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Industrial clusters, flagship enterprises and regional innovation

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ABSTRACT

For a sample of all 88 counties in the State of Ohio over a 5-year period, this study documents the effect of flagship enterprises and concentrated industrial clusters on regional innovation. Consistent with the agglomeration arguments and the knowledge spillover theory of entrepreneurship, both appear to affect regional innovation positively. Additionally, regional educational attainment positively moderates the effect of industrial clusters on innovation. At the same time, flagship enterprises primarily affect regional innovation in regions with low education levels. Results are obtained with the help of conservative econometric techniques and are robust to the choice of alternative dependent variables and estimators. The findings have major policy implications and provide insights into alternative routes to encouraging regional innovation.

KEYWORDS

Industrial clusters; regional innovation; flagship enterprises; knowledge spillover; entrepreneurship

Introduction

Entrepreneurial ventures, specifically start-ups, have long been postulated to be the driving force of innovation (Audretsch 1995; Schumpeter 1934). Yet, because technological development requires massive investment and marketing support, many scholars believe that start-ups are no longer adequately equipped to face the challenges of generating breakthrough innovative initiatives (Caves 1998; Malerba and Orsenigo 1995; Vossen 1998). The corollary of this viewpoint is the shifting of the locus of innovation to large corporations, and scholarly reports investigating the effectiveness of innovative activities by incumbents abound (Abernathy and Clark 1985; Breschi, Malerba, and Orsenigo 2000; Schumpeter 1942). Still, because successful innovation often brings with it creative destruction of the foundation on which sustainable success of incumbent corporations rests, there is some scepticism as to corporations' commitment to *creative self-destruction*, and the locus of innovation – specifically, whether it is the purview of small or large firms – keeps generating much scholarly and public debate (Abernathy and Utterback 1978; Tidd, Bessant, and Pavitt 2001).

That debate notwithstanding, scholars have recognized that start-ups have found a way to overcome their liability of smallness and newness by creating clusters – innovative milieus of sorts – that allow them to collectively address the challenges faced by each individual firm and pool their efforts to offer coordinated (intentionally or not) innovative offerings that appeal to customers, perform on a par with initiatives championed by their larger counterparts, and may in fact outcompete them (Audretsch 1995). This success can be attributed to the agglomeration benefits

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discussed by Marshall early in the twentieth century and well acknowledged by recent research (see, e.g. Puga 2010; Rosenthal and Strange 2004). At the same time, such clusters become a sort of collective entrepreneur that, according to Mosakowski (1998), is particularly effective at innovative endeavours. Moreover, small firms networked in clusters retain their independence and are free to align themselves with initiatives with the highest innovation potential interorganizationally while not being bounded by the rigid organizational confines (Pickernell et al. 2007; Rocha 2013; Thorgren, Wincent, and Örtqvist 2009; Wincent et al. 2010a).

In other words, the literature supports the positive effects on innovation of both large flagship organizations and interorganizational arrangements such as clusters over and above what small firms can contribute on their own. It is, however, largely silent on the way that clusters and flagship enterprises go about delivering innovative output. This is a critical shortcoming. Over the last three decades, there have been persistent calls to address the limited knowledge of how local conditions such as access to skilled labour affect innovative output (Abernathy and Clark 1985; Archibugi, Cesaratto, and Sirilli 1991; Bougrain and Haudeville 2002), yet to date, little is known beyond the fact that environment matters. This is unfortunate because access to qualified labour is a key concern in innovation policy frameworks. We take a first step towards closing this gap. Our point of departure from the prior literature is that we acknowledge a substantial difference between clusters and flagship enterprises when it comes to assembling resources to innovate. In this paper, we develop theory and test it empirically, predicting that agglomerated cluster firms use what Marshall described as the pool of skilled labour – the highly qualified labour force found in the area. They also benefit heavily from knowledge spillover among competitors, and the pool of specialized labour providers. For that reason, we suggest, their impact on local innovative outputs would be most visible where prevalence of higher education is high. Flagship enterprises, on the other hand, have a much broader reach: Due to their sheer size (Qian 2007), regardless of the industry, they appeal to and source qualified labour and inputs from everywhere and are not limited by the local search that many small firms are limited to (Freel 2003; Mudambi and Swift 2012). In that case, their innovative contribution would be most visible in areas where local conditions are unlikely to facilitate innovative breakthroughs often capitalized upon by the smaller firms. It follows then that the innovative impact of flagship enterprises will be most apparent where local levels of education are lower.

Our theory and empirical results have important research and policy implications. While on their own, both concentrated milieus of entrepreneurially minded firms and larger flagship enterprises exert positive influence on the local innovative output, the routes that their innovative efforts take differ non-trivially. Accordingly, policy recommendations should reflect such differences. For areas that boast highly skilled labour, encouraging joint efforts of industry-specific, geographically proximate businesses is a winning strategy that would promote innovation and likely generate wealth spillovers to the educated workforce. For areas that lack similarly trained labour, encouraging formation of industrial clusters will not have the desired effect and may in fact be detrimental. A better strategy would be to encourage establishment – and prevent out-migration – of flagship enterprises in the area, something that many policymakers have intuitively understood for years (Archibugi, Cesaratto, and Sirilli 1991; Everitt 1993). The benefits that the regional economy receives from flagship enterprises may somewhat differ from those expected of clusters, but wealth spillover and the sharpening of the regional innovative profile are likely to follow.

Not only do our results have implications for policymakers, but they also offer strategy implications for decision makers at the firm level. Inasmuch as successful innovation is a goal explicitly pursued by the firm, our results suggest the importance for smaller firms to seek cooperation with other similarly sized entities operating within the same geographical confines. Rather than try to avoid fellow industry firms for the fear of competition, such firms should acknowledge the benefits of cooperation. The pursuit of such benefits, especially where the local conditions are right, is bound to result in superior innovative outcomes. At the same time, for the flagship enterprises

being locked in the local environment may not be particularly productive, and their path to superior innovativeness may lie elsewhere.

This paper proceeds as follows. The next section develops a conceptual framework for the empirical study and sets up testable hypotheses that link clusters and flagship enterprises to regional innovation outputs. This is followed by the description of the data, methods and empirical results. The supported relationships are then discussed in light of anticipated results and prior literature. The paper concludes with limitations and suggestions for future research.

Flagship enterprises and clusters as sources of regional innovation: brief literature review and hypothesis development

From the early writings of Schumpeter (1934) to the recent knowledge spillover theory of entrepreneurship (Acs et al. 2009), the entrepreneurship literature has attributed innovation to the actions of entrepreneurs. By introducing new means, new ends, or new means-ends frameworks (Eckhardt and Shane 2003), entrepreneurs are said to usher in the wave of creative destruction by pushing the technological frontier. It follows that regions – however defined – that are high on new venture formation should display above-average rates of innovation. Indeed, there is solid empirical support for the positive relationship between entrepreneurship and innovation at the level of cities (Audretsch and Feldman 2004), metropolitan statistical areas (Audretsch 2007), regions (Audretsch and Keilbach 2004) and countries (Anokhin and Schulze 2009; Wong, Ho, and Autio 2005). However, even in Schumpeter's own later writings (1942) and in those of other researchers, doubts were voiced as to whether individual entrepreneurs and their new ventures are well equipped to produce innovation given the rising technological complexity (Tidd, Bessant, and Pavitt 2001), the capital demands (Florida and Kenney 1988) and the need for marketing support (Cooke 2001) that successful innovation requires. Some authors went as far as to suggest that chronically entrepreneurial industries were not a sign of well-being (Ferguson 1988) and argued instead in favour of larger enterprises as the main conduits for innovative ideas. Empirical evidence supports this duality by indicating that the relationship between start-up rates and innovation is context-dependent and that relative wealth may be one factor that determines whether smaller start-ups are in a position to introduce meaningful innovations to their environments (Anokhin and Wincent 2012).

We agree that start-ups may be positively related to regional innovation, especially in developed contexts such as that of the USA (Shane 2003). At the same time, we believe that the possibility that the largest regional corporations – what we refer to as flagship enterprises – positively affect regional innovative output should be explored systematically (Anokhin and Wincent 2012).[1] After all, the largest companies are known to be repositories of innovative ideas, with giants like IBM generating over $1 billion per year in licensing revenues from their patenting portfolio alone (Ludlow 2014). Yet, most research on the innovative output of incumbents has been conducted at the firm level. Indeed, studies documenting best innovative strategies for established firms are common (see, e.g. Tidd, Bessant, and Pavitt 2001). We extend this logic to suggest that regions stand to benefit in terms of innovation from the presence of the largest corporations and that hosting flagship enterprises should be associated with the heightened innovative profile of the local area.[2]

Flagship enterprises disproportionally contribute to the economic well-being of the regions where they establish their domicile (Mudambi and Swift 2012; Rugman and D'Cruz 1997). It is based on this premise that local authorities often offer preferential tax treatment to the largest employers, especially when trying to lure big companies to the region or prevent them from leaving (Hayter 1997).[3] But apart from offering employment opportunities to the local population, flagship enterprises generate a host of other benefits for the regions they call home. Innovation is one such benefit. Growing technological complexity requires a certain scale of business, along with sizeable R&D departments, complementary assets and well-functioning marketing functions and

distribution channels (Tidd, Bessant, and Pavitt 2001). Regions that host such companies may expect to emerge as technological hotspots. From Silicon Valley in California to Redmond in Washington, one may easily observe the disproportionate innovative impact of the largest employers on the communities where they operate. Although Silicon Valley tech giants and Redmond's Microsoft are extreme examples, the principle should hold true universally (Saxenian 1994). All things being equal, regions with above-average representation of flagship enterprises should similarly display above-average rates of innovative activity. This gives rise to the following hypothesis:

Hypothesis 1: Presence of flagship enterprises in the region is positively associated with the rates of regional innovation.

At the same time, although smaller firms and start-ups may find themselves disadvantageously positioned to introduce meaningful innovations to their environments with respect to their larger counterparts, they have tools at their disposal that allow them to circumnavigate the unfortunate environmental limitations. Specifically, to fight the liabilities of newness and smallness long associated with start-ups (Stinchcombe 1965), smaller firms may choose to work closely with similar firms creating regional industry-specific milieus. Sometimes such clusters take on formal or informal boundaries as networks (Baker 1992; Saxenian 1990; Thorgren, Wincent, and Örtqvist 2009) whose participants coordinate their activities by instituting governance devices such as boards. Often, however, they operate informally. Examples of interorganizational arrangements of this kind are well documented in the literature and include, for instance, clusters and networks in Italy (Cesaratto and Mangano 1993), industry sector networks in manufacturing innovation (Freel 2003), clusters of electronics and software firms (Romijn and Albaladejo 2002) and the wood-processing networks in Sweden (Wincent et al. 2010b). Consistent with the views of Marshall, such clusters tend to derive sizeable benefits from their joint efforts and often outcompete larger enterprises. Research by Wincent and colleagues (Wincent, Anokhin, and Örtqvist 2013; Wincent, Thorgren, and Anokhin 2013; Wincent et al. 2010b) specifically shows that there are innovation benefits to geographic clustering of industry firms.

When the region has a concentrated the presence of industry firms, knowledge spillovers occur naturally. Saxenian (1990, 1994) documents the importance of interfirm knowledge flows in spurring innovation in Silicon Valley. Innovative ideas developed by some firms often cross fine organizational boundaries and pollinate their fellow industry members. Imitating competitors' products, services and processes is common, and careful analysis by Posen, Lee, and Yi (2013) indicates that such imitation often results in innovative developments that surpass targets. Besides, innovation often requires creative recombining of resources, routines and practices, and having a concentrated presence of firms pursuing similar agenda generates a critical mass of players that makes such recombinations possible and indeed likely. Mosakowski (1998) claims that collective entrepreneurs are well suited to innovation. Accordingly, when the region serves as a home for (formal or informal) industrial clusters, innovation is likely to soar. Stated formally:

Hypothesis 2: Presence of concentrated industrial clusters in the region is positively associated with the rates of regional innovation.

The research shows that the relationship between entrepreneurial activity and innovation is context-dependent. In the global context, relative wealth emerges as a powerful determinant of relationship strength and sign (Anokhin and Wincent 2012). Within a country, where differences in wealth are not as pronounced, other environmental variables may affect the relationship. Education is known to affect the rates at which entrepreneurial effort translates into innovation (Shane 2003). Accordingly, we expect the direct effects of flagship enterprises and concentrated

industrial clusters on regional innovation to differ between regions with higher and lower education levels.

Importantly, flagship enterprises, due to their sheer size and reach, are not limited to localized search (Rugman and D'Cruz 1997). There are both pull and push forces at play that make it easier for them to cast their talent search net wide. First, because of their heightened profile, they possess enormous visibility that attracts job seekers from well outside their region. In fact, flagship enterprises source their innovative talent globally (Acs and Audretsch 1988). Second, because they can afford sophisticated legal and HR departments, which can navigate the complicated immigration regulations with ease, they often proactively sponsor international labour for employment. Even if they decide to limit themselves to country nationals who do not require visa sponsorship, they engage in nationwide search and can select the best-qualified applicants for the open positions. In this sense, local endowment with qualified labour does not play a highly significant role in what flagship enterprises do in terms of R&D, and it is usually other considerations – such as tax incentives and logistical advantages – that determine their choice of domicile.

It follows that the innovative impact of flagship enterprises on their regions will be most pronounced where local innovation is less likely to occur – that is, in regions that do not have sufficient representation of educated labour to produce innovative ideas on their own. In fact, flagship enterprises are likely to serve as a main source of innovations in such regions. Overtime, as the knowledge spillover theory suggests (Acs et al. 2009), it may result in the creation and rise of new firms that also pursue innovative avenues, and for that reason, flagship enterprises are desirable to the authorities beyond the immediate impact they have on employment and the well-being of local residents. It is, however, logical to expect that the innovative effect of flagship enterprises should be most visible where the current pool of educated workers is smallest, whereas in regions with high education levels, their impact is likely to be far less pronounced. Stated formally:

> Hypothesis 3: The effect of flagship enterprises on the rates of regional innovation is negatively moderated by the education level of the local workforce.

Because industrial clusters lack the kind of visibility enjoyed by the flagship enterprises, which may source their inputs – including innovative talent – from elsewhere, they rely heavily on the locally available resources (Kim, Song, and Lee 1993). They are not necessarily on the radar of extra-regional job seekers, and they lack the scale to proactively scout the nation and the world for qualified applicants, let alone manage the complex process of visa sponsorship. It is thus critical for the region to have an above-average endowment in its highly educated workforce for clusters to introduce innovations. For smaller firms, the search is, by necessity, local (Hoffman, Parejo, and Bessant 1998). It is essential for the local labour market to offer enough skilled applicants who may introduce innovative ideas for clusters to challenge the status quo and develop products, services and processes that push the technological frontier.

It is, of course, possible for smaller firms to poach talented employees from their local industrial competitors. Yet, if the pool of skilled labour is limited, so are the opportunities for sustainable growth through innovation. Prior research has underscored the importance of ties for innovation and performance (Guan, Zhang, and Yan 2015; Ter Wal et al. 2018; Thorgren, Wincent, and Örtqvist 2009; Van Dijk et al. 1997; Waxell and Malmberg 2007). Having ties to the right specialists – the ones who are qualified to innovate – is important for smaller firms to leverage the innovative potential of the region and may facilitate both explorative and exploitative product innovation (Ozer and Zhang 2015). It, thus, follows that unlike flagship enterprises, concentrated industrial clusters are most likely to have an impact on the regional innovation rates when a highly educated workforce is available. Stated formally:

Hypothesis 4: The effect of concentrated industrial clusters on the rates of regional innovation is positively moderated by the education level of the local workforce.

Method

Data

We test our hypotheses for the sample of all 88 counties in the State of Ohio over the 5-year period from 2002 to 2006. County level is appropriate when analysing regional entrepreneurial dynamics (Anokhin 2013) because a regional rather than national level of analysis has repeatedly been cited as the most fitting for the investigation of entrepreneurship phenomena (Armington and Acs 2002; Bosma, Stam, and Schutjens 2011; Feldman 2001; Fritsch and Schmude 2006). Ohio is a fitting context to study entrepreneurship in that it is very representative of the entire USA in terms of its entrepreneurial dynamics and key development indicators. Thus, it resembles the nation very closely when it comes to the number of entrepreneurs per 100,000 residents as reported by the Kauffman Foundation – 270 for Ohio compared to 290 for the USA as a whole (Fairlie 2005). Similarly, in terms of per capita income, Ohio residents report that they earn $32,000, while the national average is $34,000 (United States Department of Commerce 2010). Ohio is also representative of the USA when it comes to welfare recipients, ranking 24th out of 50 states (United States Department of Health and Human Services 2003). Besides, the state offers sufficient variability in the county profiles because it comprises rural, suburban and urban counties, thereby allowing for the generalizability of our findings. The data were sourced from reputable secondary sources, including the Ohio Department of Development, the Ohio Secretary of State, the Ohio Department of Education, the Ohio Department of Taxation, the Ohio Department of Job and Family Services, the Ohio Bureau of Workers' Compensation, the USA Census Bureau, the Bureau of Economic Analysis and the National Bureau of Economic Research.[4]

Dependent variables

We employed the per capita number of utility patents granted to the county's assignees as a measure of regional innovation. To avoid potential multicollinearity due to high correlation with flagship enterprises, the measure was log-transformed. In the robustness check section, we also report the results obtained with the original patent variable. Information on patents was sourced from the National Bureau of Economic Research's Patent Data Project. The database published by the National Bureau of Economic Research provides data on the assignee's municipality. Matching municipalities to counties was performed with the help of the Ohio municipal, township and school board roster, which is published by the Ohio Secretary of State. County population estimates necessary to normalize patents by population count were gathered from the US Census Bureau data files.

Independent and moderator variables

Flagship enterprises were operationalized as the number of the state's largest corporations that operated in a particular county. For each county, the Ohio Department of Development compiles a list of which of the state's 200 largest employers that county hosts. The number of flagship enterprises per county during the studied period ranged from 0 to 23. Because some enterprises were similar in size and it was hard to arbitrarily cut off some corporations while keeping others, the number of firms on the state flagship list varied from 200 to 228 companies per year.

Industrial cluster concentration was operationalized with the help of the Herfindahl-Hirschman index, which sums the squared terms of region's industry shares by economic output. The data

were taken from the Bureau of Economic Analysis. Higher values of this variable indicate the prevalence of co-located same-industry firms in the county that are responsible for a sizeable share of the county's economic output. The variable does not differentiate between particular industries and simply reflects the extent to which industrial clusters are concentrated within the region. Measures of this nature has been used extensively in prior research (see, e.g. Knoben, Ponds, and van Oort 2011), and entrepreneurial clustering is often proxied with the help of the Herfindahl-Hirschman index (see, e.g. Glaeser, Kerr, and Ponzetto 2010).

Education level of the local workforce was proxied by the *share of college graduates* among the county's population. Specifically, it was operationalized as the percentage of the adult population with a bachelor's degree or higher. The data were gathered from the US Census Bureau. This is a very common measure of educational attainment (Anokhin 2013), which aids meaningful cross-study comparisons.

Controls

We also controlled for a number of other factors that may have a bearing on regional innovation rates to parse out their unique variance. Because innovation is often attributed to the new venture formation rates (Audretsch 1995), we controlled for the *start-up rates* in the county, measured as the per capita number of new firms created in the county. The measure was taken from the Ohio Department of Development and is ultimately traceable to the Ohio Bureau of Workers' Compensation. Prior research has used this specific measure extensively (see, e.g. Franquesa et al. 2009; Mendoza et al. 2015). As the extent to which innovation occurs may depend on dense individual networks (Johannisson 1998), we controlled for the log of population in each county. The variable was sourced from county profiles by the Ohio Department of Development. We also controlled for *industry intensity*, measured as the number of establishments per 100 people (Armington and Acs 2002). This was deemed necessary because dense interfirm networks may affect knowledge spillover processes (Schilling and Phelps 2007) and thus affect the regional innovation rates. The variable was sourced from the Ohio Department of Development. Because innovation requires access to funding (Shane 2003) and because relative wealth is known to affect the relationship between entrepreneurship and innovation (Anokhin and Wincent 2012), we controlled for per capita *income* in the county, taking the variable from the Ohio Department of Development. We also accounted for the county *unemployment rate* because this reflects both the presence of the workforce that can be tapped by local firms and the workforce qualification (Storey 1991). The unemployment estimates were provided by the Ohio Department of Job and Family Services. Finally, because incentive structure has been shown to affect innovation (Gentry and Hubbard 2005), we controlled for the county *income tax, property tax* and *sales tax* rates. Tax rates were calculated and, where necessary, aggregated to the county level based on the Ohio Department of Taxation data.

Table 1. Descriptive statistics and correlations.

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. Log of patents per capita	−3.09	4.17											
2. Flagship enterprises	2.40	3.61	.39										
3. Industrial clusters	.11	.03	−.14	−.32									
4. Start-up rates	2.06	.60	.13	.24	−.29								
5. Log of population	11.16	.98	.57	.73	−.55	.32							
6. Industry intensity	2.03	.37	.12	.09	−.08	.25	−.01						
7. Education level	.15	.07	.47	.48	−.39	.34	.73	−.05					
8. Per capita income	25.89	6.67	.22	.35	−.21	.17	.36	.03	.49				
9. Unemployment rate	6.31	1.35	−.38	−.18	.20	−.08	−.35	−.10	−.50	−.28			
10. Income tax	.62	.37	.39	.57	−.29	.15	.69	.19	.49	.30	−.26		
11. Property tax	49.55	8.04	.40	.60	−.23	.15	.64	−.01	.54	.21	−.26	.55	
12. Sales tax	1.15	.31	−.34	−.35	.30	−.21	−.55	−.09	−.50	−.20	.33	−.41	−.33

Correlation coefficients larger in absolute value than .14 were significant at the $p < .01$ level.

Descriptive statistics and correlations are provided in Table 1. To avoid non-essential ill-conditioning, all predictor variables were standardized as suggested by Marquardt (1980). Multicollinearity diagnostics did not reveal a threat to valid inference as the mean VIF was 2.36, and the maximum VIF (associated with the log of county population) was 7.46, well below the recommended cut-off value of 10.0 (Aiken, West, and Reno 1991).

Models and estimation

Given that we used panel data, we employed proper econometric techniques to obtain the estimates of the hypothesized relationships. Specifically, we tested our models with the help of Prais-Winsten regression with panel-corrected standard errors, while allowing for the common AR1 autocorrelation across panels (Beck and Katz 1995). Because the number of years in our panel was much smaller than the number of counties, the panel-specific autocorrelation option might have resulted in overly confident estimates of standard errors. The method used in this study is advantageous to many alternatives and provides conservative estimates (Beck and Katz 1995).

In all, we developed three models to test our hypotheses. Model 1 is a baseline comparison model that includes control variables. Model 2 adds flagship enterprises and concentrated industry clusters to the set of predictors and serves to test Hypotheses 1 and 2. Model 3 includes interaction terms of flagship enterprises and industry clusters with the county education levels and serves to test Hypotheses 3 and 4.

Results

Table 2 summarizes the results of hypotheses testing. As Table 2 shows, Model 1 was highly significant: Wald $\chi^2_{(9)} = 5854.28$, $p < .001$. Control variables were largely associated with the regional innovation rates, as expected: Population size exerted a significant positive effect on innovation ($p < .001$); the same was true of industry intensity, although the significance level was only marginal ($p < .10$). Unemployment rate and income tax rates were negatively related to regional innovation ($p < .001$ and $p < .05$, respectively). Start-up rates failed to bring about positive innovative changes to Ohio counties. In fact, their impact had a negative sign, although the probability level was only marginal ($p < .10$). Apparently, at the within-state level of analysis, new ventures largely pursue opportunities of a different kind, which is consistent with Anokhin's (2013) findings. Other control variables were not significant at conventional levels.

Table 2. Results.

	Model 1		Model 2		Model 3	
Flagship enterprises			−.35 (.32)		.47 (.59)	
Industrial clusters			1.25 (.22)	***	1.22 (.22)	***
Flagship enterprises x Local education level					−.49 (.21)	*
Industrial clusters x Local education level					.17 (.11)	†
Local education level					.21 (.24)	
Start-up rates	−.29 (.17)	†	−.23 (.15)		−.18 (.16)	
Population	2.48 (.47)	***	3.59 (.66)	***	3.35 (.73)	***
Industry intensity	.70 (.42)	†	.87 (.44)	*	.90 (.45)	*
Per capita income	−.02 (.11)		.01 (.10)		−.02 (.11)	
Unemployment rate	−.78 (.19)	***	−.76 (.19)	***	−.36 (.47)	
Income tax rate	−.39 (.19)	*	−.58 (.20)	**	−.65 (.21)	**
Property tax rate	.12 (.25)		.01 (.26)		−.06 (.28)	
Sales tax rate	.13 (.42)		.17 (.43)		.24 (.42)	
Intercept	−2.91 (.34)	***	−2.84 (.29)	***	−2.57 (.31)	***
Model fit	$\chi^2_{(8)} = 5854.28$	***	$\chi^2_{(10)} = 3937.47$	***	$\chi^2_{(13)} = 54{,}658.51$	***
R^2	.2246		.2598		.2604	

Note: Dependent variable: Log of patents per capita; N = 440; † p < .10, *p < .05, **p < .01, ***p < .001; Standard errors in parentheses.

Direct effects of flagship enterprises and industrial clusters

Model 2, which tested Hypotheses 1 and 2, was also highly significant: Wald $\chi^2_{(11)} = 3937.47$, $p < .001$. The coefficient for flagship enterprises failed to reach statistical significance. As such, Hypothesis 1 is not supported by this model. (See the post-hoc analysis section later for additional inquiry into this specific issue.) The coefficient for industrial clusters was consistent with theoretical predictions ($\beta = 1.25$, $p < .001$) thus supporting Hypothesis 2. The size, sign and significance of the control variables was consistent with those for Model 1.

Moderated effects of flagship enterprises and industrial clusters

Model 3 tested Hypotheses 3 and 4. It fit the data well: Wald $\chi^2_{(13)} = 54{,}658.51$, $p < .001$. Again, the magnitude, sign and significance of control variables were consistent with what was established in Models 1 and 2. The interaction of flagship enterprises and education level in the region was negative and significant, as expected ($\beta = -.49$, $p < .05$). This result supports Hypothesis 3. Indeed, the impact of flagship enterprises on regional innovation was most visible in areas that did not have an adequate supply of highly educated workers. The interaction of industrial clusters and education level was positive and marginally significant ($\beta = .17$, $p < .10$), thereby lending support to Hypothesis 4. Clusters' effect on regional innovation was most pronounced in counties with above-average availability of educated labour. To ease interpretation of the interaction terms, we plot the interactions in Figures 1 and 2.

As Figures 1 and 2 show, the role of flagship enterprises in regional innovation was strictly positive when educational attainment was low, but they contributed less in the sense of innovativeness when educational attainment was above average. At the same time, innovative clusters had a positive effect on regional innovativeness in all contexts, although their effect was more pronounced when educational attainment was high. Both observations are consistent with our predictions.

Post-hoc analysis

We also considered alternative estimations to ensure that our results were robust to the choice of alternative variables and estimation techniques. Specifically, we considered the raw number of patents assigned to the county residents as an alternative dependent variable. Because the number

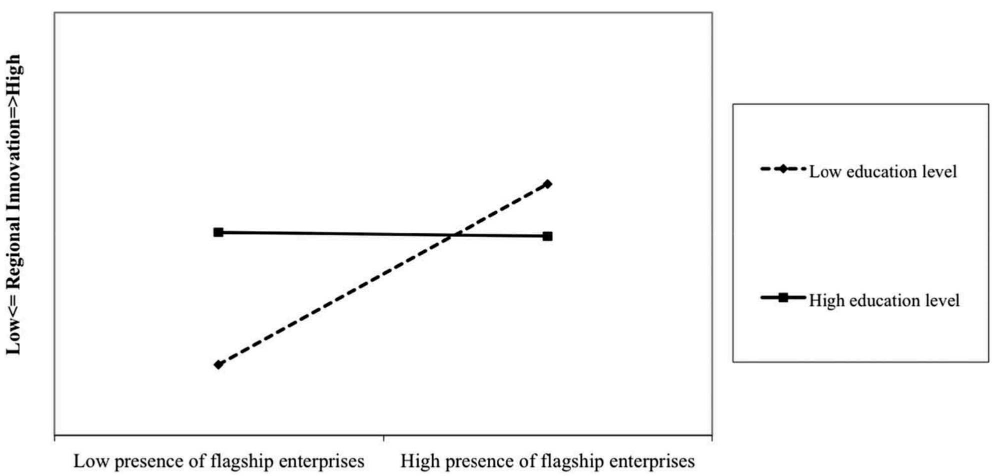

Figure 1. Effects of flagship enterprises in regions with low and high education levels.

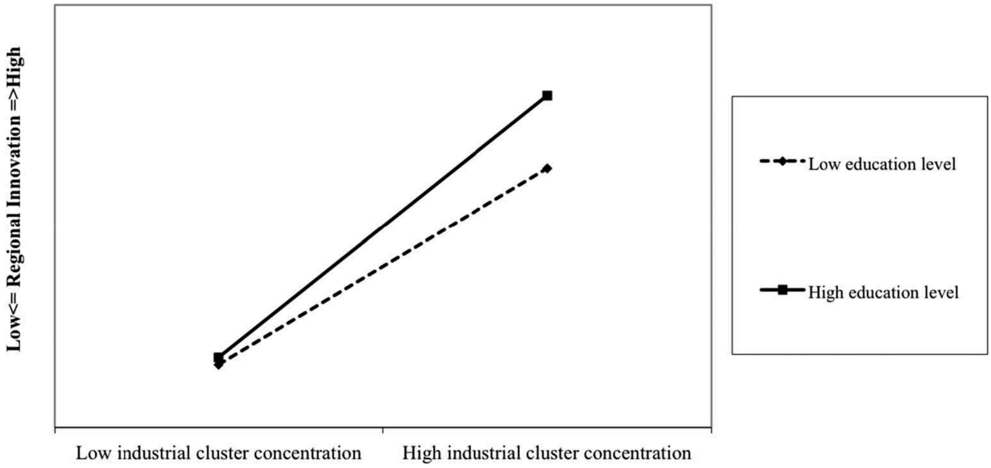

Figure 2. Effects of concentrated industry clusters in regions with low and high education levels.

of patents was a count variable, we employed negative binomial estimation with random effects. Notably, the correlation between the number of patents and flagship enterprises domiciled in a county was .85, which may indicate possible multicollinearity problems. Still, the VIFs were acceptable. The mean VIF was 2.42, and the highest VIF was 5.36, both of which were well below the recommended cut-off value of 10.0 (Aiken, West, and Reno 1991). Similarly, the condition number was 6.21, well below the suggested cut-off value of 30.0 (Belsley, Kuh, and Welsch 2005). Taken together, the results indicate that multicollinearity should not pose problems for valid inference. If, however, it did affect the results, the standard errors should be inflated to make it harder to establish statistical significance. In this sense, this robustness check may be treated as conservative.

The results (reported in Models 4, 5 and 6, which closely followed Models 1, 2 and 3) were consistent with those reported in Table 2 and lend additional support to our hypotheses. We summarize these results in Table 3. In fact, not only do these results support the positive effect of industrial clusters on regional innovation ($\beta = .55$, $p < .001$, Model 5) but they also indicate a positive significant impact of flagship enterprises ($\beta = .08$, $p < .01$, Model 5), something that our original models were not able to uncover. Thus, both Hypotheses 1 and 2 are supported with the alternative dependent variable and the proper estimation technique. At the same time,

Table 3. Results of post-hoc analyses.

	Model 4		Model 5		Model 6	
Flagship enterprises			.08 (.02)	**	.16 (.08)	*
Industrial clusters			.55 (.11)	***	.52 (.11)	***
Flagship enterprises x Local education level					−.04 (.04)	
Industrial clusters x Local education level					.17 (.10)	†
Local education level					.23 (.14)	
Start-up rates	.07 (.03)	**	.07 (.03)	**	.07 (.03)	**
Population	1.42 (.12)	***	1.75 (.19)	***	1.63 (.16)	***
Industry intensity	.04 (.09)		.16 (.09)	†	.19 (.09)	*
Per capita income	.03 (.02)	†	.04 (.02)	†	.03 (.02)	
Unemployment rate	−.06 (.06)		−.11 (.06)	†	−.09 (.06)	
Income tax rate	.29 (.05)	***	.17 (.06)	**	.17 (.06)	**
Property tax rate	−.09 (.05)	†	−.06 (.04)		−.06 (.04)	
Sales tax rate	.02 (.05)		.03 (.05)		.03 (.05)	
Intercept	1.62 (.19)	***	1.62 (.20)	***	1.67 (.20)	***
Model fit	$\chi^2_{(8)} = 325.72$	***	$\chi^2_{(10)} = 423.41$	***	$\chi^2_{(9)} = 453.90$	***

Note: Dependent variable: Patents; N = 440; † p < .10, *p < .05, **p < .01, ***p < .001; Standard errors in parentheses.

although the interaction term of flagship enterprises and education level had the expected sign (β = −.04, Model 6), it failed to attain statistical significance. Thus, Hypothesis 3 is not supported. The interaction of industrial clusters and education level was positive and marginally significant (β = .17, p < .10), supporting Hypothesis 4 and mirroring what was established in Model 3.

Taken together, the results provide empirical support for our hypotheses and suggest that both flagship enterprises and concentrated industrial clusters are important determinants of regional innovation. Moreover, their effects are context-dependent. Whereas the effect of flagship enterprises is most visible in regions with low education levels, industrial clusters do best when the region has above-average supply of qualified workers.

Discussion and conclusions

In this paper, we shift the focus for understanding regional innovation patterns from start-ups to flagship enterprises and concentrated industrial clusters. Insofar as research has emphasized the role of small firms and has tended to ignore larger entities or industrial clusters, we see this as one of the contributions to understanding the way in which regional innovation emerges. Our conceptual development indicates that these are important determinants of regional innovation, and the empirical analysis based on the 5-year panel data from the Ohio counties supports our hypotheses. Importantly, the variety of counties included in our analysis – urban, suburban and rural – enable generalizability of our findings and thus add a degree of confidence to the results we report. Of the two considered sources of innovative ideas, industrial clusters appear to have a stronger effect in that they emerge as significant positive predictors of innovative dynamics across all our models. Direct effects of flagship enterprises only manifest in the second set of models, which used an alternative dependent variable and estimation technique.

As in other studies documenting the relationship between entrepreneurship and innovation, our results are context-dependent. Because flagship enterprises are not truly reliant on the local resources and may source innovative talent and key inputs from elsewhere, they do not stand to benefit much from the locally available qualified workforce. Regions that boast above-average availability of college graduates are where industrial clusters do their best in bringing new ideas to the forefront. Because such regions have a much more active innovative scene, the relative contribution of flagship enterprises in their innovativeness is limited. Where, however, local labour lacks proper qualification, smaller firms – even if they are interconnected within a cluster – are at a disadvantage because their search is necessarily localized. In such conditions, flagship enterprises' innovations do stand out, lending support to Ferguson's (1988) claims regarding the leading role of large firms in spurring innovation.

The study underscores the importance of agglomeration for regional development. Prior research indicated that by coordinating (formally or informally, willingly or unwillingly) their activities with fellow industry members, smaller firms improve their chances of survival (Hoang and Antoncic 2003), strengthen their competitive profile (Lechner and Dowling 2003) and benefit in terms of innovation. We demonstrate that such benefits accumulate at the level of the region where cluster firms choose to operate. We also show that particularly for regions where the population has a lower education level, encouraging creation or in-migration and discouraging out-migration of flagship enterprises is important not only as a means to ensure local employment and the associated payroll but also as a means to promote innovation.

The temporal limitations of our data – we only had five years of observations – meant that we were unable to investigate whether innovative activities of flagship enterprises spillover to facilitate new venture formation in the region and whether new firms created in this way would be more innovative in their own right. For the same reason, we were not in a position to study the long-term effects of industrial clusters on the formation of new businesses. This is something that the future research should tackle. We do, however, believe that our results offer interesting insights

into regional innovation dynamics, and we expect future research to uncover further fascinating details that link flagship enterprises and clusters to regional development indicators.

Limitations and future research

Our results need to be considered in the light of the study's limitations. While the use of panel data obviously provides a number of benefits over cross-sectional research designs, we were only able to obtain 5 years of data, which limits what we could do both conceptually and econometrically. Both measures of innovation employed in this study were patent-based, and issues with the use of patents as a proxy for innovation are well covered in the literature (Griliches 1979; Hall, Jaffe, and Trajtenberg 2001). Yet, given the limited availability of secondary data at the level of analysis that was suitable for the study, we were willing to accept such limitations, which we readily acknowledge.

Our measure of concentrated industry cluster was based on the Herfindahl-Hirschman diversity index, and it did not differentiate between formal and informal networks. In fact, if a region had more than one network of firms operating within the same industry, the technique treated them as part of the same concentrated cluster. Because our analysis was performed at the regional level and because we did not aim to study the inter-network competition, its use was consistent with our conceptual development. However, as future research unravels the relationships between clusters and innovation, a finer-grained analysis will be necessary, and it may be beneficial to engage in careful data collection efforts to obtain data on specific industrial networks and inter-cluster dynamics across regions.

Finally, our results were obtained for a sample of counties in the State of Ohio. Whether they hold in other contexts – including international comparisons – is something future research should consider. We sought the context where we could isolate other factors – such as relative wealth – that could affect the relationship between flagship firms, clusters and innovations, and we focused on the moderating role of education. Now that we have our results, it may be interesting to see the extent to which our findings hold across more diverse environmental comparisons.

We believe that despite these limitations, our conceptual development and empirical results offer new insights into the nature of regional innovation. We, therefore, invite our fellow scholars to investigate these new factors to explain innovative dynamics at the regional level. We hope this paper will serve to spark the scholarly dialogue in this area.

Notes

1. The literature does not offer a more precise definition of a flagship enterprise. Given the lack of theoretically justified thresholds to classify an enterprise as flagship, we follow the established policy practice that tracks the 200 largest enterprises in the state as a separate group (see, e.g. research files by the Ohio Department of Development). In this paper, we identify those enterprises as flagship, although future research may want to revisit the criteria for classifying firms as flagship enterprises.
2. We readily acknowledge that innovation is a multifaceted concept and that there are many ways to capture it empirically, including R&D expenses, production frontier shifts and patent-related measures. In this paper, we opt for a patent-related measure of innovation. We of course realize that not all innovative ideas are patented and not all patents are acted upon.
3. For instance, in 2011, Ohio governor John Kasich signed House Bill 58, which offered corporate tax incentives to the American Greetings Corporation to keep the company – and its $150 million payroll – in Ohio (Bullard 2011).
4. The following web address may be used as an initial gateway to state and county data for Ohio: https://development.ohio.gov/reports/reports_research.htm.

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