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Social Capital and Innovation: Evidence from the US (1997-2014)

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Abstract

The controversial nature of social capital and its role in economic processes favour a growing interest in the topic. Authors aimed at defining and measuring this phenomenon, and those considering it a possible determinant of growth and innovation, find no definitive solutions for the issues raised. Despite the mounting literature and since hitherto research has been focused on the potential determinants and the cross-states geographical distribution, the relation between social capital and innovation in US counties has been largely neglected. Consequently, the present study confirms a polarization in social capital distribution and provides a closer perspective on such a community-level attribute. Moreover, it contributes to the field by covering the existing shortcomings and paving the way for further research. The Poisson regression shows that social capital positively affects innovation between 1997-2014, thus presumably behaving as a knowledge catalyst and an innovators' incentive. However, social capital appears to have a negative sign in the lagged model, suggesting a possible prevalence of Putnam–type effects in the short run and Olson-type effects in the long run.

JEL Classification: O30, O31, O5, Z13
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I. Introduction

As the term social capital was coined, an increasing number of studies was devoted to the topic. The first stream of literature aims at capturing the elusive nature of social capital, whose definition and measure have been gradually refined (Tocqueville, 1838; Hanifan, 1916; Banfield, 1958; Bordieu, 1984; Coleman, 1988; Bourdieu et al., 1992; Putnam, 1993, 2000; Putnam et al., 1993; OECD, 2001; Scrivens and Smith, 2013). In particular, Putnam's theories and his ground-breaking Social Capital Index (hereafter SCI) have been accepted as the dominant paradigm for decades, attracting both criticism (Ostrom, 2000; Fine and Green, 2000; Arrow, 2000; Durlauf and Fafchamps, 2005) and approval.

Furthermore, Putnam's work has drawn attention to the relationship between civic values and politico-economic performance (Whiteley, 2000), and social capital became a possible determinant of economic growth. Ambiguous evidence has been provided depending on the chosen methods and measures (Putnam et al., 1993; Helliwell and Putnam, 1995; Knack and Kneefer, 1997; Beugelsdijk and van Shaik, 2003; Beugelsdijk and Smulders, 2003; Tabellini, 2005; Akçomak and ter Weel, 2009; Felice, 2012; Cappelli, 2017). Nonetheless, social capital is theoretically accepted as a vehicle of growth as it would reduce transaction costs (Fukuyama, 1995), encourage risk-taking activities (Narayan and Pritchett, 1999), reduce information asymmetries (ibid) and solve collective action problems (Putnam, 1993). These features are also recalled as a possible cause of innovation and justified the rise of studies debating the effects of social capital on innovation (Kotabe and Swan, 1995; Hall and Jones, 1999; Collinson and Wilson, 2006; Capaldo, 2007; Akçomak and ter Weel, 2009; Larson et al., 2012).

Different approaches, a variety of methods, and collected data could not provide a univocal claim on the matter, and the supporting evidence is still weak. Despite the growing interest toward the topic and the presence of cross-country studies, the relation between social capital and innovation in the US has been neglected, and previous researchers have mostly focused on its possible determinants and the geographical distribution across States (Alesina and La Ferrara, 2000; Rupasingha et al., 2006).

The present study is the summary of a Master Thesis in Economics defended in July 2020. The reader may consult the thesis (Viggiano, 2020) for an in-depth overview of the issues covered. On the one hand, this paper follows previous streams of literature, confirming a polarization in

social capital distribution but providing a closer perspective on such a community-level attribute. On the other hand, it adds a new contribution to the literature on social capital and innovation; it covers the existing shortcoming and paves the way for further studies. The analysis is based on county-level data drawn from Rupasingha et al. (2006) and primary governmental sources, and it concerns 2882 US counties in four years (1997, 2005, 2009, 2014). The second section provides a detailed theoretical framework and literature review for social capital issues; the third section focuses on data sources, treatments and overview, while the fourth section shows the adopted model and corresponding results. Lastly, the fifth section draws appropriate conclusions and suggests further developments.

II. A theoretical framework for Social Capital

Defining Social Capital

The French aristocrat Alexis de Tocqueville is widely recognized as a pioneer of social capital. His travels in America brought him to outline the first definition of this concept in 1838, subsequently formalized by the school supervisor Lyda J. Hanifan in 1916, when he emphasized the role of community involvement for schools' success and described social capital as "*goodwill, fellowship, sympathy, and social intercourse among the individuals and families who make up a social unit*" (Lyda J. Hanifan, 1916, p. 130). Despite the novelty of the concept, this first instance of social capital was neglected until the release of The Moral Basis of a Backward Society in 1958. The author Banfield identified the ultimate cause of poverty and backwardness in the so-called amoral familism that arose from the socio-economic, historical and cultural circumstances and prevented any form of coordination among the inhabitants of a Southern Italian village. Amoral familism revealed itself in several forms, such as the absence of organized voluntary charities and welfare activities. Banfield acknowledged that poverty and backwardness have a cultural and social root, but the spread of studies conceptualizing and measuring social capital occurred in the 1980s.

The French sociologist Bourdieu combined both the concept of cultural and social capital to explain how dominant classes retained their position (1984) and highlighted the role of social connections as a source of inequality. Coleman (1988) made a further step, defining social capital by its functions and presenting it as an integrative tool for the economic approach. All the above-mentioned definitions of social capital represent a step toward Putnam's theory. He

defined social capital as "*features of social organizations, such as networks, norms and trust that facilitated action and cooperation for mutual benefit*" (Robert D. Putnam, 1993, p. 35) and coined an index whose dimensions were inspired by Banfield's experience in Southern Italy.

Table 1. Social capital in brief

Author	Contribution
Tocqueville, 1838	Recognized that public gatherings played a major role in American democracy and provided a first hint of social capital.
Hanifan, 1916	Formalized the concept of social capital defining it as "*those tangible assets that count for most in the daily lives of people: namely goodwill, fellowship, sympathy and social intercourse among the individuals and families who make up a social unit*" (p. 130).
Banfield, 1958	Provided a testimony of the daily life in a small Italian village, characterized by lack of social cooperation and supremacy of familiar interest over the common good. Coined the term *amoral familism.*
Bordieu, 1984	Emphasized the role of social capital in determining inequality. Together with cultural capital, it would be used by dominant classes to retain their position.
Coleman, 1988	Social capital is "*defined by its functions*" and considered as an integrative tool in economic analysis.
Putnam, 1993	"Social capital is defined as the "*features of social organizations, such as networks, norms and trust that facilitate action and cooperation for future benefit*" (p. 35) and measured with a Social Capital Index based on civic culture and engagement.
OECD, 2001	Embraced all the preceding contributions with a comprehensive definition of social capital, defined as those "*networks, together with shared norms, values and understandings that facilitate co-operation within or among groups*" (p. 41).
OECD, 2013	Proposed four interpretations of social capital comprising of personal relationships, social network support, civic engagement, and trust and cooperative norms.
Arrow, 2000	Social capital is not capital since it does not simultaneously meet the condition of temporal dimension, alienability and present sacrifice for future benefit.
Ostrom, 2000	Social capital differs from other forms of capital. It does not wear out with use; it is not easy to measure and to build through external incentives; its quality and quantity depends on national institutions.
Fine and Green, 2000	The term social capital is not able to convey whether it is a private or public good.
Durlauf and Fafchamps, 2005	Highlighted the inadequacy of social capital theories in facing circularity and identification issues.

Source: Made by the author, based on cited references.

Finally, in 2001, OECD defined social capital as "*networks, together with shared norms, values and understandings that facilitate cooperation within or among groups*" (OECD, 2001, p. 41). A further contribution was published by Scrivens and Smith in 2013, when OECD suggested four interpretations of this concept, referring to personal relationships, social network support,

civic engagement and trust and cooperative norms. Overall, OECD provides a comprehensive definition embodying the different social capital theory developed and refined across years.

As seen, the definition of social capital is controversial, and its measurement is even more complicated given the elusive nature of the concept. Arrow (2000) and Ostrom (2000) criticized the term itself, stating that it cannot be considered as capital since it does not fully meet the conditions for this definition. Durlauf and Fafchamps (2005) highlight the inadequacy of social capital theories in facing issues such as identification and circularity, while Fine and Green (2000) claim that the term is not able to convey whether social capital is a collective or individual good. However, as Crudeli (2006) specifies, this confusion is surprisingly appealing for scholars and the blurred boundary between individual and social item offers a precious chance to overcome the typical individualistic attitude in economics in favour of a more socially oriented approach. The inclusion of social capital among the traditional determinants of growth is a further step in this direction.

Social capital could not be excluded by the long-standing debate regarding the determinants of economic growth. Helliwell and Putnam (1995) used the Social Capital Index to study a possible relation with economic performance and succeeded in showing that social capital promotes economic growth both in the short and long run. This first evidence was fundamental for subsequent developments, but it was not free from criticism. Using the number of voluntary organisations as a proxy for social capital neglects that members already share the same values and have high civic attitudes (Uslaner, 2002).

Social capital and economic growth, an overview

Moreover, social capital could be an impediment for economic performance (Olson, 1982). A significant number of organisations would create closed circles lobbying for specific policies that may hurt collective interest and prevent economic growth. Given the doubts related to the original social capital measure, a new stream of literature, including trust as a proxy for social capital arose.

Existing literature shows the systematic employment of OLS regressions to estimate this relation. Knack and Keefer (1997) showed that trust and civic norms are not usually related to organisations' presence but have a remarkable impact on economic performance. Beugelsdijk

and van Shaik (2003) found that both trust and associational activity are positively related to regional economic growth, while Tabellini (2005) drew similar conclusions using generalised trust and respect for others as potential social features determining economic growth.

All the above-mentioned studies are liable to criticism. Firstly, all research is based on data collected within World Value Surveys (WVS). As Sabatini (2006) stressed, WVS are addressed to individuals with a singular perception of the social environment, influenced by their social position. When aggregated, those data describe a phenomenon of "macro" or "social" trust, that loses whatever contact with the social and historical circumstances in which it accrued in. Secondly, as Akçomak and ter Weel (2009) pointed out, reverse causality may affect the relationship between social capital and growth estimated via OLS. Hence, Akçomak and ter Weel (ibid) used a 3SLS model to estimate both the direct effect of social capital on growth and the effect of social capital on innovation as a mean for development. Authors found that social capital affects economic performance via innovation. Still, social capital does not have any direct role on the income growth.

To sum up, any evidence about social capital and growth is made problematic by the controversial conceptualisation of the former and the resulting difficulty in adopting a widely recognised measure. However, scholars seem to agree about the possible channels through which social capital may affect growth (i.e., reducing transaction costs, encouraging risk-taking activity, facilitating collaboration).

Following Sabatini's (2006) approach, two main streams can be identified: the first branch of literature showing that social capital positively affects growth but suffering from questionable methods for its measurement. The second branch of studies finding no positive relation independently from the employed measurement method. Despite empirical evidence showing a positive impact of social capital on growth, Skidmore (2001) mitigates the enthusiasm.

Existent literature would demonstrate that social capital plays a positive role only when horizontal ties are strong and social groups are organised into relatively encompassing associations. However, these conditions are restrictive, and societies do not usually meet them in full. Hence, enthusiastic appraisals should be tempered, but social capital's potential in creating a conducive environment for growth cannot be denied (ibid). In the ongoing debate, the remarkable amount of literature focusing on this issue can be interpreted as an attempt to

fill the gap between social framework and theoretical economic models and integrate economics and sociology in a consistent way (Sabatini, 2006).

Social Capital and innovation, previous contributions

Existing literature provides strong theoretical support on social capital as a determinant factor for innovation, conceiving it as an enabler for knowledge and good practices sharing. Nonetheless, empirical evidence is scarce and often contradictory. The underlying idea is that innovation processes are interactive (Edquist, 1997) and nourished by social connections as a mean of transfer of technical knowledge (Nohria and Eccles, 1992). Still, this hint is differently treated and developed according to the authors' approach and analysis level.

Putnam himself paved the way for a possible relationship between social capital and innovation when he said that "*trust lubricates cooperation*" (Putnam, 1993, p. 171). Beugelsdijk and van Schaik (2005) and Capaldo (2007) drew similar conclusions, showing that higher levels of trust lead to higher levels of cooperation and knowledge sharing. Furthermore, Larson et al. (2012) concluded that a high level of social capital leads to a higher propensity to innovate, and that localized social capital is complementary to firms' investments in internal R&D.

Other studies highlight that social capital may prevent innovation at the firm level. Collinson and Wilson (2006) showed that the presence of solid external connections with suppliers and R&D partners might hurt innovation by reducing firms' flexibility. Kotabe and Swan (1995) described a trade-off in firms' allocation of efforts, resulting in high cooperation efforts to obtain mutual benefits and low efforts to innovate their products. Finally, Akçomak and ter Weel (2009) showed that social capital could affect economic growth only through innovation, as trust would reduce the perception of research as a risky activity.

The voluminous literature about social capital and innovation in regional development can be summarized as done by Edquist (1997), who defined some common features. Most regional studies analysing the impact of social capital on innovation are characterised by holistic and interdisciplinary assessments that embody a historical perspective. Innovation, learning and institutions are central in every study, but differences in systems are always contemplated, emphasising non-linearity of innovation and interdependence. Lastly, all the approaches provide conceptual frameworks rather than formal theories.

To conclude, it is easy to conceive theoretical channels through which social capital exerts a positive impact on innovation. Still, it is not equally easy to find concordance in empirical results. As in the case of social capital and growth, the level of analysis, the chosen definition and measurement of social capital and its combination with other variables affects the authors' conclusions.

Table 2. Main contributions regarding the role of social capital in innovation activity

Study	Place and period	Innovation measure	SC measure	Results	Method
Hall and Jones (1999)	127 countries, 1986-1995	Unexplained changes in output per worker	Social infrastructure: - Index of Government Anti diversion Policies - Openness to international trade	Differences in output per worker are caused by differences in institutions and government policies	OLS regression
Capaldo (2007)	Italy, September 1998-October 2000, and March 2003-October 2003	Innovation performance: - number of new products launched in the market - market feedback: years between launch in the market and withdrawal - critic's rating: number of prize-winning products in major innovation focused contexts	Presence of strong ties: - mutual knowledge - actions and investments made by the organizations believing that interfirm alliance can positively affect firm performance - inter organizational trust and reciprocity	Strong ties provide competitive advantages driven by firms' dynamic innovative capability	Multiple case study comparative approach
Larson et al. (2012)	21 Italian regions	Dummy variable taking value 1 if the firm introduced a new product and 0 otherwise	*Structural dimension* (informal relations, e.g., participation to political meetings, volunteering) *Relational dimension* (assets rooted in those relations, e.g., trust)	Being located in a region with high intensity of SC leads to greater propensity to innovate	Logit estimation for binary data
Collinson and Wilson (2006)	UK and Japan, 1996-2003.	Questionnaire replies regarding R&D initiatives and activities	Embeddedness of knowledge related routines	Solid relations with external suppliers and R&D partners may reduce firms flexibility	Comparative observation of two case studies

				and hence innovativeness	
Kotabe and Swan (1995)	US, Western European countries, and Japan, 1988-1992.	Innovativeness of the product - newness to the market - newness to the firm - dynamic interaction between the marketplace and the firm	Strategic linkages between cooperating firms	High cooperation efforts undermine product innovation.	OLS regression
Akçomak and ter Weel (2009)	14 EU countries (102 regions), 1990-2002.	Patents	Measures of trust based on European Value Surveys	Innovation is the mean through which social capital affects economic growth	3SLS estimation

Source: Made by the author, based on cited references.

III. Methodology and Data Sources

A measure for Social Capital

The chosen measure for social capital is provided by *Rupasingha, Goetz and Freshwater* (2006), who coined a social capital measure collecting county-level data on establishments, census participation, non-profit organizations and voter turnout. The above-mentioned data are combined to create a multidimensional Social Capital Index, contemplating two measures of associationism, voter turnout and census response rate in 1997, 2005, 2009 and 2014. The first indicator of associationism summarizes the number of religious, civic, business, political, professional, labour, bowling, recreational, golf and sports organizations in the year of analysis, while the second indicator comprises the overall number of non-profit organizations, excluding those with an international approach.

Clearly, the dimensions of this Social Capital Index recall Putnam's original Index. It relies on civic engagement measures and political participation and adds to an existing body of literature treating civic involvement as a form of social capital and determinant of growth. Hence, this Social Capital Index is theoretically and empirically well-grounded, but it is also a hint for a new stream of literature studying social capital in US counties.

The creation of the county-level Index and subsequent studies of the authors are motivated by the spirit of moving to a closer level of analysis and provide more specific policy suggestions, necessary for a community-level attribute such as social capital. The underlying difficulties in evaluating such an elusive concept remain, but the Index has the merit of narrowing the focus of research and encouraging new studies.

Other variables

Measuring innovation appears as much as complicated as measuring social capital. The present study follows the stream of literature using patents to measure innovation, as it employs the data on utility patents awarded by county (United States Trademark and Patent Office) and it uses the Social Capital Index years (1997, 2005, 2009, 2014) as benchmarks (Viggiano, 2020).

Choosing patents as a measure of innovation implies some limitations. Firstly, they do not convey information about the kind of innovation that occurred, since utility patents cover both creation and product improvements. Therefore, this study cannot assess whether social capital has an impact on vertical innovation, horizontal innovation, neither or both. Moreover, patents cannot provide information about the degree of innovativeness and its effect on the markets, so it cannot be qualified as incremental, sustaining, radical or disruptive. However, using the number of patents as a measure of innovation is always a workable solution, since it allows for an objective measurement of a theoretical concept.

Per capita, real GDP, population density and educational attainment are chosen as control variables (Viggiano, 2020). Furthermore, the level of expenditure for research activities is likely to affect innovation so that it is also considered a control. The National Centre for Science and Engineering Statistics provided state-level-data on R&D expenditure expressed in millions of dollars. Therefore, national research funds are assumed to be equally distributed throughout counties to obtain county-level data and the resulting amount is divided by population to obtain *per capita* expenditure in each year.

The above-mentioned methodologies and data were used to create a panel dataset for 48 States (Alaska, Hawaii and islands are excluded), District of Columbia and 2882 US counties.

Data at a glance

The dataset allows an overview of the geography of social capital across counties and states. At first glance, Midwest appears as a highly concentrated region, while South presents scarcity of social capital (Appendix 1 and 2).

The polarization is even clearer by looking at the overall map (Map 1, showing the general distribution of social capital in all the years under study) since states in the top and second quantile are almost exclusively in Northern USA. The scatterplots 1-4 reveal a further important detail for our analysis. Social capital is always greater among Midwestern states (especially Iowa, Kansas, Minnesota, Nebraska, North and South Dakota) and lower in South. In contrast, Western and North-eastern states are usually located in the middle and show medium-low and medium-high social capital indices.
Although this scheme is repeated each year, states progressively reduce their scattering across time, and they seem to converge until 2009. A slight increase in dispersion is observed in 2014.

Furthermore, some states belonging to the same area show similar dynamics and some of them are neighbouring (Graph 1-4). Relevant findings also concern the distribution of social capital in each dimension of the SCI, since the highest Social Capital Indices in Midwest mirror better performances in all their components (Viggiano, 2020).

The used dataset does not include any figure regarding income distribution, population composition or labour market features. Hence, it is impossible to draw certain conclusions about the reasons for such distribution of social capital across time, states and counties. Fortunately, Rupasingha et al. (2006) employ their county-level Social Capital Index to identify the possible sources of associationism and overall social capital, finding that ethnic diversity and income inequality undermine social capital formation. Simultaneously, rural areas' presence, women participation in the labour force and education positively contribute to developing tight social networks.

Since the present study is based on the same measure of social capital of Rupasingha et al. (2006), we can affirm that ethnic and income heterogeneity are two of the causes of scarce social capital in Southern regions (also due to the proximity to Latin America). Furthermore,

education and labour composition are important factors influencing our findings regarding social capital distribution.

Map 2 provides a general idea of the concentration of patents awarded and intuition of the possible relations with the other variables comprised in our model. It is worth mentioning that patents have been normalized (by the population and expressed per ten thousand residents) to allow for cross-state comparisons. At first glance, it is possible to identify two areas presenting a higher concentration of innovation. The West Coast states and those in Northern regions systematically receive patent awards in all the years under study (Viggiano, 2020), while the South appears as a poorly innovative area.

The findings are only partially overlapping concerning those regarding the distribution of social capital across states and we do not have a straight intuition of the possible relation between the two considered variables (Viggiano, 2020). Similarly, the geography of control variables (Map 3 – 6) does not address univocal conclusions regarding their role as determinants of innovation (Viggiano, 2020). The regression exercise clarifies any hypothesis regarding possible relations between innovation and other variables.

IV. The Model and Results

The analysis is based on a Poisson model with form:

$$E(Patents \mid X) = \exp(\alpha + \beta SCI + \Sigma_c \gamma_c Z_c + \Sigma_d \delta_d year_d + \ln population) \quad (1)$$

where *innovation* (measured in patents awarded) is the dependent variable, *SCI* is the chosen measure of social capital, *Z* is a vector of control variables including *educational attainment*, *per capita real GDP*, *population density* and *per capita expenditure in research and development*, and *year* represents the fixed effect applied to the model to control for variations over time. Lastly, *population* has been chosen as exposure variable.

As shown by Gourieroux, Monfort and Trognon (1984), the estimates of a Poisson regression model are consistent even if the count variable does not follow a Poisson distribution and the data show greater variance concerning the one dictated by the model (overdispersion). At first, Poisson regression was used to study the effect of the selected variables on innovation. At first

sight, education plays a decisive role in determining innovation, while *per capita* GDP and population density show almost null coefficients.

Social capital also appears with a positive and significant coefficient, suggesting that social capital's theoretically accepted role in facilitating information exchange could find confirmation in this framework. Lastly, R&D expenditure does not provide a significant contribution to the dependent variable. The unexpected result may be due to our assumption of the equal partition of R&D funds among counties and the lack of more grounded assumptions on the adopted criteria for research funds division.

Table 3. Panel Poisson regression results

Variables	Innovation	Standard Errors
SCI	0.117***	0.006
Educational attainment	2.445***	0.054
GDP *per capita*	0.006***	0.0002
Population density	0.0007***	0.0004
R&D *per capita* expenditure	1.211	1.3
Population	1	*exposure*

Note: Wald chi2=7886.10***, *** 0.001 level of significance.

Source: Made by the author.

This first insight encourages further analysis but also some assessments regarding the interpretation of the coefficients. This first regression and subsequent ones are likely to be affected by endogeneity, given the already debated measurement issues. Moreover, spatial autocorrelation is not considered in our regressions, increasing the probability of biased results. Given the lack of certainty regarding the channels through which social capital can affect innovation, any interpretation of this result remains speculative. Nonetheless, scholars agree in recognizing that social ties exert a positive influence on information and communication.

Social capital would reduce information asymmetries and transaction costs by creating a more efficient communication channel (Adler and Kwon, 2002; Bebbington and Perreault, 1999). It would facilitate the spread of knowledge among economic agents (Tiepoh and Reimer, 2004). Moreover, if social ties generate trust and "*trust lubricates cooperation*" (Putnam, 1993, p. 171), social capital would be able to encourage both innovative ideas and their implementation.

As highlighted by Akçomak and ter Weel (2009), the trust would also stimulate risky investments and research activities, often preliminary to remarkable inventions.

The mutual influence of social and human capital has to be considered in interpreting results. As theorized by Coleman (1988), social capital would foster emotional intelligence and learning skills and hence it would encourage the acquisition of technical knowledge, necessary to develop innovations. In a few words, we could explain the Social Capital Index's positive coefficient by referring to Sandefur and Laumann's theory on social capital's productive capacity (2000).

Unfortunately, our measure of human capital does not specify the nature of educational attainment. Therefore, we cannot address more detailed interpretations of the positive and significant coefficient. At this stage, establishing a causal chain between social capital and innovation would be reckless. Still, the model shows that social capital's positive effect seems to survive the introduction of fundamental control variables. Table 4 reveals that social capital has a positive and significant coefficient size at each specification of the model so that it systematically confirms its active participation in innovative processes.

Table 4. The specifications of the model

Variables	Innovation I	Innovation II	Innovation III	Innovation IV	Innovation V
SCI	0.196*** (0.006)	0.172*** (0.006)	0.131*** (0.006)	0.116*** (0.006)	0.117*** (0.006)
Edu. att.		3.403*** (0.0450)	2.847*** (0.048)	2.452*** (0.0538)	2.455*** (0.054)
PC GDP			0.0062*** (0.0002)	0.0061*** (0.0002)	0.0060*** (0.0002)
Pop. dens				0.00076*** (0.00004)	0.00075*** (0.00004)
PC R&D exp.					1.211 (1.30)
Population	1	1	1	1	1

Note: robust standard errors in parenthesis, *** 0.001 level of significance.

Source: Made by the author.

As announced, previous results may suffer from endogeneity and yield misleading evidence. Hence, a lagged model was run as a robustness check. In this second model, the independent variables were used to explain the subsequent period's innovation activity. The new Poisson

regression confirms that educational attainment is the primary determinant of innovation, with the highest positive and significant coefficient. Similarly, *per capita* GDP and population density still provide a minor but positive and significant contribution to innovation activity.

The R&D *per capita* expenditure becomes positive and significant in the lagged model. The change in result may be due to the time-consuming nature of R&D and the fact that research investments produce effects in the long run. Hence, our first models would not be able to capture the impact of research and development funds. Surprisingly, the Social Capital Index changes its sign but remains significant. Two possible explanation can be proposed. On the one hand, the model may be considered as affected by endogeneity and hence as unreliable. As a matter of fact, endogeneity often arises from omitted variables or measurement errors, likely to occur in modelling such an elusive concept as social capital. If it is the case, the present study could be extended by choosing appropriate instruments and employing Instrumental Variable approaches.

Table 5. Lagged model, results

Variables	Innovation	Standard Errors
SCI	-0.234***	0.0097
Educational attainment	4.116***	0.070
GDP *per capita*	0.0145***	0.0004
Population density	0.0006***	0.0002
R&D *per capita* expenditure	0.017***	0.004
Population	1	*exposure*

Note: Wald chi2=8808.48***, *** 0.001 level of significance.

Source: Made by the author.

On the other hand, the composition of the Index itself could clarify contradictory coefficients. As seen, our SCI creators included different kinds of associations in their measure intending to capture both Olson-type and Putnam-type effects. The Olsonian groups would lobby for preferential policies at the rest of society's expense and gather to achieve personal benefits. At the same time, Putnam-type organizations would generate trust and cooperation. Despite the apparent difference in the two groups' nature and scope, nothing is known about their effects' eventual dynamic and timing. Since the first model leads to a positive and significant coefficient of SCI and the second one, characterized by a greater time lag, yields negative but

still significant β, we could imagine a major impact of Putnam-type effects in the short run and the prevalence of Olsonian outcomes in the long run. Of course, the formulation of rigorous theories and empirical models is necessary to validate this intuition.

V. Conclusion and Discussion

The concept of social capital is elusive and controversial by nature, but it has paradoxically fuelled a terrific amount of literature to define, measure, and study the phenomenon. Scholars easily find theoretical explanations for social capital effects, but empirical results depend on employed data and analysis levels. Social capital often appears to be positively related to growth and innovation, since it would generate cooperation and prevent rent-seeking behaviours by creating a beneficial system of shared values, sanctions and norms.

Despite the voluminous literature addressing social capital issues, a deficiency has been detected in that no study has previously investigated the relationship between social capital and innovation in the US. The present study covers the shortcoming by focusing on 1997-2014 years and adopting the county-level Social Capital Index by Rupasingha et al. (2006). Innovation enters the Poisson model as a dependent variable measured in utility patents awarded. The regression includes control variables as educational attainment, research and development expenditure, GDP per capita, and population density.

Results show that educational attainment is the most powerful determinant of innovation, while population density and per capita income provide a modest contribution. R&D per capita expenditure is surprisingly not significant, but the result may be associated with the restricted assumption of equal cross-county distribution of research funds. The above-mentioned results are partially confirmed by the lagged model, run as a robustness check.

Interestingly enough, our Social Capital Index shows contradictory signs. The initial model reveals that social capital would positively and significantly affect innovation, probably by improving the efficiency of information channels and encouraging risky but potentially proficuous investments. On the other hand, the lagged model denies our first result by showing a negative and still significant coefficient. Two interpretations can be proposed: either the model embodies measurement errors and neglects variables, thus causing endogeneity, or it

reveals that social capital exerts both Putnam-type (beneficial) effects on innovation in the short run and Olson-type (harmful) effects in the long run.

This analysis surely presents some limitations. Firstly, both innovation and social capital are subject to conceptualization problems, and the adopted measures are unable to capture the complexity of these phenomena fully. Furthermore, county-level data are not always available, and the study surely neglects some important control variables affecting innovation. Given the presence of such measurement errors and omitted variables, endogeneity is likely to affect our model. Furthermore, the presence of spatial autocorrelation is not contemplated in our regressions, and our findings may not be truthful. Hence, future studies could revisit the same issue with instrumental variable approaches and spatial regression models.

The novelty of county-level social capital research also implies the scarcity of other empirical studies and prevents a further interpretation of our results. Despite the shortcomings, the present study paves the way for future investigations on the topic and policy implications. Local authorities could create incentives for Putnam-type gatherings and associations, facilitating bureaucratic issues for non-profit organizations, civic, sports and religious associations. Moreover, since social capital's positive effects seem to be constrained to certain characteristics of associations such as easy access and horizontal ties, local authorities should ensure that those organizations do not assume the typical traits of pressure groups. Moreover, authorities should work to reinforce pro-social institutions and avoid the efficacy of interest groups. What is sure is that social capital issues are not confined to theoretical speculations and should be taken into account in designing local policies and interventions.

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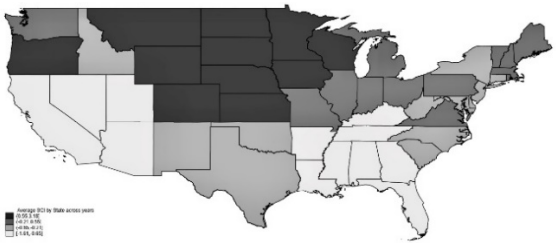
Appendix 1. Top 5 States with highest SCI

State	Area	SCI
DC	SOUTH	3.179
N. DAKOTA	MIDWEST	2.118
S. DAKOTA	MIDWEST	1.709
MINNESOTA	MIDWEST	1.643
KANSAS	MIDWEST	1.484

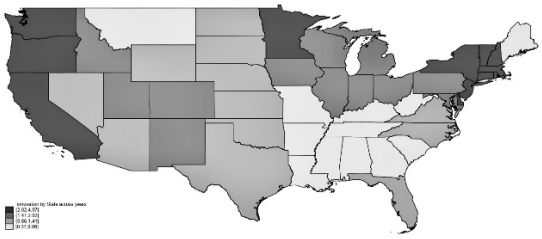
Appendix 2. Top 5 States with lowest SCI

State	Area	SCI
ARIZONA	WEST	-1.613
UTAH	SOUTH	-1.221
GEORGIA	SOUTH	-1.081
TENNESSEE	SOUTH	-1.040
NEVADA	SOUTH	-0.902

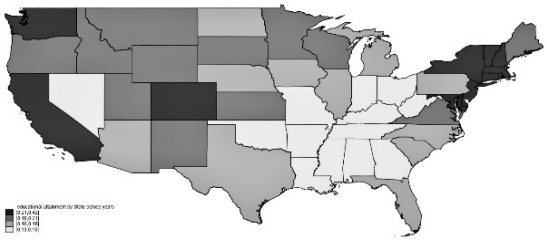
Map 1. Social capital distribution across years



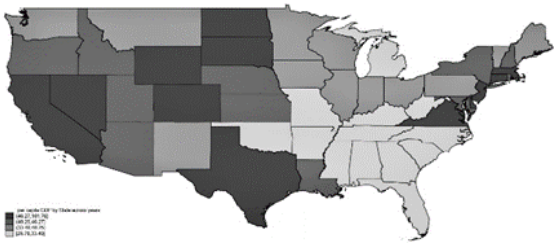
Map 2. Normalized patents across years



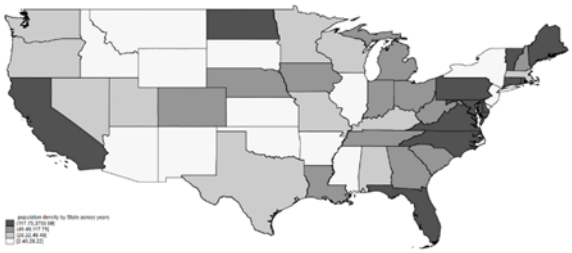
Map 3. Educational attainment across years



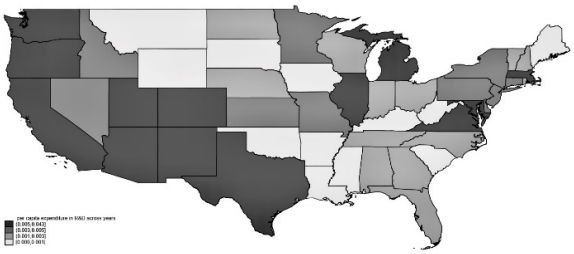
Map 4. Per capita GDP across years



Map 5. Population density across years

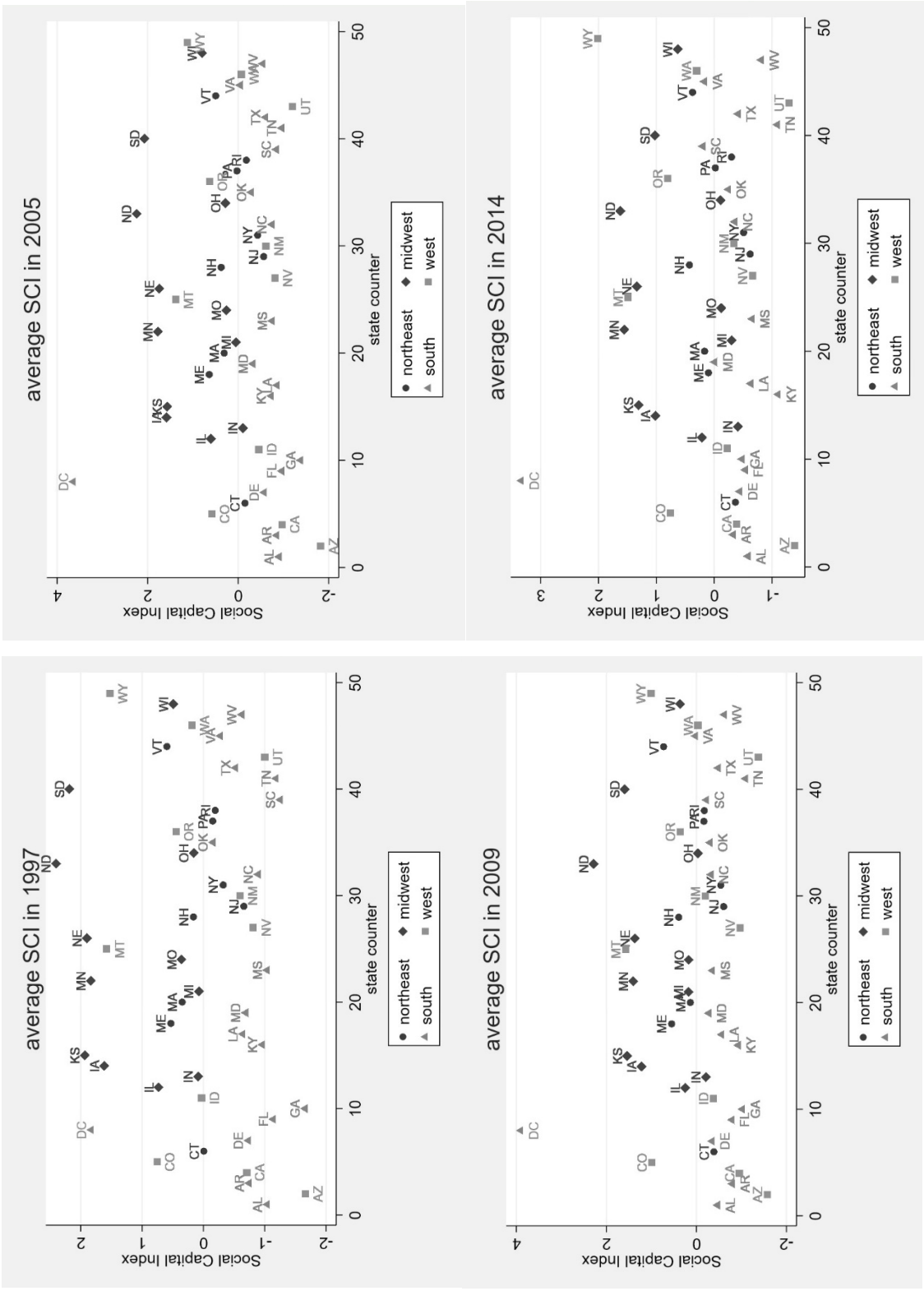


Map 6. Per capita R&D expenditure across years



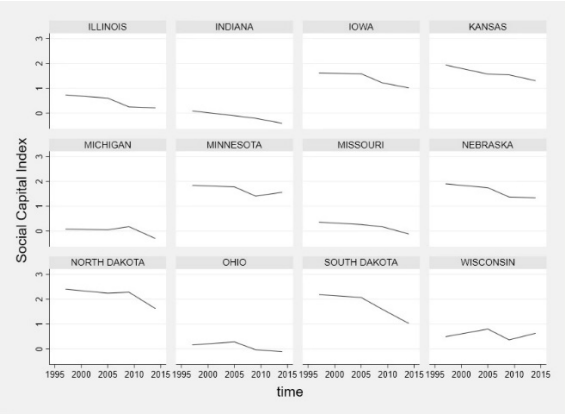
Scatterplots

Scatterplots 1-4, average social capital by State

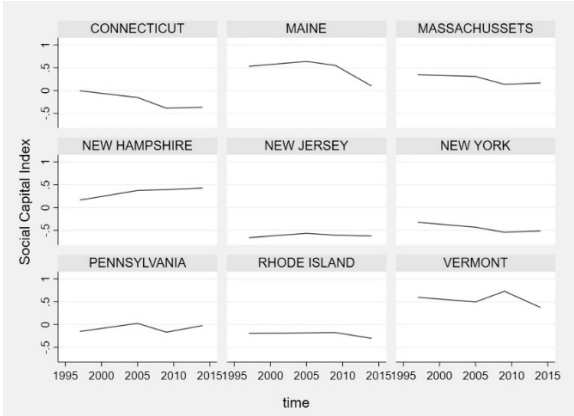


Graphs

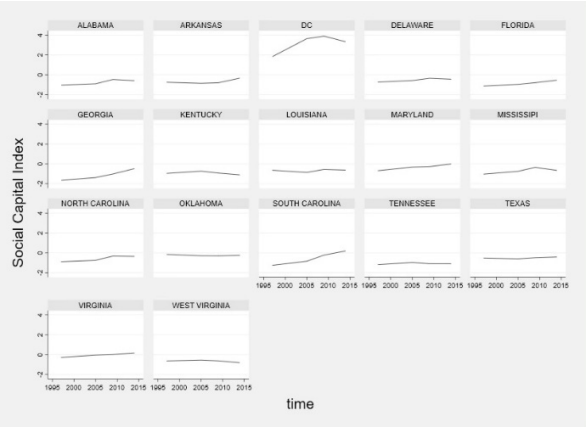
Graph 1. Dynamic of social capital in Midwestern States



Graph 2. Dynamic of social capital in North-eastern States



Graph 3. Dynamic of social capital in Southern States



Graph 4. Dynamic of social capital in Western States