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Regional innovation and firm performance☆

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ABSTRACT

This paper uses novel measures of innovation and engagement, at the county level in the US, to frame the relationship between innovation levels in a region and the performance of publicly traded firms in those areas. In theory, an innovative community should foster improved firm performance, reinvestment, and continued growth for both the firm and the community, feeding back into firm performance, a virtuous cycle. Our results suggest that inventive activity within a county, measured using a patent index, is positively related to revenue and profit growth, while technical creativity, measured using an index of employment in technical fields, is associated with process improvement and net income growth. Finally, the opportunity to collaborate and interact socially within a community is positively associated with firm performance measures, but with only weak statistical significance for the publicly traded firms in the sample.

1. Introduction

Personal growth consultants quip, "if you're the smartest person in the room, you are in the wrong room." This colloquialism recognizes there is much to be learned from others, and the quote serves to prove the point that knowledge is shared and adapted through social interaction. Social interaction and collaborative "cultures of improvement" within firms breed innovation; it is reasonable to expect that creative cultures in communities further enhance firm performance within those communities.

Existing research, including Swan, Newell, Scarbrough, and Hislop (1999) examination of network communities and their subsequent argument for community-based models of knowledge management, along with the large literature on firm clustering, provide evidence of communal benefits. However, they do not address the spillover effects of innovative cultures in a cross-industry geographic context.

How might the innovative capacity of a community be measured? And how important is community-level "innovativeness" to firm performance? Those questions are considered in the following pages.

The analysis below employs measures of innovation and engagement, at the county level in the US, to frame the relationship between innovation levels in a region and the performance of publicly traded firms within that area. The innovation measures reflect the "innovative capacities" of the region, the engagement index represents the opportunity for ideas to cross between firms, and financial data on publicly-traded firms in the region proxy for firm performance. In theory, an innovative community should contribute to improved firm performance, reinvestment, additional innovation, and continued growth for both the firm and the community - a virtuous cycle. Our results suggest that inventive activity within a county is positively related to revenue and profit growth while technical creativity is associated with process improvement and net income growth. Finally, the opportunity to collaborate and interact socially within a community is positively associated with firm performance but with only weak statistical significance for the publicly traded firms in the sample.

2. Background

Innovation and technological improvement as a positive feedback process is not a new idea. Dosi and Nelson (2010) aptly illustrate the age of the idea using Adam Smith's Wealth of Nations and his discussion of pin workers developing machines to reduce the laborers' workload; Smith also depicts the subsequent improvement of the machines by the machine makers. However, he stops short of recognizing the process as a virtuous cycle, though the laborers who freed themselves through their inventions then had time to produce more goods, and to innovate further; a "virtuous cycle" had begun.

The literature on "cycles" regarding research and development is substantial. An examination of the extant literature reveals patterns around the "three C's" of culture, customers, and collaboration. Customers drive provider firms to improve products, but only if the relationship is collaborative, and the provider firm's culture is supportive of innovation.

Gudmundson, Tower, and Harman (2003) find that cultural and

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organizational support in small businesses is necessary to facilitate innovation. Valencia, Valle, and Jimenez (2010) identify complex relationships between culture, structure, and innovation using survey data from Spanish firms. Firms with ad hoc cultures—an emphasis on freedom to act by employees—and an external focus are more innovative than those with hierarchical cultures. Vallencia et al. suggest collaboration and external orientation are important for innovation and Gundmundson et al. suggest culture is important for implementation.

Successful profit-maximizing firms provide value to their customers by innovating to serve their customers and involving their customers in the innovation process, a symbiotic relationship. This pattern of firms providing value to customers and the customers, in turn, responding favorably with more business leads to higher margins, and more certain expectations of future business, lowering firm risk.

Among the many studies on innovation through partnership, Hsu, Kannan, Tan, and Leong (2008) find that coordination of information between suppliers and buyers leads to collaborative relationships and improved firm performance. Similarly, examining data on Dutch firms, Belderbos, Carree, and Lokshin (2004) find cooperative research and development relationships between a firm and a competitor or supplier is most commonly associated with incremental product improvements, while relationships with universities are more commonly used to develop new products. These results are supported by the work of Kim and Lui (2015) who find institutional networks between firms and public partners are more related to product innovation than market networks.

Much of the literature regarding innovation and performance examines relationships at the firm level. For example, Bloom and Van Reenen (2002) study British firms and find that patents are positively related to firm-level productivity and market cap; stock price is enhanced alongside "innovation." Others, including Bogliacino, Lucchese, Nascia, and Pianta (2016), develop a model of innovative inputs, outputs, and economic performance, and find evidence of innovation encouraging more innovation, a virtuous cycle.

Simmie (2003) goes even further and suggests the most successful firms tap into knowledge networks that extend beyond the geographic region. While not focusing on innovation directly, Pirinski and Wang (2006) study US firms and find co-movement in regional asset prices. They hypothesize that the co-movement is caused by home bias in investors, and a regional price formation process, but regional spillovers and innovative processes are likely at work, as well.

Franke and Shah (2003) find that innovators often develop a product prototype, in their case a sports-related product, and then receive feedback and constructive ideas from peers and other "community" members. Going beyond retail-level user feedback, Oerlemans and Meeus (2005) use survey data from manufacturing and service firms in the Netherlands to provide support for theoretical models that suggest close proximity between buyers and suppliers with innovative ties tends to result in these firms outperforming their less-connected peers.

Hilary and Hui (2009) proxy for firms' corporate culture and decision-making processes by positing that firms are composed of individuals from the community in which they are located. They use county-level measures of religiosity as a measure for corporate culture. Jang, Kim, and von Zedtwitz (2017) suggest that regional effects may come from geographic areas smaller than counties, even sub-city microregions.

Our work contributes to this literature by examining innovation from a regional perspective and suggests firms located in innovative areas are more successful than similar firms located elsewhere. As with corporate culture being a product of the firm's regional environment, innovative capacity and cultural emphasis may also depend on the regional environment.

The work presented in this paper examines the relationship between community innovation culture, using multiple innovation measures, and firm performance.

3. Data and methods

To examine the effect of regional innovation and engagement environments, measures of firm performance are regressed on measures of regional innovation and engagement. Firm performance data, including total revenue, net income, shareholder equity, etc. are extracted from the Compustat database. Annual patent data is available from the US patent office at the county level, and sectoral employment by industry is available from the Bureau of Economic Analysis at the county level.[1] The number of establishments and civic organizations in each county is available through the Census Bureau's County Business Patterns program. Other demographic data and controls come from the Census Bureau's American Community Survey or the Bureau of Economic Analysis. All firm level data is cleaned to remove outliers and data mismatches by removing observations above the 95th percentile and below the 5th percentile for each firm characteristic.[2] In addition, counties with an innovation index value more than three times the national average are removed. Regional data used in the analysis below is annual, county-level data for the United States from 2001 through 2014.

Innovation is a term that connotes the development of new products, processes and ideas, but is difficult to measure with a single dimension, thus, we incorporate multiple measures: a patent index to capture inventiveness, a technical worker index to capture innovative capacity, and an engagement index to capture opportunities for regional collaboration outside formal channels. Oltra, Kemp, and de Vries (2008) suggest that patents are a useful measure of the levels of "inventiveness" and technological strength of regions. However, they admit patents may not fully capture innovation, as only a fraction of ideas are patented, and patent counts do not reflect the value of the patented inventions. Popp (2005) suggests relationships based on patent counts may best be thought of as the effect of an average patent.[3] Furthermore, patents are designed to restrict use of an invention, and are more prevalent for product inventions that can be reverse-engineered once on the market. By comparison, firms may decide to keep process improvements secret rather than patent and disclose them. Galasso and Schankerman (2015) find the effect of patents and limitations on the use of invention in downstream innovation to be heterogeneous and vary across industries. For example, they suggest patents impede downstream innovation in computers and medical devices but not in manufacturing technologies.

Nevertheless, patent data remains an attractive measure of innovative activity because the data are readily available for many regions over a long time period. Acs, Anselin, and Varga (2002) compare patent data to proprietary innovation data and find patents to be a reliably proxy. In addition, Koh and Reeb (2015) cast doubt on using R &D expenditure data as firms may under-report or omit R&D expenditures from financial statements yet still receive patents. Koh and Reeb's work suggests inventive activity is taking place despite a lack of financial reporting. In addition, R&D expenditure data includes monetary inputs but no other innovative inputs such as contributions by line workers, etc. (Acs & Audretsch, 1989). Thus, while imperfect, patent data remains a commonly used proxy for innovation and is included in our regressions. To numerically represent a region's inventive activity, a patent index is constructed as follows:

$$Patent\ Index = \left(\frac{Regional\ Patents}{Regional\ Emplyoment}\right) \Big/ \left(\frac{National\ Patents}{National\ Employment}\right) \quad (1)$$

[1] To avoid disclosing individual firm data, the BEA suppresses data for geographic regions with only a single firm or a small number of firms in an industry.

[2] While the cleaning process results in a sizable loss of observations, outliers on variable are often outliers on others, minimizing the observation costs.

[3] Popp's comments suggest patent data may not be ideal for regional analysis when small regions lack a sufficient number of patents to hone in on the average value.

The index measures a region's level of inventiveness with the number of patents, a la Oltra et al. (2008), and scales inventiveness by regional employment. To put the regional number into context, the ratio is divided by the equivalent for the country as a whole. Thus the patent index represents "relative" inventiveness. A number greater than one indicates that the region is more inventive than the nation, a number less than one indicates that the region is less inventive than the nation, and a value of one suggests that the region's inventiveness is in line with the national average.

The creative thought of employees and related parties—including customers and suppliers—is an important contributor to innovation but is not captured by many traditional innovation measures, such as patent counts. Similarly, the large literature on information management underscores the value of collaborative contributions within and between firms. Popp (2005) suggests that a considerable amount of innovation is "process innovation," rather than "invention." Complicating the issue is, as Polanyi (1966) suggested in his seminal work, that a considerable portion of knowledge is difficult to write and pass to others, tacit knowledge. This tacit knowledge, gleaned from experience, is likely important to process innovation but difficult to capture. Polanyi famously wrote "we can know more than we can tell" (Polanyi, 1966, p. 4).[4] Polanyi less famously but more clearly stated the idea as follows:

"An art which cannot be specified in detail cannot be transmitted by prescription, since no prescription for it exists. It can be passed on only by example from master to apprentice. This restricts the range of diffusion to that of personal contacts, and we find accordingly that craftsmanship tends to survive in closely circumscribed local traditions." (Polanyi, 1958, p. 53).

Numerically capturing tacit knowledge that community members may not realize they have learned is difficult. Since a direct measure of tacit knowledge is not available, we are forced to use a proxy. Amadi-Echendu (2007) finds that engineers and technically related survey respondents rank problem solving, logical thought, conceptualizing, analyzing, and interpersonal thought, as the most important thinking styles. Thus, an index of technical workers is included in our analysis to capture a community's process innovation capacity.

$$Tech\ Worker\ Index = \left(\frac{Regional\ Tech\ Workers}{Regional\ Employment}\right) \Big/ \left(\frac{National\ Tech\ Workers}{National\ Employment}\right) \tag{2}$$

Workers are classified using the North American Industrial Classification System or NAICS codes. The system classifies industries in a hierarchical manner with industry classification numbers ranging from two digits to six digits with each additional digit in the industry code representing a subcategory of the broader parent category. Data for categories containing a small number of firm level observations for the reported region are suppressed to maintain firm confidentiality. The innovation index is computed using broad level classifications, two-digit NAICS, to maximize the number of counties in the dataset. Technical workers are defined as workers in the "professional, scientific, and technical services" (NAICS code 54), "healthcare and social assistance" (NAICS code 62) and "information" (NAICS code 51). The index of technical workers, is calculated as the total number of employees in technical fields divided by total employment in the region, divided by the equivalent figure for the nation. A value of one on the index indicates that a community employs technical workers at the national average. A value greater than one indicates a higher density of technical workers than for the nation.

Innovation is arguably a collaborative process, with positive spillover and network effects. As Nataraajan (2016) points out, innovation may not be a new idea to the world, but need only be new to the organization. One might argue that collaborative, or open, innovation is increasing (Chesbrough, 2003). West, Salter, Vanhaverbeke, and Chesbrough (2014) provide a summary of the recent "open innovation" literature. Open innovation can be crowd sourced code, formal partnerships, or as Liu, Huang, Dou, and Zhao (2017) suggest, informal interaction through which knowledge and ideas are transferred. The relationships between firms and the effects on innovation are complex. Collaboration and information sharing are built on long-term relationships, can have a positive effect on both product and process innovation (Lin, Chen, & Chiu, 2010), but may also lead to hold up problems (Krolikowski & Yuan, 2017) or context specific benefits (Anning-Dorson, 2017).

To quantify the potential for collaboration between community members, an engagement index is fashioned using the number of public gathering entities per capita in each county. Gathering places are defined as: civic and social organizations, religious organizations, business and professional organizations, performing arts companies, museums, venues and stadiums, and movie theaters. The number of entities in each county is extracted from the Census Bureau's County Business Patterns dataset. The index is created by taking the number of public gathering entities per capita and dividing by the national equivalent.

$$Engagement\ Index = \left(\frac{Regional\ Gathering\ Places}{Regional\ Population}\right) \Big/ \left(\frac{Total\ Gathering\ Places}{National\ Population}\right) \tag{3}$$

Thus, an engagement index value greater than one indicates that an area has more opportunities for civic and social engagement than the national average.

To identify the relationship between innovative capacity and firm performance, variations of the following model, based on Hilary and Hui (2009), are estimated using ordinary least squares.

$$\begin{aligned} Firm\ outcome_i = {} & \alpha + \beta_1 patent\ index_i + \beta_2 tech\ worker\ index_i \\ & + \beta_3 engagement\ index_i + \beta_4 religiosity_i + \\ & \sum \beta_m demographics_i + \sum \beta_n controls_i + e_i \end{aligned} \tag{4}$$

Firm outcome variables include return on assets, sales growth, income growth, and sales margin growth. The patent index, tech worker index, and engagement index are the main variables of interest and serve as measures of a county's innovative capacity and collaborative network capacity. Hilary and Hui suggest a firm's culture takes on that of the community in which it is located and find firms located in more religious communities tend to be more conservative in their financial activities, thus, religiosity – measured as the total number of adherents per thousand residents in a county – is included.[5]

Demographics is a vector of regional demographics such as population growth, educational attainment (bachelors or better), percent male, per-capita income, race, and percent married. Demographic controls are included in the model as control variables to help ensure patent index, tech worker index, and engagement index, capture the innovative cultures of each county and not demographic differences. Population growth is the percentage increase in county level population over the last five years and per-capita income is total county income divided by population, both from the Bureau of Economic Analysis. To capture the effect of educational attainment, bachelor or better is the percentage of residents over the age of 25 with at least a bachelor's degree, male is the average percentage of the population that is male, race is the percentage of the population of Caucasian descent, and percent married is the percentage of the population that is married, all averaged over the last five years. We expect that higher income and education levels will be associated with higher levels of firm performance but may slow bottom line growth as educated and talented workers expect to share in the top line growth. We are agnostic about the effect of marriage as family commitments may tighten employees'

[4] Desrochers (2001) argues that the clustering of industry, at least partially for tacit knowledge reasons, is a vindication of Austrian economic theory.

[5] Religiosity data comes from the Association of Religion Data Archives' *U.S. Religious Census: Religious Congregations and Membership Study, 2010 (County File)*. Accessed January 2017.

time constraints, but also provide a partner for idea discussion[6]. Data regarding educational attainment, percent married, race, and percent male are available from 2009 to 2014. For the years between 2001 and 2008, the average percentage for the period in which data is available is used.

Controls is a vector of firm specific control variables, including size, liquidity, loss, and leverage. Size is each firm's market capitalization, liquidity is the ratio of short term assets to total debt, loss is a binary variable set equal to one if the firm's income before extraordinary items is negative, and leverage is the ratio of total debt to total equity. Control variable data is extracted from the Compustat database. Large firms, less liquid firms, and firms with a loss are expected to exhibit slower growth than small, nimble firms that are in a position to capitalize on innovative opportunities. Firms with low leverage levels may have debt capacity to exploit opportunities, but highly leveraged firms may be comfortable with debt and more willing to use it to exploit opportunities; thus, we are agnostic about the relationship between leverage and firm performance. All errors are robust to heteroskedasticity and clustered on the firms.

In addition to removing outliers, some of the more variable data is smoothed by looking at a five year trailing average, the average of the observation year and the previous four years. The dependent variables are constructed in two versions, the average of the annual growth rates over a five-year period and total growth over a five year period to allow for innovations to be reflected in financial data. All observations are at the firm level. Summary statistics for each variable are provided in Table 1. Sample means suggest publicly traded firms included in the dataset tend to locate in more innovative and engagement rich regions of the country as evidenced by the mean scores for the patent index, tech worker index, and engagement index, which are all greater than the national average, one. This pattern is not surprising considering publicly traded firms tend to cluster in metropolitan areas. Educational attainment levels reflect this location pattern as well. Other controls, including percent male, educational attainment etc., also match the pattern of more urban firm locations.

Table 1
Summary statistics.

Variable	Mean	Std. Dev.	Min	Max
Net income growth (5 yr trailing avg)	8.166	34.34	− 200.8	121.3
Return on equity (5 yr trailing avg)	0.118	0.0945	− 0.922	0.348
Gross profit margin (5 yr trailing avg)	− 2.803	30.89	− 206.9	101.7
Total revenue growth (5 yr trailing avg)	10.03	8.342	− 17.83	57.42
Net income growth (past 5 yrs)	63.67	245.1	− 4017	2876
Return on equity growth (past 5 yrs)	− 6.095	121.1	− 1613	998.9
Gross profit margin (past 5 yrs)	− 1.957	124.9	− 1622	1193
Total revenue growth (past 5 yrs)	66.38	74.47	− 62.99	864.4
Patent index (5 yr trailing avg)	1.127	0.894	0.100	4.591
Tech worker index (5 yr trailing avg)	1.124	0.184	0.443	1.575
Engagement index (5 yr trailing avg)	1.292	1.258	0.332	6.749
Religiosity	522.3	100.4	273.1	909.5
Population growth	4.784	5.428	− 7.374	40.70
Bachelor or better (5 yr trailing avg)	36.75	9.635	17.99	71.14
Male (5 yr trailing avg)	48.84	0.820	47.01	51.01
Per capita income	51.29	18.98	22.64	135.2
Race (5 yr trailing avg)	0.698	0.129	0.332	0.969
Married (5 yr trailing avg)	47.31	7.284	26.14	67.63
Size	7.971	20.35	0.200	388.4
Liquidity	2.245	1.488	0.196	19.23
Loss (in last 5 yrs)	0.161	0.368	0	1
Leverage	0.458	0.467	0	3.870

Firm financial data is from the Compustat database. Profit margins are calculated as net income as a share of revenue. The patent index is patents per job in the region divided by the ration for the nation. The technical worker index is the percent of the regional workforce employed in technical positions divided by the national equivalent. The *engagement index* is fashioned using the number of public gathering entities per capita in the county scaled by the national equivalent. Gathering places are defined as: civic and social organizations, religious organizations, business and professional organizations, performing arts companies, museums, venues and stadiums, movie theaters, and golf courses as provided by the Census Bureau. Religiosity is the number of religious adherents on church membership rolls per thousand residents. Size is measured by market capitalization, liquidity is current assets over current liabilities, loss is a binary variable equal to one if the firm had negative net income in the last five years and leverage is the ratio of total debt to total equity.

4. Results

Estimation results of the model, presented in eq. 4, are provided in Tables 2 and 3. The first column in each table provides estimates with net income growth as the dependent variable, the second column present the results for return on equity growth as the dependent variable, the third column gross profit margin growth, and the fourth column total revenue growth. Table 2 presents regression results using a five-year, trailing average of annual growth rates as the dependent variable and Table 3 presents the results using the growth rates over a five year period.

Examining Table 2, we see the story of regional innovativeness is mixed, with the regional patent index positively correlated with gross profit margin growth and the technical worker index positive and significantly correlated with net income growth and gross profit margin growth. It is worth noting that the point estimates for the patent index are positive for net income growth and total revenue growth but not statistically significant. These estimation results are consistent with prior literature suggesting patents represent inventiveness, as new products being brought to market are able to command a premium. But innovation is more than just invention, it also includes process innovation and improvement. The positive relationships between the technical worker index and both, net income growth and gross profit margin growth, are consistent with the notion that a tech savvy and creative workforce innovates and finds efficiencies in firms' use of assets. The estimated coefficients on the technical worker index of 15.98 for net income growth and 10.7 for gross profit margin suggest firms located in counties one standard deviation above the sample average, increase net income at a nearly 3% faster rate and gross profit margin at a 2% faster rate, meaningful differences in annual growth. These relationships are broadly supported by the longer period estimates in Table 3. The empirical relationships in this work are complementary of Simmie's (2003) suggestion that growth may be driven more by interregional connections than intraregional connections. The estimated relationships suggest that regional innovation levels are important to firms and are evidence of potential positive spillover effects from urban clustering.

To the extent that process innovation comes from workers thinking creatively and contributing ideas about how to improve processes, we might expect that the ability to share and discuss ideas with other talented workers should help to further improve returns. Regional collaboration in the innovation process is supported, albeit weakly in terms of statistical significance, by the positive coefficient on the engagement index in Table 3 and the positive point estimates for the engagement index across seven of the eight models. The lack of consistent statistical significance across the models does raise some concern about the assertion that engagement opportunities are important for innovation; however, it is likely external engagement is most valuable for smaller firms that are outside of the publicly-traded-firm sample used here. Larger firms are likely to innovate across regions and workers can collaborate within the firm more easily than for smaller firms. The consistently positive point estimates, and significance with regards to return on equity growth, suggest regional collaboration is important enough to show up even in a very noisy dataset.

We do not find religiosity to be of importance to firm growth rates, in contrast to Hilary and Hui (2009). However, the results are

[6] At least one author's partner does not care about academic research but acts as though she is listening to provide an opportunity to flesh out ideas.

Table 2
Regression results: five-year trailing average of annual performance.

Dependent variable (5 year trailing average):	Net income growth	Return on equity growth	Gross profit margin growth	Total revenue growth
Patent index	1.933	− 0.00675	1.916*	0.589
	(1.62)	(− 1.53)	(1.90)	(1.23)
Technical worker index	15.98**	− 0.00585	10.70*	3.072
	(2.29)	(− 0.22)	(1.75)	(1.25)
Engagement index	2.803	− 0.00714	2.049	0.503
	(1.51)	(− 1.21)	(1.21)	(0.93)
Religiosity	0.000550	0.0000141	− 0.000223	0.00187
	(0.07)	(0.42)	(− 0.03)	(0.61)
Population growth	− 0.556***	0.000689	− 0.536***	0.0499
	(− 3.07)	(1.14)	(− 3.49)	(0.71)
Bachelor or better	0.00569	0.000603	0.0389	− 0.0281
	(0.03)	(1.06)	(0.27)	(− 0.47)
Percent male	0.507	− 0.00102	− 0.202	0.833*
	(0.40)	(− 0.21)	(− 0.20)	(1.68)
Per-capita income	− 0.260**	0.000164	− 0.198**	− 0.0321
	(− 2.44)	(0.44)	(− 2.11)	(− 0.98)
Race	− 13.91	0.0436	− 12.13	− 0.116
	(− 1.40)	(1.05)	(− 1.47)	(− 0.03)
Percent married	0.631**	− 0.000884	0.529**	− 0.0436
	(2.35)	(− 0.92)	(2.28)	(− 0.49)
Size	− 0.0784**	0.000502***	− 0.0380	− 0.0385***
	(− 2.49)	(3.75)	(− 1.50)	(− 3.47)
Liquidity	0.816	− 0.00717***	− 0.689	0.705**
	(0.93)	(− 2.65)	(− 1.30)	(2.51)
Loss	− 55.07***	− 0.133***	− 51.98***	− 1.258
	(− 17.54)	(− 8.82)	(− 18.22)	(− 1.45)
Leverage	3.137	0.0181*	2.912*	0.0587
	(1.51)	(1.88)	(1.72)	(0.08)
Constant	− 37.83	0.194	− 6.652	− 31.79
	(− 0.56)	(0.83)	(− 0.12)	(− 1.27)
R^2	0.412	0.355	0.458	0.181

t statistics in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Firm financial data is from the Compustat database. Profit margins calculated as net income / revenue. The patent index is patents per job in the region divided by the ratio for the nation. The technical worker index is the percent of the regional workforce employed in technical positions divided by the national equivalent. The *engagement index* is the number of public gathering entities per capita in the county scaled by the national equivalent. Gathering places are defined as: civic and social organizations, religious organizations, business and professional organizations, performing arts companies, museums, venues and stadiums, movie theaters, and golf courses as provided by the Census Bureau. Religiosity is the number of religious adherents on church membership rolls per thousand residents. Models are estimated using classic regression techniques with clustered standard errors. Size is measured by market capitalization, liquidity is current assets over current liabilities, loss is a binary variable equal to one if the firm had negative net income in the last five years and leverage is the ratio of total debt to total equity. N ≈ 2630.

potentially compatible as our results focus on outcomes rather than firm actions; religious corporate culture may be a story of conservative management and risk aversion. Firm-specific control variables are mostly as expected, larger firms, as evidenced by the coefficient on size, have realized many efficiencies and find further efficiencies difficult. Audretsch and Feldman (1996) suggest that innovative activity is more concentrated and clustered in early phases of product development but disperses as firms mature, consistent with large market cap firms having slower net income growth.

The estimation results presented in Tables 2 and 3 leave open the possibility that regional innovation cultures may be more valuable to smaller firms than for large firms. The significance levels of the estimated relationships for the relatively large firms in our sample are likely to be smaller than the relationships for a more typical firm size as the regional innovation indices are based on the county in which a firm's headquarters is located, and not a weighted average of all the firm's locations, adding noise to the measure. Noise in the measures and relationships makes identifying the relationship between local innovation cultures and firm performance difficult, especially for geographically dispersed firms with access to tacit knowledge and innovative capacities around the globe. One might assume the relationship between regional innovation and firm performance is stronger for smaller firms with less access to global innovation assets. Nevertheless, the estimation results suggest a regional culture of innovation is positively related to firm growth, even with the noise.

Table 3
Regression results: performance over five year period.

Dependent variable (over 5 years):	Net income growth	Return on equity growth	Gross profit margin growth	Total revenue growth
Patent index	5.938	2.773	1.129	7.233*
	(0.84)	(0.63)	(0.33)	(1.68)
Technical worker index	128.7***	44.83	50.52**	30.72
	(2.93)	(1.56)	(2.20)	(1.49)
Engagement index	13.52	8.374*	3.640	6.379
	(1.48)	(1.83)	(0.73)	(1.41)
Religiosity	0.0801	0.0233	0.0176	0.0346
	(1.37)	(0.75)	(0.64)	(1.38)
Population growth	− 0.0395	− 0.175	− 0.248	0.532
	(− 0.04)	(− 0.28)	(− 0.49)	(0.90)
Bachelor or better	− 2.679***	− 0.527	− 0.944**	− 0.353
	(− 2.76)	(− 1.07)	(− 2.22)	(− 0.73)
Percent male	11.89	− 1.438	3.000	8.669**
	(1.53)	(− 0.35)	(0.82)	(2.07)
Per-capita income	0.241	− 0.223	0.261	− 0.482
	(0.44)	(− 0.80)	(0.94)	(− 1.63)
Race	− 3.536	− 12.00	− 10.00	− 0.191
	(− 0.06)	(− 0.36)	(− 0.35)	(− 0.01)
Percent married	1.341	0.976	0.685	− 0.394
	(0.80)	(0.97)	(0.79)	(− 0.55)
Size	− 0.0871	0.0553	0.0500	− 0.261***
	(− 0.48)	(0.53)	(0.51)	(− 3.57)
Liquidity	6.517*	− 0.786	0.236	2.276
	(1.84)	(− 0.42)	(0.17)	(1.34)
Loss	− 156.7***	− 69.93***	− 90.82***	− 8.623
	(− 10.13)	(− 7.48)	(− 11.10)	(− 1.24)
Leverage	− 5.668	6.672	− 5.243	2.472
	(− 0.51)	(1.03)	(− 1.03)	(0.47)
Constant	− 352.9	25.92	− 70.13	− 364.5*
	(− 0.75)	(0.12)	(− 0.32)	(− 1.72)
R^2	0.084	0.072	0.090	0.142

t statistics in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Firm financial data is from the Compustat database. Profit margins calculated as net income / revenue. The patent index is patents per job in the region divided by the ratio for the nation. The technical worker index is the percent of the regional workforce employed in technical positions divided by the national equivalent. The *engagement index* is the number of public gathering entities per capita in the county scaled by the national equivalent. Gathering places are defined as: civic and social organizations, religious organizations, business and professional organizations, performing arts companies, museums, venues and stadiums, movie theaters, and golf courses as provided by the Census Bureau. Religiosity is the number of religious adherents on church membership rolls per thousand residents. Models are estimated using classic regression techniques with clustered standard errors. Size is measured by market capitalization, liquidity is current assets over current liabilities, loss is a binary variable equal to one if the firm had negative net income in the last five years and leverage is the ratio of total debt to total equity. N ≈ 3200.

5. Conclusion

The analysis here suggests that the innovativeness of the region in which a firm is located contributes to firm performance. Inventive regions produce higher rates of profit margin growth, and regions with large innovative capacities - in terms of workforce and technical talent - realize higher rates of net income growth and profit margins. Furthermore, weak evidence exists of positive collaborative effects; areas with more opportunities to informally engage with peers show consistently positive coefficient estimates for the relationships between engagement opportunities and the different measures of firm performance.

The existing literature focusing on firm structure and inter-firm relationships is extended with this regional consideration. The results suggest innovative communities are an important contributor to the success of publicly traded firms. However, the results suggest that the regional culture may be most important for *process* improvement. These discoveries could encourage communities to develop their innovation communities through the attraction of technically skilled workers, and the creation of opportunities for cross firm cooperation and engagement.

The relationships here are drawn from publicly-traded firms, even the smallest of which are relatively large compared to most communities' average firm size. Future research should extend this analysis to examine the performance of small and mid-sized businesses, potentially examining growth rates, employment levels, proprietor income, etc. To the extent that innovative culture and engagement opportunities are important to publicly traded firms, one might assume these regional assets are more important to small businesses without access to global innovation assets. Finally, future research should examine interactions between innovation cultures and engagement opportunities. While there is much left to be done in order to fully identify the relationships between regional cultures and firm performance, there is no doubt that communities that nurture and attract talented workers and innovative firms will outperform their peers.

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References

Acs, Z. J., Anselin, L., & Varga, A. (2002). Patents and innovation counts as measures of regional production of new knowledge. *Research Policy, 31*, 1069–1085.
Acs, Z. J., & Audretsch, D. B. (1989). Patents as a measure of innovative activity. *Kyklos, 42*(2), 171–180.
Amadi-Echendu, J. E. (2007). Thinking styles of technical knowledge workers in the systems of innovation paradigm. *Technological Forecasting and Social Change, 74*, 1204–1214.
Anning-Dorson, T. (2017). Customer involvement capability and service firm performance: The mediating role of innovation. *Journal of Business Research*. In process. Retrieved from https://doi.org/10.1016/j.jbusres.2017.7.015.
Audretsch, D. B., & Feldman, M. P. (1996). Innovative clusters and the industry life cycle. *Review of Industrial Organization, 11*, 253–273.
Belderbos, R., Carree, M., & Lokshin, B. (2004). Cooperative R&D and firm performance. *Research Policy, 33*, 1477–1492.
Bloom, N., & Van Reenen, J. (2002). Patents, real options and firm performance. *The Economic Journal, 112*, 97–116.
Bogliacino, F., Lucchese, M., Nascia, L., & Pianta, M. (2016). Modeling the viruous circle of innovation: A test on Italian firms. *Industrial and Corporate Change*, 1–18.
Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology.* Boston: Harvard Business Review Press.
Desrochers, P. (2001). Geographical proximity and the transmission of tacit knowledge. *Review of Austrian Economics, 14*(1), 25–46.
Dosi, G., & Nelson, R. R. (2010). Technical change and industrial dynamics as evolutionary processes. *Handbook of the economics of innovation* (pp. 51–128). North-Holland: Elsevier.
Franke, N., & Shah, S. (2003). How communities support innovative activities: An exploration of assistance and sharing among end-users. *Research Policy, 32*, 157–178.
Galasso, A., & Schankerman, M. (2015). Patents and cumulative innovation: Causal evidence from the courts. *The Quarterly Journal of Economics, 130*(1), 317–369.
Gudmundson, D., Tower, C. B., & Harman, E. A. (2003). Innovation in small businesses: Culture and ownership structure do matter. *Journal of Developmental Entrepreneurship, 8*(1), 1–17.
Hilary, G., & Hui, K. W. (2009). Does religion matter in corporate decision making in America? *Journal of Financial Economics, 93*, 455–473.
Hsu, C.-C., Kannan, V. R., Tan, K.-C., & Leong, G. K. (2008). Information sharing, buyer-supplier relationships and firm performance. *International Journal of Physical Distribution and Logistics Management, 38*(4), 296–310.
Jang, S., Kim, J., & von Zedtwitz, M. (2017). The importance of spatial agglomeration in product innovation: A microgeography perspective. *Journal of Business Research, 78*, 143–154.
Kim, y., & Lui, S. S. (2015). The impacts of external network and business group on innovation: Do the types of innovation matter? *Journal of Business Research, 68*, 164–173.
Koh, P.-S., & Reeb, D. M. (2015). Missing R&D. *Journal of Accounting and Economics, 60*, 73–94.
Krolikowski, M., & Yuan, X. (2017). Friend or foe: Customer-supplier relationships and innovation. *Journal of Business Research, 78*, 53–68.
Lin, R.-J., Chen, R.-H., & Chiu, K. K.-S. (2010). Customer relationship management and innovation capability: An empirical study. *Industrial Management & Data Systems, 110*(1), 111–133.
Liu, X., Huang, Q., Dou, J., & Zhao, X. (2017). The impact of informal social interaction on innovation capability in the context of buyer-supplier dyads. *Journal of Business Research, 78*, 314–322.
Nataraajan, R. (2016). Knowledge and innovation: Musings from the 2015 GIKA ivory tower. *Journal of Business Research, 69*, 3572–3575.
Oerlemans, L. A., & Meeus, M. T. (2005). Do organizational and spatial proximity impact on firm performance. *Regional Studies, 39*(1), 89–104.
Oltra, V., Kemp, R., & de Vries, F. (2008). *Patents as a measure for econ-innovation.* Brussels: DG Research of the European Commission.
Pirinski, C., & Wang, Q. (2006). Does corporate headquarters location matter for stock returns? *The Journal of Finance, 61*(4), 1991–2015.
Polanyi, M. (1958). *Personal Knowledge: Towards a post-critical philosophy.* Chicago, IL: The University of Chicago Press.
Polanyi, M. (1966). *The tacit dimension.* New York, NY: Anchor Books.
Popp, D. (2005). Lessons from patents: Using patents to measure technological change in environmental models. *Ecological Economics, 54*, 209–226.
Swan, J., Newell, S., Scarbrough, H., & Hislop, D. (1999). Knowledge management and innovation: networks and networking. *Journal of Knowledge management, 3*(4), 262–275.
Simmie, J. (2003). Innovation and urban regions as national and international nodes for the transfer and sharing of knowledge. *Regional Studies, 37*(6), 607–620.
Valencia, J. C., Valle, R. S., & Jimenez, D. J. (2010). Organizational culture as determinant of product innovation. *European Journal of Innovation Management, 13*(4), 466–480.
West, J., Salter, A., Vanhaverbeke, W., & Chesbrough, H. (2014). Open innovation: The next decade. *Research Policy, 43*, 805–811.