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# Why are some regions more innovative than others? The role of small firms in the presence of large labs

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ABSTRACT

We study the impact of small firms on innovation in regions where large labs are present. Small firms generate demand for specialized services that lower entry costs for others. This effect is particularly relevant in the presence of large firms that spawn spin-outs caused by innovations deemed unrelated to the firm's overall business. We examine MSA-level patent data during the period 1975–2000 and find that innovation output is higher in regions where both a sizable population of small firms and large labs are present. The finding is robust to across-region as well as within-region analysis and the effect is stronger in certain subsamples in a manner that is consistent with our explanation.


## 1. Introduction

A striking feature of economic geography is the large variation in innovation productivity across regions. Silicon Valley and Boston are popular examples of regions that are significantly more productive than others in terms of innovation. In Fig. 1, we illustrate a broader cross section of such variation using patent data on US computers and communications. Even Metropolitan Statistical Areas (MSAs) of a similar size in terms of the number of local inventors often differ substantially in terms of their innovation productivity (number of citation-weighted patented inventions per inventor). For example, Rochester, NY and Portland, OR had a similar number of innovators working in the computer and communications industry in 1995, but Portland inventors generated almost double the number of citation-weighted patents.

Regional productivity disparities have led to a variety of policies focused on enhancing local innovation. Such initiatives often focus either on encouraging entrepreneurship (e.g., San Diego, CA, New York, NY, and St. Louis, MO) or on attracting large corporate labs (e.g., Flint, MI, Greenville, SC, and Shelby, AL).[1] We argue that effective regional innovation policymaking requires an understanding of how the structure of local R&D manpower is related to innovation productivity.

In this paper, we study how local innovation is affected by the organization of R&D manpower in that region. For over six decades, since Schumpeter (1942), innovation scholars have tried to understand the relationship between product market industry structure

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[1] The 2008 Brookings Institute's Blueprint for American Prosperity offers a comprehensive overview of such regional initiatives. For example, in San Diego, the CONNECT program has helped the development of more than 2000 small firms in the hi-tech and bio-tech sectors since 1985. New York recently launched the NYC High-Tech CONNECT program modeled on San Diego's CONNECT. Similarly, St. Louis implemented a number of policies to promote regional entrepreneurship. Flint, Greenville, and Shelby focused instead on attracting large firms – GM, BMW, and Mercedes, respectively.

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and innovation (Geroski, 1990; Grossman and Helpman, 1991; Cohen and Klepper, 1996; Aghion et al., 2005). Other research has focused on the relationship between innovation and regional industrial diversity, for example, comparing innovative output from cities focused primarily on one industry (e.g., automobiles) with industrially diverse cities (e.g., electronics, chemicals, and textiles) (see Jacobs, 1969; Glaeser et al., 1992; Feldman and Audretsch, 1999; Delgado et al., 2010). Despite this extensive literature, the effect of R&D labor organization on local innovation has so far attracted little empirical and theoretical attention. We fill this gap by combining insights from urban economics and entrepreneurship.[2]

A number of previous studies provide guidance to our analysis of the impact of R&D labor organization on regional innovation. First, Vernon (1960) and Chinitz (1961) argue that an increasing number of small firms "thicken" local markets for ancillary services and thus reduce the cost of spin-out formation. Second, Schumpeter (1942) and Galbraith (1952) suggest that large firms may have an advantage in the production of ideas.[3] Third, Cassiman and Ueda (2006) argue that large firms only commercialize innovations that "fit" with their established research activities. However, if potentially profitable, then spin-outs may commercialize "misfit" inventions that do not fit with the assets, mandate, or strategy of the parent firm.[4]

These forces indicate that the manner in which regional R&D manpower is organized may have an impact on local innovation. In particular, they suggest that innovation productivity is greater in MSAs where a sizeable population of small labs is present together with at least one large lab. This is because spin-out formation requires the presence of large labs and small firm market thickness lowers the cost of entry, rendering a spin-out more profitable. This suggests that spin-out formation is enhanced when numerous small labs and at least one large lab are present. Because spin-outs allow innovators to commercialize inventions that would otherwise be abandoned since they are not a good fit with their employer's research activities, the number of commercialized inventions also increases when both types of labs are present.

We test these empirical implications using a 26-year panel dataset at the MSA-technology-year level.[5] The data show a substantial regional innovation premium in MSAs "diverse" in firm-sizes, which we define as MSAs where numerous small labs coexist with at least one large lab compared to MSAs of a similar size without many small labs or a large lab. For example, focusing on between-region variation, we find that in 1995 "diverse" regions have an average 47% innovation productivity premium five years later.

The empirical variation we exploit in these regressions is mostly driven by changes in the population of small labs in regions where at least one large lab is present. This is because regions with a sizeable population of small labs typically have large labs as well. Thus, we interpret a switch to one in the "diverse" indicator as an increase in the number of small labs where a large lab is present.

We approach the cross-sectional correlations with caution because firm size composition and regional innovation are surely endogenous. In other words, although our focus is on whether and how firm size composition influences region-level innovation, regional innovation likely influences local firm size composition. For example, regions that are more innovative, perhaps due to large companies and/or universities that spend heavily on R&D, likely generate more new small firms that increase the likelihood that those regions will be "diverse". In addition, small firms that are especially innovative are more likely to either grow or attract large firms into their region, increasing the likelihood that those regions become diverse. Furthermore, unobserved characteristics of a region may affect both the local allocation of R&D labor as well as innovation. For example, a positive shock in the value of technologies produced in the MSA-class (e.g., regional variation in expertise in software development for mobile devices at the time of the arrival of the first iPhone) may lead to an increase both in the entry of small firms and in the likelihood of innovation and lead to an upward bias in the OLS estimates. Downward bias is possible too. For example, successful innovation may induce incumbents to deter entry of new firms, making diversity less likely.

Thus, we take a series of steps to reject the null hypothesis that small firms in the presence of a large lab do not play a role in influencing regional innovation. First, we employ an estimation approach that controls for MSA-class specific attributes (with MSA-class fixed effects) and general technology trends (with class-year effects). When we focus on within-region-technology class variation over time (1975–2000) and use MSA-technology fixed effects (our baseline specification), we find that in periods where at least one large lab and numerous small labs co-exist, MSAs experience a 17% increase in citation-weighted patent counts per inventor relative to periods when those MSAs have below this threshold level of diversity.

In addition, to address the concern that our diversity measure is simply capturing variation in regional product market competition that is correlated with innovation, we show that our results are robust to introducing additional measures of industry rivalry. Similarly, our findings are not affected when we control for more detailed measures of agglomeration, suggesting that diversity is not simply a proxy for regions with a large number of inventors.

Next, we turn to exploring the *mechanism* that links firm size diversity to regional innovation. First, we show that diversity is associated with a 28% increase in spin-out formation. Second, we expect that any barrier to spin-out formation will reduce the beneficial effect of firm size diversity. We show that the effect of firm size diversity on innovation is indeed reduced by the presence of strong non-compete laws. Third, since spin-out formation is predicated on ideas produced by large labs that are subsequently deemed unrelated, we expect that regions with large labs that maintain a narrower focus and thus produce more "misfit ideas" will benefit more from firm size diversity. We show that the effect of firm size diversity on innovation is indeed higher in regions with

[2] See Cohen (2010) for an excellent survey of the 'neo-Schumpeterian' empirical literature. Our paper also contributes to the literature on spin-out formation. While this literature has explored the impact of parent firm characteristics on spin-out performance (Franco and Filson, 2006) and contrasted spin-outs to other entrants (Chatterji, 2009), our paper is to our knowledge the first to examine the impact of regional R&D manpower organization on local spin-out formation.

[3] This typically arises when the lab can spread R&D fixed costs over a larger number of innovations (see Cohen and Klepper (1996) for a micro-foundation). Empirical evidence of such an advantage is provided in Klette (1996); Henderson and Cockburn (1996); Cockburn and Henderson (2001). Alternatively, scale advantages may arise from division of labor efficiencies (Arora and Gambardella, 1994) or human capital complementarities (Jones, 2008).

[4] Prominent examples of such spin-outs include: Intel, founded by Andy Grove, Bob Noyce and others to make a product that Fairchild was unwilling to make; Lotus Development, founded by Mitch Kapor, that left Digital Equipment Corporation; and FreeMarket, founded by a General Electric (GE) engineer after GE rejected his initial proposal. In 2002, the Wall Street Journal reported that in 2001 GE's researchers suggested more than 2,000 new products but only five proposals were accepted for product development (see Cassiman and Ueda (2006) and Klepper and Sleeper (2005) for additional examples).

[5] A number of case studies also provide support for our theory. For example, consider Portland, OR versus Rochester, NY (lack of small firms) and Atlanta, GA versus Seattle, WA (lack of large firms) in 1995. In terms of Portland and Rochester, the number of inventors patenting in the "computers and communications" technology class is very similar in the two cities (roughly 1000 inventors). Nonetheless, Portland outperforms Rochester, obtaining almost 50% more patents and about twice the number of citation-weighted patents than Rochester. While both cities register a similar presence of large labs, the number of small labs is substantially different: Portland has more than five times the number of small labs as Rochester. On the other hand, in the "chemicals" technology class, Seattle and Atlanta have a similar number of small labs (38 and 36, respectively) and also a similar number of overall inventors (457 and 484, respectively), but only Atlanta has a large lab (Kimberly Clark). The difference in innovation output: Atlanta has 37% more citation-weighted patents.