêtre and Sato, 2014; Greenstone et al. 2012). As

for artistic capital, which includes monuments, archaeological sites and museums (tangible cultural capital in Throsby, 1999), research so far has found a weak relationship with GDP growth (Perucca, 2014). Authors also argue that these assets can be particularly important in sectors such as tourism and accommodation (Throsby, 1999). Overall, little is known about the impact of regional assets on industry growth; the existing evidence only counts a handful of contributions (Marrocu et al. 2012; Lasagni et al. 2015) and the role of natural and artistic capital is often neglected[4].

Existing studies also suggest that different regional assets are closely connected, and they need to be jointly considered in the empirical analysis to fully understand their impact on productivity performance. However, the focus is often on a few components of TC, which do not sufficiently capture the complex relationship between TC and firms' productivity. This leads to the formulation of our first hypothesis:

H1: firms' productivity performance is positively related to the total endowment of TC, all else being equal.

Evaluating the impact of TC is challenging for two main reasons: the high degree of heterogeneity in the components of TC implies that it might be particularly difficult to identify a homogenous effect in a country characterised by wide regional disparities (Tabellini, 2010). In addition, the impact of TC can differ, not only across regions, but also across different industries. To account for these two sources of heterogeneity, we formulate two additional hypotheses:

H2: the impact of TC in the Northern regions is weaker compared to the rest of the country, all else being equal;

H3: there is a significant difference in the way TC affects productivity performance in firms operating within specific industries, all else being equal.

[4] Italy counts the greatest number of UNESCO World Heritage Sites in the world http://www.unesco.it/cni/index.php/siti-italiani. Accessed on April 2nd , 2018. Hence, it is important to control for the role of artistic capital in our analysis.

The formulation of H2 draws upon the neoclassical assumption of decreasing returns, whereby an increase in TC will have a larger effect on the productivity of companies located outside the Northern regions. This also implies that TC may play an essential role in the catching-up process of the more underdeveloped Italian regions to the productivity levels of the North. This intuition was already advanced by Camagni and Capello (2013), who show that TC is subject to decreasing returns to scale, but to our knowledge it has not been tested at the firm level. The third hypothesis is more explorative and aims at improving our understanding of how firms' operating in different sectors benefit from different forms of TC. For instance, it is reasonable to expect that some resources such as human and financial capital have a positive effect across the whole industry spectrum; technological capital will likely be more important for high tech industries, whilst the presence of natural and artistic capital is expected to positively impact the tourism sector. Testing this hypothesis allows us to draw conclusions on which forms of territorial capital are more important to promote the development of specific industries, with relevant implications for industrial policy.

3. Methods

To investigate the relationship between TC and productivity, we begin with the formulation of a log-linear Cobb-Douglas production function, where company level output *(y_{it})* is expressed as a function of the total number of employees *(l_{it})*, tangible capital *(tk_{it})* and intangible capital *(ik_{it})*:

$$y_{it} = \alpha_0 + \alpha_1 tk_{it} + \alpha_2 ik_{it} + \alpha_3 l_{it} + u_{it} \quad (1)$$

where *i* denotes firm, *t* denotes time and u_{it} is an error term. This is a composite error term, which includes a stochastic component (ϵ_{it}), with zero expected mean and uncorrelated with input choices, and a component that represents unobserved productivity (ω_{it}). The latter is a state variable and thus affects the firm's equilibrium choices of capital and labour. Because productivity is unobservable, the estimation of equation (1) using Ordinary Least Squares (OLS) is affected by simultaneity bias.[5]

[5] For further discussion on these issues see Griliches and Mairesse (1995) and Van Beveren (2010).

The Levinsohn and Petrin (2003) estimator addresses this issue by expressing unobserved productivity as a function of observable quantities of intermediate materials and capital stocks: $\omega_{it} = f(m_{it}, tk_{it}, ik_{it})$. Under the assumption of common input and output prices across firms and no measurement errors, the use of this productivity *proxy function* addresses the simultaneity issue, generating unbiased production function estimates. From the estimation of equation (1) we can derive predicted value of productivity, commonly identified as Total Factor Productivity (TFP). We can then express TFP as a function of TC at the regional level (TC_{zjt}) and the unobservable i.i.d. component (u_{it}):

$$TFP_{ijt} = \omega_{it} + \epsilon_{it} = y_{it} - \hat{\alpha}_0 + \hat{\alpha}_1 tk_{it} + \hat{\alpha}_2 ik_{it} + \hat{\alpha}_3 l_{it} = \sum_{z=1}^{N} \beta_z TC_{zjt} + \epsilon_{it} \quad (2)$$

where the subscript *z* denotes the different dimensions of TC considered in our analysis.

We augment the specification of equation (2) with the inclusion of time dummies (d_t), capturing the effects of macroeconomic phenomena which vary over time but not across firms; geographical dummies, to control for the well-known Italian divide between North and South (reg_r); sector dummies to account for industry heterogeneity ($sect_s$); and controls for firm's size and age. Hence, we can write our benchmark specification as follows:

$$tfp_{ijt} = \beta_0 + \sum_{z=1}^{N} \beta_z TC_{zjt} + \sum_{t=1}^{n} \delta d_t + \sum_{r=1}^{m} \gamma reg_r + \sum_{s=1}^{S} \theta sect_{st} + \rho size_{ijt} + \sigma age_{ijt} + \epsilon_{ijt} \quad (3)$$

Equation (3) is initially estimated using OLS, under the assumption of i.i.d. errors. We will relax this assumption in section 5.2.

4. Data

4.1 Company Data

The estimation of equation (1) requires firm-level data on output and inputs. From the AIDA dataset[6] we extract information on value added (y_{it}), total number of employees (l_{it}) and firm's capital stock. This includes tangible assets (tk_{it}) - equipment, machineries and plants - and intangible capital (ik_{it}) - patents, R&D expenditures, copyrights, trademarks, software, and employee trainings. Data is collected for the 2004-2012 period.

We select firms with more than 10 employees in the year 2008[7] as micro-firms usually provide poor quality of information (ECB, 2014). Following Lasagni et al., (2015) we drop observations in the 1st and 99th percentile, to eliminate outliers. Our final dataset consists of 91,652 firms, operating in 12 different economic sectors. Approximately 60% of firms are located in the North of Italy, 20.4% in the Centre and 18.8% in the South. All balance-sheet data, including tangible assets[8], intangible assets[9] and value added, are adjusted for inflation using industry-level deflators[10].

Appendix table A.1 presents summary statistics for our sample, while table A.2 shows the size distribution, based on the average number of employees for the entire period. Around 97% of firms belong to the category of SMEs, highlighting the importance that SMEs play in the Italian economy. Table A.3 shows the firms' distribution by sector and geographical area, based on the location of their headquarter. Approximately 44% of firms operate within the manufacturing sector, while the remaining 66% is in services. The highest number of firms is located in Lombardia, the most industrialized Italian region, followed by Veneto and Emilia Romagna. Basilicata, Molise and Val D'Aosta have the lowest proportion of companies.

[6] The AIDA dataset, maintained by Bureau Van Dijk, provides comprehensive balance-sheet information on Italian commercial companies, collected and re-elaborated from their official financial statements. https://www.bvdinfo.com/en-gb/our-products/data/national/aida

[7] This date has been chosen as it is the intermediate point of the data availability (2004-2012).

[8] AIDA definition: "All tangible assets such as buildings, machinery, etc".

[9] AIDA definition: "All intangible assets such as formation expenses, research expenses, goodwill, development expenses and all other expenses with a long term effect".

[10] Deflators extracted from the EUKLEMS database.

4.2 Territorial Capital proxies

To estimate the relationship between productivity and TC (equation 3), we merge company level estimates on TFP with regional measures of TC. We identify proxies for eight dimensions of TC, namely *technological capital, human capital, social capital, institutional capital, financial capital, infrastructure capital*, *natural* and *artistic capital*. We collect data from various sources, for the 2001-2012 period. Table 1 presents the full list of variables and data sources, together with references to articles that have used the same or similar proxies. The first three columns of table 1 refer to our main set of variables, while columns (4) – (6) provide information on an alternative set that we use for robustness check. For example, we measure technological capital using R&D expenditure as a proportion of GDP and, as an alternative indicator, we use the number of patents registered at the European Patent Office (EPO) per 100 people. Although R&D is a measure of input in the innovation process, while patents measures the output of research activities, related studies show that the two variables are highly correlated therefore they can both be used as valid proxies for the regional capability to innovate and create (Van Ophem et al.2002; Danguy et al. 2010; Rodriguez-Pose and Crescenzi, 2008; Piergiovanni et al., 2012). In a similar way, the impact of human capital is assessed using graduates in science and technology subjects and the percentage of population aged 25-64 with tertiary education.

Social Capital is perhaps one of the most difficult dimensions of TC to measure. In our first set of variables we rely on information on the number of workers in cooperative societies[11] over the total number of employees. We choose this proxy to capture individuals' willingness to cooperate, under the assumption that stronger relations boost economic activity (Camagni, 2008; Camagni et al., 2011). As an alternative, we follow Crescenzi et al. (2013) in using the number of blood donations per resident population. This proxy captures the level of civic sense and social commitment that is another important aspect of social capital (Guiso et al., 2010). Institutional capital is proxied by the percentage

[11] They include different types of cooperative societies such as production, worker, financial and social

of people that declare to wait more than 20 minutes in public offices, under the assumption that a longer waiting time is associated with poorer efficiency and management of public services (Batabyal, & Yoo, 2007). As an alternative indicator we make use of the number of violent crimes per 10,000 people,[12] which captures the strength of the rule of law (Lasagni et al.2015). Both proxies are expected to be negatively related to productivity performance as higher values indicate lower institutional quality.

Two other components of TC are *natural* and *artistic* capital. The former is proxied *w*ith the presence of 'important natural sites', defined as the percentage of Natural Surfaces 2000 network divided by the regional surface. [13] As an alternative measure we use the share of protected natural areas over the regional surface. Both variables intend to capture the richness of the Italian landscape and they are preferred to indicators of endowment of natural resources, such as oil and gas, as these are quite scarce in the Italian territory. Artistic capital measures the richness of Italian historical and cultural heritage, whose impact is summarised, in the first instance, by the number of visitors of public institutes of antiquities and art, including monuments, museum and archaeological sites. A second proxy refers to the diffusion of theatre and music performances and it is measured by the number of tickets sold within each region per 100 people.

The final two components of TC considered in our analysis are *financial and infrastructure capital.* We measure the former using regional bank credit as a percentage of GDP, which captures the private dimension of finance and the availability of financial resources. As an alternative indicator, we use a measure of financial risk, represented by the ratio of non-performing loans and stock to total bank lending within regions. This variable proxies for the propensity to repay debts at the regional level. Finally, infrastructure capital represents the level of transport infrastructure available within regions.

[12] Violent crimes include murders, infanticide, malicious injuries, sexual assault, kidnapping, attacks and robberies

[13] Natural Surfaces 2000 network have been established following the enactment of Directive 92/43/EEC "Habitat" and it is the main instrument of EU policy for the conservation of biodiversity.

In the main set of indicators this is measured by the highway length over the terrestrial area. We perform robustness checks using, as an alternative indicator, the number of flights departed and landed per year.

Appendix table A.4 reports summary statistics of all the indicators used as proxies for the eight dimensions of TC, while table A.5 provides correlation matrices for both sets of indicators. These show that most correlations are <.5, except for Financial and Social capital (0.66) and Financial and Technological capital (0.68) in the main set of indicators. Therefore, collinearity should not be a major issue in our regression analysis.

[INSERT TABLE 1 HERE]

5. Results and discussion

5.1 Estimation of the benchmark model

Our empirical analysis starts from the estimation of the production function (equation 1) using the Levinsohn and Petrin (2003) technique, as discussed in section 3. Results are presented in Table 2. The first column shows coefficient estimates derived by pooling all companies together. Columns (2) – (11) present results based on pooling companies within each industry, to allow for different technological conditions in the estimation of the production function coefficients.

Our estimated coefficients are all positively signed and statistically significant. As expected, there are variations in the input elasticities across industries. A 1% increase in the labour input increase value added between 0.347% (Accommodation and food services) and 0.711% (Scientific research and other technical activities). The tangible capital elasticity also varies between 0.076% (Transport

and storage) and 0.144% (Arts, entertainment and recreation). Coefficients of this size, are consistent with related work based on company account data. For example, in Lasagni et al. (2015) the labour (capital) input coefficient ranges between 0.058 and 0.408 (-0.03 – 0.141), depending on the industry group and the estimation method implemented. Borghi et al. (2016) and Marrocu et al. (2012) also report similar coefficient estimates. The impact of intangible capital is also positive and statistically significant, with the only exception of the Accommodation and food service industry (Column 3). Overall, results suggest the presence of decreasing returns, which is not uncommon in the literature (Marrocu, 2000, Vecchi, 2000, Marrocu et al., 2012, Lasagni et al., 2015)[14].

[INSERT TABLE 2 HERE]

Using the coefficient estimates in columns (2) - (11) we derive estimates of TFP at the firm level. Following Lasagni et al. (2015) and Marrocu et al. (2012), we then estimate equation (3) – the TFP specification – using a pooled OLS estimator, under the assumption that all territorial variables are exogenous. Table 3 presents results based on the use of our first set of indicators for the different dimensions of TC, as described in table 1, column (1). We first consider the effect of each proxy individually (table 3 – columns 1 – 8) and we then include them in the same specification (column 9). In columns (10) and (11) we add controls for the economic wealth of the region, which might be correlated with our TC proxies, using regional unemployment rate and regional value added, respectively. For all specifications we report standardized coefficients to compare the relative importance of each factor. Standard errors are clustered at the regional level to warrant correct inference on the regional variables (Moulton, 1990).

[14] The presence of decreasing returns to scale is not a problematic issue even from a theoretical viewpoint. As discussed in Hulten (2001) the traditional Solow growth model establishes a link between the GDP growth accounting identity and the production function. Although this setting usually assumes constant returns to scale, this assumption is not required for the validity of the model.

Results for individual components of TC show that each measure measures is significantly correlated with firms' productivity, with the only exception of natural and infrastructural capital (highways). The proxy for institutional capital, (waiting time at the public office), is unexpectedly positively correlated with TFP. However, given the omission of other components of TC, coefficient estimates in models (2) – (8) may be biased. In fact, in the full specifications (column 9 – 11) the impact of institutional capital has the expected negative sign, while infrastructures are positively related to productivity performance.

Estimates for the other dimensions of TC are consistent throughout, although the effect of human capital (graduates in science and techonoly subjects) and artistic capital (visitors at public institutes of antiquities and art) are no longer statistically significant. It is possible that their impact on the overall sample cannot be clearly identified because of cross-sector heterogeneity. For example, Mason et al. (2012) show that positive spillovers from the use of certified high-level skills are confined to industries which make intensive use of university-educated labour, hence the effect for the overall economy might be more difficult to identify. Our results are also robust to the introduction of the two measures of regional economic conditions (columns 10 and 11).

Overall, our results confirm our expectations of a positive relationship between TC and firms' productivity performance, providing support for our first hypothesis. Financial capital plays the most important role, followed by institutional, infrastructure and social capital. Consistent with the discussion in Isaksson (2007), the efficient allocation of resources, promoted by a developed financial system, and the role of infrastructure in lowering transportation costs and facilitating interchanges, are important for productivity performance. The effect of technological capital also shows that, although regional factors are not the primary source of firms' innovative behaviour, they favour the generation of new ideas, which promote growth (Sternberg and Arndt, 2001). Consistent with Perucca (2014), we find that natural capital is negatively associated with firms' productivity performance, although the effect is never statistically significant.

[INSERT TABLE 3 HERE]

5.2 Identification issues

In the previous section we have assumed that each dimension of TC is exogenous and therefore uncorrelated with firms' productivity performance. A fundamental problem of this approach is that it does not control for the possible issue of sorting (i.e. the most productive firms will locate in those regions endowed with better TC resources). This is a major source of endogeneity and it can make the identification of causal effects particularly challenging. Although the inclusion of data at the firm level, next to macro data at the territorial level, may overcome the endogeneity problem (Fazio and Piacentino, 2010), large firms could still influence some of the TC components, such as financial capital and infrastructure, by lobbying regional administrative bodies.

A common solution to the endogeneity problem is the use of instrumental variables. However, finding valid instruments correlated with the 8 dimensions of TC but uncorrelated with productivity, is challenging, and using weak instruments can generate results that are less reliable than the OLS estimates. As an alternative, we re-estimate equation (3) using lagged values of all territorial variables, under the assumption that the decision to locate in a certain region at time *t* is not correlated with past endowments of TC. Table 4 presents results based on the specification of two lag structures (5 and 8-year lags).[15]

[INSERT TABLE 4 HERE]

[15] We did not consider longer time lags to avoid a drop in the number of observations.

Results in table 4 re-affirm the role of financial capital, infrastructure institutional and social capital, although the latter is less precisely estimated. The main difference compared to the results reported in table 3, is the lack of significance of technological capital, which could be due the reduced sample size or the high correlation between this component and financial capital, as discussed in section 4.2.[16] Overall, results are consistent with those presented in table 3, suggesting that the endogeneity issue might not be too serious. In addition, two features of our data set could contribute to reduce the relevance of sorting. First, the majority (97%) of firms in our sample are SMEs (< 250 employees), which are less likely to have enough power to influence the external environment. Second, SMEs are usually strongly embedded and rooted in their local context. Thus, they are more likely to be affected by the resources in the area where they operate, rather than sorting themselves into regions with better TC endowment (Agostino et al. 2019). For these reasons, in the reminder of our study we will rely on the assumption of exogenous territorial assets, although interpretation of causal effects should be treated with caution.

5.3 Robustness checks

In this section we present a series of sensitivity checks to assess the robustness of our results. We fist evaluate whether our conclusions are affected by different proxies for TC (alternative indicators, shown in column 4 of table 1). Results are presented in appendix table A.6. For comparison purposes, the first two columns report the results for the benchmark model (table 3, columns 9 and 10). Results in columns 3 and 4 show that the estimated effect of social capital and infrastructure is robust to the use of the different indicators. Technological and human capital are always positively associated to firms' productivity performance, although in some cases the effect of one proxy is not statistically significant. Institutional capital, which plays an important role when proxied with 'waiting time at

[16] We also note that the human capital coefficient is statistically significant in columns (1) and (2) when we exclude the control for the economic wealth of the region.

the public office' in the first set of indicator, is no longer significant when using the alternative proxy – number of violent crimes per 10,000 people – nor it has the predicted negative sign. Similar results are obtained when we summarize the two proxies for each component of TC using factor analysis (columns 5 and 6).[17] It is possible that the weaker performance of some of our indicators is driven by the features of our data, rather than the choice of the indicator. In fact, while our dependent variable varies significantly over time, the regional components of TC tend to be quite persistent. This difference degree of variability may lead to imprecise estimates. To address this issue, we run another set of regression using 5-year time averages of all our variables. Coefficient estimates in Appendix table A.7 show that results for our main components of TC hold.

Another issue that can affect our results is the inclusion of large firms in our sample (2.2% of our sample, as shown in table A.2). The use of the location of headquarters to assess the effect of TC might be problematic for these firms as their production units might be located in different regions. Hence, as a further robustness check, we re-run our benchmark model excluding large companies from our sample. Appendix table A.8 presents the new results based on the two sets of indicators for TC. Coefficient estimates are consistent with those reported in table 3 (column 10) and appendix table A.6 (column 4).

Overall, this first part of the analysis shows that technological capital, social and institutional capital, financial capital and infrastructure capital play a positive role in firms' productivity performance. Natural capital, on the other hand, has a negative impact while the role of artistic capital is always insignificant.

5.4 The effects of TC at regional and sector level

[17] The two indicators describing the same component of TC are strongly correlated, hence FA provides just one factor for each TC dimension.

In this section we relax the assumption of homogeneous coefficients and allow the impact of TC to differ across different regional areas and industries. We first distinguish the Italian territory into North and Centre-South, following the well-known Italian economic divide.[18] We present our results in table 5.

[INSERT TABLE 5 HERE]

As expected, we find several differences across the two parts of Italy. In section 2 we discussed the possibility that technological capital might have a stronger effect in the Centre-South compared to the North of the country, because of the catching up process. Our results for this indicator support this assumption as the technological capital coefficient is positive and statistically significant only in the Central and Southern regions. This also shows that, like classical capital assets, some of the components of TC are subject to decreasing returns to scale, hence their benefits are likely to be stronger in regions where the level of TC is lower (Camagni and Capello, 2013). However, these conclusions contrast with the results for human and social capital, which are only significant in promoting productivity in firms located in the North of Italy. This apparent contradiction can be explained by the different degree of mobility of this type of assets and the diverse historical and cultural background of the two Italian regions. For example, authors have discussed the migration of graduates from the South to the North of the country, where job opportunities are more plentiful. This Italian 'brain-drain' is well-documented in the literature and can explain the insignificant effect of human capital in the South (Viesti, 2005; Fratesi and Percoco, 2009). As for social capital, the assumed positive effect on firms' performance would be undermined if driven by favouritisms and by individuals in position of power, rather than by genuine cooperation for the common good. This

[18] We use two categories to ensure a more balanced number of firms between the two groups as 61% of firms are located in the North, 20% in the Center and 19% in the South.

'dark side' of social capital, which is particularly common in the South of Italy, can explain the negative effect on productivity in this part of the country. (Leonardi, 1995; Woolcock, 2004; Malecki, 2012).

A similar reasoning can explain the difference in the impact of infrastructure and financial capital in the two Italian areas. These are positively associated to firms' productivity performance in the North, while they are either negative (financial) or insignificant (infrastructure) in the rest of the country. Higher quality of both transport and financial services in the North can contribute to the efficient circulation and distribution of resources, which in turns can boost productivity. Levels of corruption and bureaucracy, which are notoriously higher in the Southern regions, can lead to the inefficient use of resources, the decrease in the quality of infrastructure and credit misallocation, with detrimental effects on firms' performance (Del Monte and Papagni, 2001, Crescenzi et al. 2016, Moretti, 2014).

A form of TC that seems to particularly favour the performance of firms in the Central and Southern regions is artistic capital. In the North, on the other hand, coefficient estimates indicate a negative effect. It is possible, that in the South, where the creative environment is less vibrant, the presence of artistic capital contributes to create economic opportunities and stimulate new ideas which are important for productivity performance (Cerisola, 2019; Morretta, 2017; Santagata, 2002). In the North, the negative coefficient might capture the negative relation between regulations and productivity, as artistic capital may impose limits on the expansion of economic activities (for example, construction). This result could also indicate that inherited hard assets are not always beneficial to growth (Perucca, 2014).

Although differences across the North and the Centre-South are important, heterogeneity across firms that operate in different sectors can also shed light on the role of different types of TC. In fact, as advanced in our third hypothesis, different components of TC could be relevant in different industries. To test this hypothesis, we carry out the estimation of equation (3) distinguishing between manufacturing and service companies. For the latter group, we also present results for the largest

sectors. Results in table 6 show that our third hypothesis is generally rejected as the same components of TC contribute to productivity performance in both sectors. These include social capital, financial capital and infrastructure, which are positively associated to TFP, and institutional capital (low quality of institutions), which is associated with a decline in TFP. The main difference between manufacturing and services is in the role of human capital, which is positively associated with productivity performance only in firms belonging to the service sector. This is true for the whole sector and for some major industries such as wholesale and retail trade, accommodation and food and information and communications services. In the latter, we also find that technological capital is positive and statistically significant, a result consistent with related evidence on the complementarity effect of ICT and innovation on productivity (Pieri et al., 2018). Unexpectedly, technological capital is not significant in the manufacturing sector nor in the scientific research industry; however, although investments in technological assets, such as R&D, are mainly carried out within these industries, potential externality effects that are captured by our proxy might be prevented because of secrecy and protection of new ideas.

Consistent with previous results, natural capital is inversely associated with TFP in most service industries, as environmental regulations can impose constraints on firms' activities (Greenstone et al., 2012; Dechezleprêtre and Sato, 2014). The only exception is the food and accommodation industry, which particularly relies on the beauty of the landscape. Hence firms operating in this industry might see environmental regulations more of an asset than a hindrance.

6. Conclusions

This work provides a comprehensive analysis of the relationship between TC and firms' productivity performance of Italian firms. Using our newly constructed measures of different components of TC, we find that several indicators play an important role in driving productivity, consistent with our first hypothesis, with heterogeneous effects across widely defined regional areas

and industries. In the full sample, results reveal that institutional, infrastructure and financial capital are important in driving companies' productivity performance. Results also suggest that social and technological capital are relevant components, albeit coefficient estimates are more sensitive to different model specifications.

When we consider two main Italian regional areas, we find that only two forms of TC, technological and artistic capital, improve productivity in the Centre-South of the country, hence they contribute to the catching up process towards the more productive northern regions. Other components, such as social, infrastructural, institutional and financial capital, while important in the most industrialised areas of the North of Italy, are mostly insignificant in the rest of the country. Results at the industry level show that financial capital and infrastructure are important in promoting productivity performance in most sectors. In terms of policy implications, these would be the two main components of TC that should be targeted to contribute the productivity performance of a wide spectrum of firms. However, the estimates for the North and Centre-South, suggest that if social and institutional capital are weak, financial capital and infrastructure alone might not be enough to promote the efficient distribution of resources and to resolve regional disparities. This suggests that industrial policies should consider the region where firms operate when designing measures aimed at to promoting productivity performance. Overall, the use of TC as a conceptual framework is important to develop new frontiers of research aimed at explaining long-run productivity with endogenous factors rooted in the coexistence of assets within different territories.

Future research should focus on the interaction among different elements of TC and between firms and regional assets to assess the presence of complementarities. This will answer the question of whether firms' internal choices, in terms of skills and management practices, can promote the firm's ability to take advantage of regional resources, i.e. whether the concept of absorptive capacity, which is usually analysed in the context of technological innovations, is also valid for the exploitation of a different mix of regional resources.

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Table 1 – Territorial capital dimensions and their proxies

	(1)	(2)	(3)	(4)	(5)	(6)
Dimension	**Proxy**	**Authors that suggested or used similar proxies**	**Data Source**	**Alternative proxy**	**Authors that suggested or used similar proxies**	**Data Source**
Technological Capital	R&D expenditure per % of GDP	Rodríguez-Pose and Crescenzi, 2008	OECD	Patents Registered at the European Patent Office (EPO) per 100 of people	Piergiovanni et al., 2012; Marrocu and Paci, 2012	European Patent Office/Istat
Human Capital	Graduates in science and technology subjects (%)	Camagni et al., 2011; Brasili et al., 2012	Istat/Miur	First and second stage of tertiary education (levels 5 and 6)(%)	Several authors. Common proxy for human capital	Eurostat
Social Capital	Employees in cooperatives (%)		Istat	Blood donations (%)	Crescenzi et al., 2013	Avis
Institutional Capital	Waiting time at the public office (%)		Istat	Violent Crimes per 10.000 people	Lasagni et al., 2015 (Crime Index is one component of the Istitutional Quality Index)	Istat, Ministero dell'Interno
Natural Capital	Important natural sites (%)		Istat/Ispra	Protected sites (%)		Istat/Ispra
Artistic Capital	Number of public institutes of antiquities and art	From the definition of Throsby, 1999	Istat	Diffusion of Theatre and Music Performances (%)	From the definition of Piergiovanni et al., 2012	Istat/SIAE
Financial Capital	Bank credit as % of GDP	Brasili et al., 2012	Banca d'Italia/Istat	Financial risk (%)		Banca d'Italia/Istat
Infrastructure Capital	Highway length (Km)/Terrestrial area (Km2) (%)		Asti	Flights departed and landed	Perucca, 2013	Asti

Table 2 - Cobb Douglas Production function coefficients. (Dependent variable: firms' value added).

	(1) Entire Sample	(2) Arts, entertainment and recreation (R)	(3) Accommodation and food service activities (I)	(4) Financial and insurance activities (K)	(5) Manufacturing (C)	(6) Scientific research and other technical activities (M)	(7) Wholesale and retail trade (G)	(8) Administrative and support service activities (N)	(9) Information and communication (J)	(10) Education (P) & Human health services (Q)	(11) Transport and storage (H) & Other services (S)
Tangible Capital	0.078***	0.144***	0.128***	0.067***	0.082***	0.060***	0.080***	0.077***	0.063***	0.045***	0.076***
	(0.003)	(0.038)	(0.010)	(0.023)	(0.003)	(0.012)	(0.006)	(0.012)	(0.008)	(0.010)	(0.010)
Labour	0.683***	0.521***	0.347***	0.601***	0.639***	0.711***	0.571***	0.692***	0.676***	0.666***	0.697***
	(0.003)	(0.032)	(0.013)	(0.036)	(0.004)	(0.010)	(0.006)	(0.008)	(0.010)	(0.008)	(0.007)
Intangible Capital	0.022***	0.022**	0.004	0.040***	0.016***	0.042***	0.023***	0.046***	0.049***	0.006*	0.008**
	(0.001)	(0.010)	(0.004)	(0.010)	(0.001)	(0.006)	(0.002)	(0.005)	(0.005)	(0.003)	(0.003)
Observations	533,318	5,540	29,137	3,460	253,777	23,542	123,721	19,634	23,658	17,762	33,087

Notes: Levinsohn and Petrin (2003) estimates. Standard errors in brackets (Bootstrap). ***p<0.01, **p<0.05, *p<0.1. We have imposed homogenous coefficient in sectors P and Q, H and S because of limited number of observations in individual sectors.

Table 3 – The effect of territorial capital on firms' productivity performance: benchmark model

(Dependent variable: Total Factor Productivity)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Technological capital	0.047**								0.019*	0.018*	0.023*
	(0.018)								(0.010)	(0.010)	(0.011)
Human capital		0.040***							0.015	0.017	-0.025
		(0.011)							(0.010)	(0.011)	(0.032)
Social capital			0.030**						0.024**	0.025*	0.0186
			(0.012)						(0.011)	(0.012)	(0.011)
Institutional capital				0.027*					-0.039**	-0.037**	-0.038**
				(0.013)							(0.014)
Natural capital					-0.021				-0.013	-0.012	-0.014
					(0.016)				(0.009)	(0.009)	(0.010)
Artistic capital						0.030**			0.004	0.006	0.004
						(0.013)			(0.007)	(0.008)	(0.006)
Financial capital							0.061***		0.065***	0.061***	0.057***
							(0.018)		(0.010)	(0.017)	(0.012)
Infrastructure capital								0.008	0.037**	0.036**	0.038**
								(0.011)	(0.013)	(0.013)	(0.014)
Unemployment Rate										-0.023	
										(0.059)	
Added Value											0.059
											(0.048)
Constant	4.306***	4.293***	4.317***	4.320***	4.293***	4.309***	4.306***	4.300***	4.287***	4.323***	3.590***
	(0.0356)	(0.0288)	(0.0396)	(0.0374)	(0.0313)	(0.0401)	(0.0321)	(0.0414)	(0.0254)	(0.103)	(0.577)
Observations	420,310	485,286	485,286	485,286	485,286	484,437	485,286	480,125	419,461	419,461	419,461

Notes: Standardized coefficients; Robust standard errors clustered by region in brackets; * p < 0.10, ** p < 0.05, *** p < 0.01. All specifications include firm's size and age, time, sector and regional dummies. TC is proxied using indicators in table 1, column (1).

Table 4 – Lagged effect of territorial capital. (Dependent variable: Total Factor Productivity)

	Lag t-5		Lag t-8	
	(1)	(2)	(3)	(4)
Technological capital	0.014	0.015	0.026	-0.036
	(0.013)	(0.014)	(0.020)	(0.032)
Human capital	0.032*	0.033	0.044*	0.015
	(0.019)	(0.021)	(0.023)	(0.030)
Social capital	0.022	0.022*	0.012	0.064**
	(0.013)	(0.013)	(0.022)	(0.026)
Institutional capital	-0.030***	-0.029**	-0.031**	-0.113***
	(0.009)	(0.013)	(0.011)	(0.035)
Natural capital	-0.012	-0.012	-0.008	-0.013
	(0.009)	(0.009)	(0.012)	(0.012)
Artistic capital	-0.026	-0.025	-0.030	-0.014
	(0.021)	(0.022)	(0.024)	(0.030)
Financial capital	0.068***	0.065**	0.056*	0.205**
	(0.018)	(0.025)	(0.029)	(0.082)
Infrastructure capital	0.042***	0.041***	0.037**	0.081***
	(0.012)	(0.014)	(0.016)	(0.020)
Unemployment Rate		-0.014		0.382
		(0.073)		(0.224)
Constant	4.280***	4.307***	4.246***	3.441***
	(0.027)	(0.141)	(0.025)	(0.454)
Observations	196,920	196,920	95,901	95,901

Notes: Standardized coefficients. Robust standard errors clustered by region in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
All specifications include firm's size and age, time, sector and regional dummies. TC is proxied using indicators in table 1, column (1).

Table 5 - The impact of territorial capital on firms' performance: North versus the rest of Italy. (Dependent variable: Total Factor Productivity)

	North		Centre-South		North Lag t-5	Centre-South Lag t-5
	(1)	(3)	(2)	(4)	(5)	(6)
Technological capital	0.010	0.009	0.104***	0.103***	0.019	0.087**
	(0.013)	(0.011)	(0.016)	(0.013)	(0.042)	(0.027)
Human capital	0.057***	0.058***	-0.004	-0.006	0.119**	-0.004
	(0.013)	(0.013)	(0.007)	(0.006)	(0.031)	(0.009)
Social capital	0.027*	0.028*	-0.016**	-0.007	0.073**	-0.018*
	(0.013)	(0.013)	(0.007)	(0.008)	(0.022)	(0.008)
Institutional capital	0.007	0.008	-0.020	-0.010	0.073	-0.022
	(0.028)	(0.028)	(0.013)	(0.013)	(0.043)	(0.014)
Natural capital	-0.001	-0.001	-0.014**	-0.006	0.044	-0.012
	(0.019)	(0.019)	(0.006)	(0.008)	(0.048)	(0.007)
Artistic capital	-0.048**	-0.048***	0.011***	0.015***	-0.042	0.030
	(0.013)	(0.012)	(0.003)	(0.004)	(0.030)	(0.018)
Financial capital	0.063***	0.060***	-0.029*	-0.073**	-0.030	-0.028
	(0.011)	(0.011)	(0.016)	(0.026)	(0.054)	(0.033)
Infrastructure capital	0.045***	0.045***	-0.001	0.002	0.006	-0.005
	(0.010)	(0.010)	(0.005)	(0.004)	(0.020)	(0.006)
Unemployment Rate		-0.011		-0.120**	-0.242	-0.021
		(0.021)		(0.049)	(0.123)	(0.049)
Constant	4.288***	4.304***	4.159***	4.352***	4.711***	4.189***
	(0.051)	(0.065)	(0.027)	(0.086)	(0.218)	(0.096)
Observations	271,994	271,994	147,467	147,467	125,631	71,289

Notes: Standardized coefficients. Robust standard errors clustered by region in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01.
All specifications include firm's size and age, time, sector and regional dummies. TC is proxied using indicators in table 1, column (1).

Table 6 – Territorial capital and productivity: industry evidence

	(1) Manufacturing	(2) Services	(3) Wholesale & retail trade	(4) Transp., storage & other services	(5) Accomodation & food	(6) Information & Communication	(7) Scientific research	(8) Admin/ services
NACE code			G	H	I	J	M	N
Technological capital	0.019	0.015	0.019	0.002	0.013	0.042***	0.001	0.030**
	(0.013)	(0.013)	(0.015)	(0.016)	(0.033)	(0.008)	(0.025)	(0.011)
Human capital	0.017	0.027*	0.032*	-0.008	0.040*	0.023**	0.029	0.021
	(0.012)	(0.015)	(0.016)	(0.013)	(0.019)	(0.010)	(0.021)	(0.013)
Social capital	0.030*	0.024*	0.012	0.069***	0.024	0.019	0.040	0.011
	(0.016)	(0.014)	(0.017)	(0.0112)	(0.026)	(0.012)	(0.026)	(0.013)
Institutional capital	-0.034*	-0.043***	-0.071***	-0.100***	0.038	0.001	-0.046*	-0.031**
	(0.017)	(0.014)	(0.017)	(0.014)	(0.023)	(0.011)	(0.022)	(0.011)
Natural capital	-0.010	-0.030***	-0.032***	-0.003	0.046*	-0.021**	-0.063***	-0.030***
	(0.010)	(0.010)	(0.011)	(0.010)	(0.025)	(0.008)	(0.020)	(0.009)
Artistic capital	-0.003	0.003	0.009	0.017**	0.007	-0.002	-0.028	-0.013
	(0.011)	(0.008)	(0.008)	(0.008)	(0.012)	(0.008)	(0.018)	(0.009)
Financial capital	0.035*	0.099***	0.099***	0.027	-0.025	0.105***	0.164***	0.163***
	(0.018)	(0.020)	(0.020)	(0.027)	(0.038)	(0.013)	(0.027)	(0.021)
Infrastructure capital	0.032*	0.047***	0.038*	0.091***	0.000	0.020**	0.063**	0.048***
	(0.017)	(0.014)	(0.018)	(0.010)	(0.019)	(0.009)	(0.023)	(0.010)
Unemployment Rate	-0.068	0.037	0.024	-0.088	-0.156	0.075	0.138	0.141
	(0.065)	(0.067)	(0.074)	(0.057)	(0.093)	(0.055)	(0.116)	(0.084)
Constant	4.955***	4.517***	5.168***	4.647***	5.477***	4.759***	4.107***	4.083***
	(0.119)	(0.125)	(0.145)	(0.107)	(0.169)	(0.089)	(0.281)	(0.165)
Observations	195,129	224332	97,618	26,641	22,889	19,658	19,296	16,023

Notes: Standardized coefficients. Robust standard errors clustered by region in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. All specifications include firm's size and age, time, sector and regional dummies. TC is proxied using indicators in table 1, column (1).

Appendix

Table A.1 – Balance-sheet data at firm level, summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Value Added	779606,0	2045,9	4284,1	6,6	107975,4
Tangible Capital	789719,0	2093,5	11648,9	0,9	2896168,0
Intangible Capital	681394,0	310,7	1373,7	0,9	66279,0
N. of employees	630471,0	44,9	79,0	2,0	1551,0

Table A.2 – Firms' size distribution

Size	Employees Number	N.of firms	(%)
Micro	less then 10	11,507	12.6%
Small	10 ≤ and < 50	63,675	69.5%
Medium	50 ≤ and < 250	13,973	15.2%
Large	≥250	2,059	2.2%
n/a	n/a	439	0.5%
Tot	Tot	91,653	100.0%

Table A.3 – Firms' distribution by sector and geographical area

Sector	N.of firms	(%)
Manufacturing (C)	40,669	44.4%
Wholesale and retail trade, repair of motor vehicles and motorcycles (G)	20,137	22.0%
Accommodation and food service activities (I)	6,110	6.7%
Transportation and storage (H)	5,639	6.2%
Scientific research and other technical activities (M)	4,226	4.6%
Administrative and support service activities (N)	4,194	4.6%
Information and communication (J)	4,075	4.4%
Human health services, residential care and social work activities (Q)	2,981	3.3%
Arts, entertainment and recreation (R)	1,406	1.5%
Other services (S)	918	1.0%
Financial and insurance activities (K)	650	0.7%
Education (P)	647	0.7%
Total	91,652	100.0%

Region		
Lombardia (North)	23,294	25.4%
Veneto (North)	10,644	11.6%
Emilia Romagna (North)	9,456	10.3%
Lazio (Center)	7,653	8.4%
Toscana (Center)	6,813	7.4%
Piemonte (North)	6,735	7.3%
Campania (South)	5,318	5.8%
Puglia (South)	3,539	3.9%
Sicilia (South)	3,272	3.6%
Marche (Center)	2,847	3.1%
Friuli Venezia Giulia (North)	2,099	2.3%
Liguria (North)	2,031	2.2%
Abruzzo (Center)	1,655	1.8%
Trentino Alto Adige (North)	1,611	1.8%
Sardegna (South)	1,543	1.7%
Umbria (Center)	1,279	1.4%
Calabria (South)	1,086	1.2%
Basilicata (South)	376	0.4%
Molise (South)	259	0.3%
Val D'Aosta (North)	142	0.2%
Total	91,652	100.0%

Table A.4 – Territorial Capital indicators, summary statistics

	Pooled Sample					North					Center					South				
Variable (Main set of TC indicators)	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
R&D expenditure	694,086	5.76	0.48	4.06	6.81	415,380	5.94	0.29	4.58	6.81	141,149	5.95	0.32	5.18	6.29	137,557	5.00	0.32	4.06	5.41
Graduates in science & tech. subjects	803,438	8.76	0.82	0.000	9.66	488,671	8.96	0.77	0.000	9.66	163,530	8.68	0.70	6.95	9.54	151,237	8.19	0.84	3.30	9.10
Employees in cooperatives	803,438	1.34	0.20	1.03	1.95	488,671	1.25	0.12	1.03	1.61	163,530	1.41	0.22	1.06	1.71	151,237	1.56	0.16	1.25	1.95
Waiting list	803,438	15.5	8.38	2.55	46.5	488,671	11.76	3.30	2.55	19.40	163,530	24.65	13.07	4.30	46.5	151,237	17.68	3.57	6.80	24.6
Natural sites	803,438	2.55	0.41	1.69	3.48	488,671	2.48	0.36	2.16	3.48	163,530	2.36	0.23	2.12	2.80	151,237	2.98	0.43	1.69	3.29
Public institutes of antiquities and art	802,204	3.15	0.82	0.000	4.52	487,437	2.88	0.59	0.000	3.50	163,530	3.92	0.69	2.40	4.52	151,237	3.17	1.03	0.000	4.09
Bank credit	803,438	4.07	0.34	3.05	4.59	488,671	4.22	0.24	3.48	4.59	163,530	4.10	0.15	3.82	4.33	151,237	3.53	0.21	3.05	4.16
Highways	794,326	1.24	0.23	0.000	2.07	488,671	1.30	0.18	0.86	2.07	163,530	1.11	0.21	0.53	1.32	142,125	1.19	0.34	0.000	1.45
Variable (TC indicators used for rob. checks)	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Patent registered at EPO	803,438	4.21	0.93	0.10	5.30	488,671	4.82	0.25	3.12	5.30	163,53	3.89	0.48	3.02	4.49	151,237	2.58	0.46	0.095	3.89
Tertiary education	803,438	2.64	0.17	2.21	3.00	488,671	2.64	0.13	2.30	2.93	163,53	2.78	0.13	2.49	2.99	151,237	2.48	0.14	2.21	2.84
Blood donations/resident population	803,438	0.003	0.004	0.001	.007	488,671	0.003	0.004	0.001	0.007	163,53	0.004	0.003	0.002	0.012	151,237	0.004	0.004	0.002	0.003
Organized crime index	803,438	120.13	44.22	18.45	512.10	488,671	111.64	29.53	40.00	231.40	163,53	152.70	50.77	70.50	342.50	151,237	112.35	57.82	18.45	512.10
Protected areas	803,438	2.43	0.53	-1.61	3.61	488,671	2.35	0.48	1.28	3.61	163,53	2.48	0.54	1.70	3.17	151,237	2.61	0.60	0.00	3.48
Artistic events	803,438	4.07	0.32	2.21	4.62	488,671	4.17	0.12	3.73	4.52	163,53	4.29	0.20	3.93	4.62	151,237	3.50	0.25	2.21	3.86
Financial risk	803,438	1.94	0.91	0.70	7.9	488,671	1.64	0.66	0.70	4.00	163,53	2.13	0.83	0.90	4.00	151,237	2.68	1.16	0.90	7.90
Flights	783,409	11.52	1.19	3.89	12.97	474,312	11.82	1.04	3.89	12.97	163,53	11.34	1.50	7.71	12.88	145,567	10.76	0.81	8.53	11.80

Notes: values are averages over years 2004-2012

Table A.5 -Territorial capital proxies correlation matrix

A. Main set of indicators

	Technological capital (R&D expenditure)	*Human capital (Graduates in science & tech subjects)*	*Social Capital (Employees in Cooperatives)*	*Institutional capital (Waiting list)*	*Natural capital (Natural sites)*	*Artistic capital (Public institutes of antiquities and art)*	*Financial capital (Bank credit)*	*Infrastructure capital (Highways)*
Technological capital (R&D expenditure)	1.000							
Human capital (Graduates in science & tech subjects)	0.423	1.000						
Social Capital (Employees in Cooperatives)	-0.126	-0.087	1.000					
Institutional capital (Waiting list)	0.179	0.196	0.663	1.000				
Natural capital (Natural sites)	-0.488	-0.514	-0.082	-0.283	1.000			
Artistic capital (Public institutes of antiquities and art)	0.084	0.424	0.293	0.621	-0.249	1.000		
Financial capital (Bank credit)	0.679	0.471	-0.382	-0.133	-0.392	-0.072	1.000	
Infrastructure capital (Highways)	0.244	0.205	-0.145	0.125	0.170	0.063	-0.140	1.000

B. Alternative set of indicators

	Technological capital (Patent registered at EPO)	*Human capital (Tertiary education)*	*Social capital (Blood donations)*	*Institutional capital (Organized crime index)*	*Natural capital (protected areas)*	*Artistic capital (Artistic events)*	*Financial capital (Financial risk)*	*Infrastructure capital (Flights)*
Technological capital (Patent registered at EPO)	1.000							
Human capital (Tertiary education)	0.151	1.000						
Social capital (Blood donations)	-0.134	0.015	1.000					
Institutional capital (Organized crime index)	0.053	0.163	0.24	1.000				
Natural capital (protected areas)	-0.262	0.184	-0.038	-0.13	1.000			
Artistic capital (Artistic events)	0.627	0.624	-0.126	0.03	0.049	1.000		
Financial capital (Financial risk)	-0.503	0.191	0.117	-0.119	0.235	-0.32	1.000	
Infrastructure capital (Flights)	0.26	0.183	-0.691	-0.305	0.145	0.444	-0.288	1.000

Robustness checks

Table A.6 – The relation between TC and firms' TFP - Alternative indicators

(Dependent variable: TFP)

	Original Table 3 (1)	Original Table 3 (2)	Robustness Check (3)	Robustness Check (4)	FACTOR ANALYSIS (5)	FACTOR ANALYSIS (6)
Technological capital	0.019*	0.018*	0.045**	0.036*	0.013	0.008
	(0.010)	(0.009)	(0.019)	(0.021)	(0.023)	(0.020)
Human capital	0.015	0.017	0.040***	0.040***	0.067***	0.061**
	(0.010)	(0.011)	(0.010)	(0.010)	(0.020)	(0.023)
Social capital	0.024**	0.025*	0.014**	0.013*	0.057***	0.052**
	(0.011)	(0.012)	(0.006)	(0.007)	(0.015)	(0.019)
Institutional capital	-0.039**	-0.037**	0.008	0.007	0.023	0.026
	(0.014)	(0.014)	(0.008)	(0.008)	(0.023)	(0.023)
Natural capital	-0.013	-0.012	-0.014**	-0.014**	-0.031**	-0.033**
	(0.009)	(0.009)	(0.006)	(0.006)	(0.011)	(0.012)
Artistic capital	0.004	0.006	-0.004	-0.004	0.026	0.028
	(0.007)	(0.008)	(0.012)	(0.013)	(0.020)	(0.032)
Financial capital	0.065***	0.061***	-0.010	-0.012	0.017	0.017
	(0.009)	(0.017)	(0.009)	(0.010)	(0.012)	(0.012)
Infrastructure capital	0.037**	0.036**	0.055***	0.054***	0.033***	0.035***
	(0.013)	(0.013)	(0.005)	(0.006)	(0.009)	(0.010)
Unemployment Rate		-0.023		-0.028		-0.033
		(0.059)		(0.043)		(0.044)
Constant	4.287***	4.323***	4.268***	4.315***	4.310***	4.357***
	(0.025)	(0.103)	(0.034)	(0.072)	(0.041)	(0.058)
N	419,461	419,461	473,152	473,152	407,528	407,528

Notes: Standardized coefficients. Robust standard errors clustered by region in brackets. *** p<0.01, ** p<0.05, * p<0.1.
All specifications include firm's size, age, time, sector and regional dummies.
Columns 1 & 2 : TC dimensions are proxied by using indicators of table 1 – column (1)
Columns 3 & 4: TC dimensions are proxied by using indicators of table 1 – column (4)
Columns 5 & 6 : territorial capital measures are proxied by factors of the different indicators belonging to the same territorial capital dimension.

Table A.7 – The relation between TC and firms' TFP average over 5 years

(Dependent variable: TFP)

	(1)	(2)
Technological capital	0.061**	0.060**
	(0.023)	(0.023)
Human capital	0.011	0.012
	(0.010)	(0.012)
Social capital	0.083	0.084
	(0.059)	(0.061)
Institutional capital	-0.004***	-0.004***
	(0.001)	(0.001)
Natural capital	-0.040**	-0.040**
	(0.017)	(0.017)
Artistic capital	0.004	0.004
	(0.006)	(0.006)
Financial capital	0.171***	0.166***
	(0.020)	(0.039)
Infrastructure capital	0.134***	0.134**
	(0.046)	(0.046)
Unemployment Rate		-0.008
		(0.047)
Constant	2.490***	2.514***
	(0.146)	(0.156)
Observations	361,091	361,091

Notes: Dep. var. is the average TFP over the last 5 years
Standardized coefficients. Robust standard errors clustered by region in brackets. *** p<0.01, ** p<0.05, * p<0.1.
All specifications include firm's size, age time, sector and regional dummies.
TC dimensions are proxied by using indicators of table 1 – column (1)

Table A.8 – Benchmark model, excluding large companies from the sample

(Dependent variable: Total Factor Productivity)

	Main set of indicators	Robustness Check
	(1)	(2)
Technological capital	0.022**	0.035*
	(0.009)	(0.021)
Human capital	0.018*	0.038***
	(0.010)	(0.010)
Social capital	0.017	0.012*
	(0.013)	(0.007)
Institutional capital	-0.043**	0.007
	(0.015)	(0.008)
Natural capital	-0.018**	-0.015**
	(0.008)	(0.006)
Artistic capital	0.007	-0.004
	(0.008)	(0.013)
Financial capital	0.060***	-0.010
	(0.015)	(0.010)
Infrastructure capital	0.031**	0.051***
	(0.014)	(0.006)
Unemployment Rate	-0.002	-0.032
	(0.062)	(0.043)
Constant	4.625***	4.319***
	(0.112)	(0.071)
N	401,727	452,942

Notes: Standardized coefficients; Robust standard errors clustered by region in brackets; * p < 0.10, ** p < 0.05, *** p < 0.01.
All specifications include firm's size, age time, sector and regional dummies.
Column 1 : TC dimensions are proxied by using indicators of table 1 – column (1)
Column 2: TC dimensions are proxied by using indicators of table 1 – column (4)