

Not Invented Here: Creative Myopia and Company Towns

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Abstract

We examine variation in the concentration of inventive activity across 72 of North America's most highly innovative locations. In 12 of these areas, innovation is particularly concentrated in a single large firm; we refer to such locations as "company towns." We find that inventors employed by large firms in these locations tend to draw disproportionately from their firm's own prior inventions (as measured by citations to their own prior patents) relative to what would be expected given the underlying distribution of innovative activity across all inventing firms in a particular technology field. Furthermore, we find such inventors are more likely to draw upon the same prior inventions year after year. We refer to this tendency as "creative myopia." However, smaller entrepreneurial firms in company towns do not exhibit this myopic behavior: they draw upon prior inventions as broadly as their small-firm counterparts in more diverse locations. Moreover, we find no evidence that inventions from company town firms have any less impact, although a greater fraction of the impact from large-firm company town inventions is realized by the inventing firm itself.

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1 Introduction

Scholars of innovation and economic geography have focused much attention on locations such as California’s Silicon Valley, Massachusetts’ Route 128, and North Carolina’s Research Triangle, which have attracted clusters of firms that seemingly benefit from agglomeration economies due to factors such as thicker labor markets, knowledge spillovers, and indivisibilities resulting from economies of scale in research and development. However, economists have paid much less attention to innovative locations dominated by a single, large, research-intensive firm. This is surprising since such locations also play an important role in North America’s innovation landscape. These regions include the Rochester metropolitan statistical area (MSA), which is dominated by Kodak (chemicals and optics); the Albany MSA, which is dominated by General Electric (electronics and chemicals); and the Binghamton MSA, which is dominated by IBM (computer hardware and software), among others. We classify such locations as “company towns.”

To the extent that knowledge spillovers between firms are important (not just from a macroeconomic endogenous growth perspective but also in terms of firm-level, innovation-related productivity) and recognizing that the single most well-documented empirical observation about spillovers is that they are geographically localized, one might infer that inventors in such isolated, non-clustered locations are disadvantaged. We conjecture that if in fact company town inventors suffer from reduced access to knowledge spillovers, then that would be reflected in the prior inventions upon which they choose to build. In other words, creativity in these locations would tend to be more myopic, drawing less upon “outside” knowledge than would be expected given the underlying distribution of knowledge across the economy.

We explore this issue by examining how myopia in the creative process of invention is related to the concentration of inventive activity across locations. Perhaps surprisingly, we find that creativity in company towns is indeed more myopic on certain dimensions. In particular, inventors in these locations are more likely than others to build upon prior inventions developed in their own firm, even after controlling for the underlying distribution of relevant

innovative activity across all firms. Furthermore, firms in these locations are more likely to draw upon the same set of prior inventions year after year, whether or not it is their own, compared to firms in more diverse locations that more quickly refresh the pool of knowledge upon which they build.

However, perhaps more surprisingly, we find no evidence of this myopic behavior among entrepreneurial firms in company towns. Smaller firms in company towns draw just as broadly from external sources in terms of the prior inventions they build upon as their small firm counterparts in more diverse locations. Thus, the creative myopia phenomenon associated with invention in company towns is present only among large firms.

We then turn to examining whether the observed myopia matters. Specifically, we examine the relation between creative myopia and the impact on subsequent innovation. We find no evidence that company town inventions have less impact on future innovation. Furthermore, although a larger fraction of the impact from company town inventions is realized by the inventing firm itself, the impact of these inventions is no less geographically dispersed.

Without data to distinguish between impact that is priced (e.g., through licensing) versus non-priced (i.e., a genuine externality of the type specified in Romer (1990)), the welfare implications of differences in the degree of appropriation, captured here by the propensity to self-cite, are not obvious, especially since the overall level of impact is similar across locations. Thus, despite an apparent reduced access to localized knowledge spillovers from other firms, our preliminary findings offer no basis to conclude that company town innovation is inferior in terms of its contribution to welfare or firm-level productivity relative to that of other locations, even though it appears to be somewhat more myopic at large firms.

2 Background

Knowledge externalities – or “spillovers” – play a critical role in most theories of innovation and growth, reflecting the widespread recognition that inventions usually incorporate or build upon ideas or information generated by others and that in many instances access to these

inputs to the knowledge production function is not explicitly priced. In Alfred Marshall’s memorable phrase, ideas are “as it were, in the air.”

But are these ideas equally accessible to all potential users? Research on the microfoundations of spillovers suggests not. On the one hand, knowledge externalities appear to be quite strongly localized (Jaffe et al. (1993), Rosenthal and Strange (2001), Rosenthal and Strange (2008), Agrawal et al. (2008)). Even in an era of relatively low communication costs and increasingly systematized, codified, and searchable knowledge, inventors appear to be significantly less likely to use knowledge generated in physically distant locations.

On the other hand, analysis of the organization and management of corporate R&D has shown that firms invest significant resources in order to develop “absorptive capacity” to enhance their ability to exploit externally generated knowledge (Cohen and Levinthal (1989), Cockburn and Henderson (1998)). In other words, even if not explicitly priced, accessing ideas generated by others is not costless and may be strongly conditioned by institutions, geography, and the optimizing responses of firms and inventors.

One interesting and important factor driving the cost of accessing knowledge spillovers is the structure of local innovation markets. The foundational work of Glaeser et al. (1992), Audretsch and Feldman (1996), and Rosenthal and Strange (2003), among others, has linked knowledge spillovers to the location and composition of production activity. The finding of Feldman and Audretsch (1999) – that diversity of economic activity at a given location promotes innovation – is particularly provocative in that it links the nature of “local knowledge” to theories of “recombinant” growth (Weitzman (1998)). Other research has linked spillovers to industry structure in the industrial organization sense; for example, Feldman (2003) and Agrawal and Cockburn (2003) link the efficiency of local knowledge spillovers to the presence of large “anchor tenant” firms.¹

Here, we investigate another potential source of heterogeneity in the cost of accessing

¹Klepper and Simons (2000a) and Klepper and Simons (2000b) also identify the role of industry structure in the sense of incumbents versus entrants driving localized innovation but emphasize knowledge that is internal rather than external to the firm.

spillovers: the (alleged) propensity of R&D workers to discount or ignore sources of knowledge that are external to their team or organization. Katz and Allen (1982) popularized the so-called “Not Invented Here (NIH) Syndrome” in their study of the propensity of research teams with little turnover to become progressively less productive.² The NIH Syndrome has since been widely evoked by practicing managers and in managerially oriented scholarship (Kanter (1983), Leonard-Barton (1995), Chesbrough (2006)), and journalists have identified colorful instances such as Apple Computer in the early 1990s where managers inhabited a “reality distortion field” that led them to reject good ideas because they were not generated in-house.³ However, there is surprisingly little quantitative evidence as to the prevalence and impact of the NIH Syndrome. A handful of managerial surveys (e.g., de Pay (1989), Mehrwald (1999)) have identified systematic biases against external knowledge, though Menon and Pfeffer (2003) find the opposite effect – a systematic preference for outsider knowledge.

Why might such a bias exist? One reason simply may be that the cost of accessing external knowledge is higher than for accessing internal knowledge. This is likely to be the case when knowledge is transmitted by person-to-person contact or when an organization raises barriers to external sources of knowledge (for example, by restricting participation in peer communities or travel to conferences) in the name of limiting disclosure of trade secrets (Cockburn and Henderson (1998)). Social psychologists also suggest powerful effects of “in-group favoritism” and “out-group derogation” as mechanisms supporting social identity (Brewer and Brown (1998)). Group affiliation and social identity may be an important contributor to self-esteem, satisfaction, or intrinsic motivation (Hogg and Abrams (1988)), and private rewards from affiliating with groups or strengthening groups may therefore play a significant role in shaping individual behavior. Economists also have interpreted group affiliation and actions that reinforce group membership as efficient mechanisms for supporting coordination or developing trust among group members that facilitate within-group transactions (Glaeser

²Clagett (1967) is an earlier reference.

³Burrows, P. “Apple; Yes Steve, You fixed it. Congrats, now what’s next?” Business Week, July 31, 2002, p.102.

et al. (2000), Efferson et al. (2008)).

In this paper, we test for evidence of a systematic bias against use of knowledge that is external to the firm as shown by the propensity to “self-cite” patents. Our analysis focuses on the role of geography, in the sense that the “Here” in our analysis of “Not Invented Here” refers to a location as much as to an organization. We recognize that self-citation may occur for many reasons. Individuals or organizations working in highly specialized fields or on very specific topics are more likely than average to self-cite simply because they constitute a large fraction of the relevant prior work. Self-citation within an organization may also be more likely to occur because of the lower cost of accessing knowledge that is familiar or transmitted by person-to-person contact. We hypothesize that the cultural/behavioral forces driving the NIH Syndrome may be particularly strong in the social or institutional environment of company towns where the activity of a single firm dominates the local innovation market. Thus, although the NIH Syndrome may cause elevated levels of self-citation within an organization, laboratory, or work group, it is likely to be difficult to distinguish it from other factors driving self-citation. Here, however, we believe that geography may provide a useful source of identification. If this is the case, then the NIH Syndrome may be visible in the propensity of organizations in such locations to self-cite at a rate that is “above baseline.”

3 Data

We construct our sample using data from the United States Patent and Trademark Office (USPTO).⁴ We collect all utility patents issued between the years 1985 and 1995, inclusive. This represents 984,888 patents. We limit our focus to the US and Canada and thus drop all patents that do not have at least one inventor residing in either country. This reduces our sample to 540,999 patents. Furthermore, we drop all patents that are not assigned to non-government organizations, including unassigned patents. In other words, we only keep

⁴Specifically, we use USPTO data that Bronwyn Hall and her collaborators cleaned and coded (Hall et al. (2002)).

patents assigned to organizations such as firms, universities, and hospitals. This results in a sample of 392,830 patents.

We further refine our sample by focusing only on geographic locations that are reasonably active in innovation. To achieve this, we use city, state/province, and country data associated with inventor addresses to assign each inventor to an MSA. We then count the number of patent-inventors per MSA where all inventors are located in the same MSA. For example, if a patent has two inventors, one in Boston and one in New York, we ignore this patent when counting the number of patents in these two cities. However, if both inventors are in Boston, then that patent increases Boston’s patent count by one. We then drop the MSAs that have fewer than 500 of these patent-inventors. As such, we focus our attention on the 72 most highly innovative MSAs (down from a total of 408 MSAs). This reduces the total number of focal patents to 264,078. We use this set of patents as our base sample.

4 Methodology

In this section, we describe the empirical techniques employed to address the following two questions: 1) Do inventors based in locations characterized by more concentrated inventive activity exhibit higher levels of creative myopia? 2) Do inventions developed in locations that are more myopic have less impact on future innovation? We use US patent data to construct our key measures of innovative activity and in particular utilize citation data to construct measures of myopia (citations made) and impact (citations received). We begin by defining our two key measures of MSA-level concentration of inventive activity.

4.1 Concentration of Inventive Activity

We measure the concentration of inventive activity across MSAs on two dimensions: 1) across firms and 2) across technology fields. In both cases, we use a Herfindahl-type index to characterize the degree of concentration. We characterize particularly concentrated locations

as company towns. We describe the construction of each measure below.

4.1.1 Concentration Across Firms

We base our measure of the concentration of inventive activity on a Herfindahl-type metric that characterizes how patents by inventors in a particular MSA are distributed across firms (i.e., assignees). In other words, if N_{msa} represents the total number of patents by inventors located in a given MSA and $N_{msa,i}$ represents the number of patents issued to assignee i , then we define our measure $FirmConcentration_{msa}$ as:

$$FirmConcentration_{msa} = \left[1 - \sum_{i \in I} \left(\frac{N_{msa,i}}{N_{msa}}\right)^2\right] \frac{N_{msa}}{N_{msa} - 1}$$

where I is the set of all assignees within the MSA that have been issued a patent.

This measure is similar to the well-known measures of *basicness* and *generality* that Hall et al. (2002) introduced. However, rather than measuring the concentration of citations made and received by a patent in a particular technology field, we instead use it to measure the concentration of firm inventive activity within an MSA. This measure takes values between zero and one, where MSAs with inventive activity more highly concentrated among assignees score values closer to zero and those with greater dispersion obtain values closer to one.⁵

4.1.2 Concentration Across Technology Fields

We construct our technology field concentration measure in a similar fashion. However, rather than measuring the dispersion of patents across assignees, we measure dispersion across two-digit technology fields.⁶ Specifically, if $N_{msa,t}$ represents the number of patents developed by inventors located in a particular MSA and categorized as belonging to technology field t , we

⁵We drop patents that are not assigned when we calculate this measure. However, we test the robustness of our results by treating unassigned patents in an MSA: 1) as if they are all assigned to a single assignee in that location and 2) as if they are each assigned to a different assignee in that location. Our results persist.

⁶Hall et al. (2002) describe the two-digit classification scheme, which has 36 distinct technology categories that can be aggregated into six broad one-digit categories.

define our technology field concentration measure $TechnologyConcentration_{msa}$ as:

$$TechnologyConcentration_{msa} = \left[1 - \sum_{i \in I} \left(\frac{N_{msa,t}}{N_{msa}}\right)^2\right] \frac{N_{msa}}{N_{msa} - 1}$$

This measure takes values between zero and one, where MSAs that are more diverse in their technological landscape obtain values closer to one and those that are more narrowly focused take values closer to zero.⁷

4.1.3 Company Towns

We classify locations that are particularly concentrated along these two dimensions as company towns. Specifically, 12 (16.7%) of our 72 MSAs with the highest levels of innovative activity are measurably more concentrated than the others. We characterize the MSAs with market structure product values ($TechnologyConcentration_{msa} * FirmConcentration_{msa}$) of less than 0.6 as company towns. Perhaps more intuitively, they appear as outliers upon visual inspection of the scatter plot presented in Figure 1.

In descending order according to the overall level of inventive activity as measured by patents, the MSAs we characterize as company towns include: 1) Rochester, NY (Kodak), 2) Albany, NY (General Electric), 3) Saginaw, MI (Dow), 4) Baton Rouge, LA (Ethyl Corp.), 5) Harrisburg, PA (AMP), 6) Ottawa, ON (Nortel), 7) Rockford, IL (Sundstrand Corp.), 8) Boise City, ID (Micron Technology Inc.), 9) Binghamton, NY (IBM), 10) Johnson City, TN (Kodak), 11) Melbourne, FL (Harris), and 12) Peoria, IL (Caterpillar).⁸

We list these locations and describe their innovative activity in Table 1. We note several interesting observations about this set of locations. First, they vary considerably in their levels of innovative activity. The largest MSA, Rochester, has just over 10 times the amount of patents (10,950) as the smallest, Peoria (976). Second, in every case the role of the dominant firm is significant. Even in Ottawa, where the dominant firm, Nortel, plays the

⁷Again, we drop patents that have no specified assignee when we calculate this measure.

⁸We list the dominant firm associated with each company town in brackets.

least significant role relative to the overall inventive activity in its location, it still accounts for more than 30% of all patents invented in that MSA during the sample period. At the other extreme, General Electric accounts for almost 72% of all patents invented in Albany.

Third, company towns vary significantly in terms of their importance to the overall inventive activity of their dominant firms. For example, Binghamton and Johnson City account for just under 10% of all inventive activity by IBM and Kodak, respectively. On the other hand, Baton Rouge and Boise City account for, respectively, 86% of Ethyl Corp.’s and 97% of Micron Technology Inc.’s overall inventive activities.

Fourth, entrepreneurial firms, which we define simply as being significantly smaller than dominant firms in terms of their level of inventive activity (less than 400 patents issued over the 11-year study period), account for approximately 20% of inventive activity in Rochester, Albany, and Saginaw, but over 60% in Baton Rouge and Ottawa. It is also interesting to note that while Rochester, Albany, and Saginaw have other large firms in addition to their dominant firm, the other MSAs do not.⁹

Finally, we illustrate the geographic distribution of our company towns in Figure 2. Although we base our data on a sample of patents issued reasonably recently (1985-1995), our company towns are predominantly located in older industrial locations. Specifically, four are in the Northeast (Rochester, Albany, Binghamton, Harrisburg), three are in the Midwest (Peoria, Rockford, Saginaw), three are in the South (Johnson City, Melbourne, Baton Rouge), and only one is in the West (Boise City), while one is in Canada (Ottawa).

4.2 Creative Myopia

Creative myopia is a measure of the degree to which inventors are “nearsighted” in drawing disproportionately from prior inventions that are in some way close to them. We employ several myopia metrics to capture different dimensions of distance. These include: 1) Organizational Myopia: self-cite (building disproportionately on the inventing firm’s own prior

⁹In other words, for most MSAs, the percentage of patents assigned to the dominant firm plus entrepreneurial firms add up to almost 100%.

inventions), 2) Organizational Myopia: new knowledge (building disproportionately on prior inventions the focal firm has built on before), 3) Technological Myopia (building disproportionately on prior inventions from the same field as the focal invention), 4) Locational Myopia (building disproportionately on prior inventions from the same MSA as the focal invention), and 5) Temporal Myopia (building disproportionately on older prior inventions). We describe the construction of each of these measures in turn.

4.2.1 Organizational Myopia: Self-citation to Own Prior Inventions

We measure this type of myopia by the extent to which a firm’s patents draw upon its own prior inventions. We do this by assessing the extent to which citations on a patent refer to prior patents by the same firm as the patent making the citation. Specifically, for each MSA we count the total number of citations, C_{msa} , made by patents produced in the MSA. Of these citations we then count those where the assignee of the citing and cited patents is the same. This is an assignee self-citation and the total number of these is given by C_{msa}^s . Consequently, the average rate at which firms within an MSA make self-citations is given by,

$$\text{SelfCiteMyopia}_{msa} = \frac{C_{msa}^s}{C_{msa}}$$

4.2.2 Organizational Myopia: Use of New Knowledge

Considering all patents issued to a firm in a particular year and a particular two-digit technology field, we measure “New Knowledge” as the fraction of the prior art aggregated over this set of patents that is cited by the firm for the first time.¹⁰ Thus, to construct this measure, we determine the number of unique patents, $C_{a,s,t}$, that are cited by assignee a ’s set of patents issued in year s in technology field t . We further determine the number of these citations

¹⁰We are limited to patent data for each assignee back to 1976. Therefore, we drop citations to patents issued before 1976 from both the numerator and denominator of this fractional count measure. Thus, “first time” actually means cited for the first time since 1976. We do not consider this data limitation problematic since our sample includes patents issued between 1985 and 1995.

made for the first time by a , $C_{a,s,t}^f$. Consequently, we define our new knowledge measure as:

$$\text{NewKnowledgeMyopia}_{a,s,t} = \frac{C_{a,s,t}^f}{C_{a,s,t}}$$

Thus, this measure can take values between zero and one. The closer this measure is to zero, the more myopic the firm's inventive process. That is to say, lower values of this measure indicate that the firm tends to build on the same prior art as it did in the past, even if that prior art was not invented by the firm itself.

At the MSA level, new knowledge myopia is given as the average value of $\text{NewKnowledgeMyopia}_{a,s,t}$ across all assignees and technology fields in the MSA during our sample period.

4.2.3 Technological Myopia

We construct technological myopia in a similar fashion and with the same citation data as organizational myopia. Here, we measure the degree to which firms within an MSA make citations that refer back to patents categorized in the same two-digit technology field as the patents that make the citations. The greater the share of citations that refer to patents in the same technology field, the greater the level of technological myopia. Specifically, if C_{msa} denotes the number of citations made by all patents in a given MSA and C_{msa}^g refers to the number of these citations where the citing and cited patent share the same technology field, then technological myopia is defined as:

$$\text{TechnologyMyopia}_{msa} = \frac{C_{msa}^g}{C_{msa}}$$

4.2.4 Locational Myopia

Locational myopia describes the degree to which patents produced within a given MSA cite patents produced in the same MSA. However, patents may have multiple inventors based in different locations. Therefore, to construct this measure we focus on the number of patent-MSA pairs that are cited and how many of these pairings involve the same MSA in which

the citing patents are produced. Generally, if patents within an MSA cite a total of C_{msa} patent-MSA pairs and C_{msa}^l of these citations refer to patent-MSA pairs originating in the same MSA as the citing patents then, the locational myopia measure is given by:

$$\text{LocationMyopia}_{msa} = \frac{C_{msa}^l}{C_{msa}}$$

4.2.5 Temporal Myopia

Our temporal myopia measures include the average and minimum citation lags measured in years. Specifically, we define a lag as the difference between the grant year of the citing patent i , ($gyear_i$), and the grant year of a cited patent x , ($gyear_x$). Thus, the average citation lag is the average difference in grant years between the citing patent and each cited patent. That is, if the citing patent makes C citations, then the average citation lag is:

$$\text{AverageCitationLag}_i = \frac{1}{C} \sum_{x=1}^C (gyear_i - gyear_x)$$

In contrast, the minimum citation lag is:

$$\text{LagtoMostRecentPatent}_i = \min\{gyear_i - gyear_x\}_{x=1}^C$$

4.3 Concentration of Inventive Activity and Creative Myopia

Next, looking across MSAs, we examine whether our measures of creative myopia are correlated with a concentration in inventive activity. For example, are inventors located in company towns more likely than inventors in other locations to build upon their own firm's prior inventions?

A comparison of mean values of assignee self-citation rates by company town patents versus those from other locations suggests that a larger fraction of the prior art used in company town inventions is drawn from the inventors' own firm. Specifically, the mean citation rate

for company town patents is 14.4%, compared to only 8.7% for other locations (Table 2, Row 5).

However, this simple comparison of means may belie import distributional differences between company town patents and those from other locations. For example, company town firms may be more focused on certain technology fields that lend themselves to higher levels of appropriation (and thus higher self-citations rates). Or company town firms may have had relatively higher levels of innovative activity earlier in our sample period when communication technologies were more costly thus resulting in higher self-citation rates, not because of creative myopia but rather due to higher costs of accessing external knowledge at the time they were relatively more active.

We employ a matched sample method similar to that pioneered by Jaffe et al. (1993) in order to control for the underlying distribution of innovative activity across technology fields and time.¹¹ We begin with the set of company town patents where all inventors on each patent, in cases of multiple-inventor patents, are based in the same location. There are 23,007 such patents. We then select a “control patent” for each company town patent using the following algorithm: 1) Construct the control sample from patents originating in the 60 MSAs that are not identified as company towns and that do not have any inventors residing in any of the 12 company town MSAs; 2) Of these, identify patents having the same application year as the focal patent; 3) Of these, identify the patent(s) having the most USPC classifications in common with the focal patent. At minimum, eligible control patents will have in common the three-digit technology field. Otherwise, control patents have the same primary classification or the same primary and secondary classification and so on, and we choose the patent that exhibits the greatest degree of similarity with the focal patent. If we are unable to find a control patent with at least the same 3-digit technology field as the focal patent, then we drop the focal patent from the sample; 4) If more than one control patent

¹¹We fully appreciate the critiques of this method presented in Thompson and Fox-Kean (2005) and Thompson (2006). We address this by matching on both more detailed and multiple technology categories; still, we recognize that the matching process is imperfect. We further address this issue in our conditional logit analysis.

remains as the “best” possible control, then we select the patent closest to the focal patent in terms of issue date as the control (in the event of a tie, we select randomly).¹²

4.4 Conditional Logit Model

To confirm the results of the matched pair analysis and to control for other determinants of self-citation, we estimate a conditional logit model for the probability of each citing-cited pair of patents in the sample falling into one of the following mutually exclusive categories: (a) a self-citation within the same “laboratory,” (b) a citation made by the focal laboratory to another entity within the same MSA, or (c) a citation to prior inventions developed outside the inventors’ own MSA.¹³ In the spirit of the classic citation function (Caballero and Jaffe (2002)), we control for differences in the number of potentially citable patents in each category by estimating the McFadden choice model (McFadden (1974)) with the size of the relevant pool of possible citations as an attribute of each of these alternatives.¹⁴ In these regressions, the main variables of interest are the company town dummy and the large laboratory dummy.¹⁵ We also control for MSA size (total number of patents and population), the number of university patents in the MSA, the technology class of the citing patent, and the citation lag (difference between the grant years of the citing and cited patents).

4.5 Creative Myopia and the Impact on Future Innovation

We employ the count of citations received by a patent as a proxy for the impact it has had on subsequent innovation. Several studies have shown the number of citations received to be correlated with various measures of patent value, including patent renewals (Harhoff et al.

¹²Given the construction of our matched sample, the potential exists that a given control patent is matched multiple times to different focal patents.

¹³We use the term “laboratory” to denote the research presence of a firm in a single location. In other words, we would refer to a firm that patents in three locations as having three labs. Where it is obvious that we are referring to a firm in a single location context we use the term “firm” and “lab” interchangeably.

¹⁴Citation functions of the type proposed by Caballero and Jaffe (2002) that are estimated from cell counts prove very difficult to estimate for these data since cells are so sparsely populated.

¹⁵We use the term “large” laboratories to denote those labs that are assigned 400 or more patents over the period under study: 1985-1995.

(1999)), consumer surplus (Trajtenberg (1990)), expert opinion (Albert et al. (1991)), and market value of the assignee firm (Hall et al. (2005)).¹⁶

We compare the relative impact of inventions across location types using the matched sample method. To this end we employ the same sample of matched patents as that described above to determine whether patents originating in company towns receive fewer citations than similar patents originating in more industrially diverse locations.

5 Results

In this section, we report results on our two relationships of interest: 1) concentration of inventive activity and myopic behavior and 2) creative myopia and impact on subsequent innovation. Overall, we find a positive correlation between concentration and lab-level myopia (though not other types) but uncover no evidence of a correlation between myopia and impact.

5.1 Descriptive Statistics

We begin by reporting descriptive statistics in Table 2 and discussing the particularly interesting characteristics of these data. First, the mean level of inventive activity over the 11-year sample period is 3,668 patents (Row 1). It is evident that the distribution is positively skewed by very active locations such as New York, San Francisco, and Boston since the median patent count is only 1,392. These data reveal that on average company towns have significantly less inventive activity than other locations in the sample (1,917 patents compared to 4,018), which, it is useful to recall, is conditioned on locations with high levels of inventive activity. In addition, company towns are, by construction, less concentrated in terms of the distribution of inventive activity across firms and technology fields (Rows 3 and 4).

¹⁶In addition, the interpretation of citations received as a proxy for impact is consistent with that held by the USPTO: “If a single document is cited in numerous patents, the technology revealed in that document is apparently involved in many developmental efforts. Thus, the number of times a patent document is cited may be a measure of its technological significance.” (Office of Technology Assessment and Forecast, Sixth Report, 1976, p. 167).

Since we base all of our myopia measures on citations to prior inventions, it is useful to note that the mean number of citations made by the patents in our sample is approximately nine (Row 2). In terms of firm-level myopia, on average approximately 9% of the citations the inventors of a patent in our sample make are to prior art from their own firm (Row 5). However, this percentage is significantly higher for the subset of patents that are from company towns (14.4%), foreshadowing the creative myopia of inventors from these locations. Furthermore, approximately 64% of the prior art cited by the average patent is in the same technology field as the citing patent (Row 6). Also, approximately 30% of the prior art cited by the average patent is from the same MSA as the citing patent (Row 7). In addition, on average 91.7% of citations made by a firm in a given year are to prior art the firm has never cited before (Row 8).

We provide further insight into the differences in citing behavior between inventors from company towns and those from other locations in Table 3. Although inventors of the average company town patent self-cite with almost twice the propensity of the average patent from other locations (19.5% compared to 10.6%), company town inventors make less than half the proportion of citations to prior art from the local MSA that was not developed by their own firm (2.8% compared to 7.0%). The inventors of the average company town patent also base a smaller fraction of their overall prior art on inventions by other firms that are outside their local MSA (73% compared to 79%).

Finally, in terms of impact, the mean patent in our sample receives a citation from approximately 14 subsequent inventions (Table 2, Row 10).

5.2 Are Company Towns More Myopic?

We report the average values of our set of myopia measures for inventions from company towns versus those from other locations in Table 4. We divide our sample into two, such that patents by large laboratories (with over 400 patents assigned over the 11-year sample period) are in one subsample and patents assigned to smaller “entrepreneurial” labs are in the other.

We base the results presented in the top panel (A) on the large-lab subsample.

The results in the first row indicate that the assignee self-citation rate for company town inventions is 1.75 times higher than for similar patents from more diverse locations; on average 28% of all citations made by company town inventors are to prior inventions from their own firm compared to only 16% in other locations. We interpret this result as suggestive that company town inventors are more myopic in the innovation process than those from other locations.

However, although they may be more myopic, we find no evidence that company town inventors draw any less widely from other technology fields. The results reported in Row 2 indicate that approximately one-third of the prior art cited is from technology fields outside of that of the focal patent, regardless of whether the inventor is based in a company town or not. This result remains remarkably consistent even when we drop self-citations from the analysis (Row 8).

The results reported in Row 3 indicate that company town inventions from large labs draw 66% more of their prior art from their local area. However, this is primarily the result of their tendency to build upon their own lab's prior art (i.e., same firm, same MSA). When we drop assignee self-citations from the sample (Row 9), we see that these inventors draw only half the fraction of their prior art from other local inventors as compared to inventors in industrially dispersed locations. In other words, company town inventors are not geographically myopic beyond their tendency to build disproportionately on prior art from their own lab. This is underscored when we focus only on lab-level self-citations (Row 4). The large lab self-citation rate of company town inventions is more than double that of inventions from outside company towns.

The results reported in Row 5 indicate that 79% of the citations made by company town inventors are to prior art that their lab has not cited before. This is less than the 86% of prior art cited by firms in more industrially dispersed locations that is new to the citing firm; moreover, this difference is statistically significant. Furthermore, this result persists when we

drop self-citations from the sample (Row 6). In addition, the 7% difference in the fraction of prior art utilized that is new to the inventing firm is more important than it may first appear since this measure is the yearly average. This difference is compounded year after year as firms in more diverse locations refresh the pool of knowledge upon which they build more quickly.

The results reported in Row 7 suggest that large-lab company town inventors do not build upon older prior art. In fact, company town citations are on average slightly more recent. However, this difference is driven by self-citations (Row 11). We find similar results when we examine the citation lag to the most recent citation on a patent, rather than the average lag across all citations (Rows 8 and 12).

In the lower panel (B) of Table 4 we examine the same set of myopia measures, this time applied to the subsample of smaller entrepreneurial firms. Overall, these results indicate that small labs in company towns do not exhibit myopic behavior as their large-lab counterparts do. The difference in myopia measures between these inventions and those from other locations is much smaller and in most cases goes in the opposite direction. That is, small-lab inventors are slightly less likely to self-cite than their non-company town matches.

To summarize, company town inventors at large labs are myopic in the sense that they are more likely to build upon prior art from their own lab and they are also more likely to build upon prior art their lab has built upon in the past, whether it is their own or invented by others. However, company town inventors at small labs do not exhibit this type of myopic behavior.

Despite company town inventors at large labs being more myopic in terms of building upon their own prior inventions, they are not particularly myopic on other key dimensions. They are not more likely than others to build upon prior art from the same technology field in which they are working. Nor are they more likely to build upon prior art from their local area above and beyond their propensity to draw from their lab's own prior art. Moreover, they build upon prior art that is equally current as that used by their counterparts in more industrially

dispersed locations. Thus, we find no evidence of company town inventors building upon relatively outdated ideas.

5.2.1 Conditional Logit Results

The results from our conditional logit regression, presented in Tables 5 and 6, suggest a significant degree of myopia in company towns. These tables report the marginal effects at sample means of each explanatory variable on the probability of citations made by a patent falling into each category. All of the estimated marginal effects are significant at the 1% level or better, even with robust standard errors.

In Table 5, the positive and strongly significant effect of the company town dummy on the self-citation and citation-within-MSA outcomes indicates a significant degree of myopia. The magnitude of this effect is substantial; all else equal, compared to a patent from a less concentrated MSA, a patent generated in a company town is more than three times more likely to self-cite its own lab, relative to the probability of citing a patent originating outside its own location. Citation to the same lab or same MSA is slightly more likely (odds-ratio of 1.04) in larger MSAs (i.e., locations with more overall patents) and less likely in MSAs with more university patents.

The negative coefficient on the citation lag indicates that citations made to older patents are less likely to be a self-citation or a within-MSA citation. There are also significant differences across technology classes and a very large negative effect of the diversity of technology on the probability of self- or within-MSA citation. We obtain very similar results when we add additional controls for the year the citation is made or the year the cited patent is granted.

Table 6 allows for a different effect of being in a company town for small versus large firms. We interact a large-lab dummy (the lab has over 400 patents assigned during the period 1985-1995) with a dummy for company town. The large and positive main effect and interaction effect indicate that myopia is much more significant for larger compared to smaller firms. Estimated coefficients on the other variables are very similar to those in Table 5.

After controlling for a variety of other MSA characteristics, we thus find evidence of significantly higher rates of within-firm and within-MSA citation in company towns. As we find in the matched-pairs analysis, large labs drive this phenomenon. Even after controlling for differences in the size of the pool of self-citable patents, smaller companies are significantly less likely to cite their own patents or patents originating in the same MSA.

5.3 Does Myopia Hinder Innovation Impact?

The findings we report above suggest that innovation in company towns is more myopic than in other locations. It is tempting to assume that myopia in innovation is undesirable. However, we have no basis upon which to make such an assumption. In this section, we bring this question to the data.

5.3.1 Myopia and Impact: Matching Method Analysis

In Table 7, we report the average number of citations received by inventions from company towns versus those from other locations. Using the same matched sample as described above, we present in the top panel results based on patents by large labs and in the lower panel by small labs.

We report the main result in the first row of the table. Although they may be more myopic, patents by inventors at large firms in company towns have no less impact on subsequent innovation than other patents in the same technology field. This result holds equally for small firms in company towns (Row 10). In both cases, patents from company towns receive just as many citations as those from more diverse locations.

Consistent with our prior results based on citations made, patents by inventors at large company town firms receive 2.3 times the number of self-citations. In other words, although there is no difference in the overall level of impact from inventions developed inside versus outside company towns, a much larger fraction of the impact is realized by the (large) inventing firm itself in company towns (Row 2). This is not the case with small firms (Row 11).

We find no evidence of a difference in the technological breadth of impact resulting from company town inventions. Approximately 40% of the citations received come from outside the focal patent's own technology field. This applies to both large and small firms (Rows 3 and 12).

The results reported in the fourth row indicate that although inventions from company towns are likely to receive more self-citations, they are not likely to receive more citations from their own location overall. Consistent with other findings in prior studies concerning the localization of knowledge flows, such as Jaffe et al. (1993), Thompson and Fox-Kean (2005), Agrawal et al. (2006), and Rosenthal and Strange (2008), we find that even firms in industrially dispersed locations receive a significant fraction of their citations from their own MSA. Thus, although firms in industrially dispersed locations “lose” in terms of local self-citations relative to those in company towns, they seem to “gain” in terms of citations from other firms in their home location. The results reported in Row 8, where we drop assignee self-citations, confirm this intuition; comparing the number of citations received from local inventors, patents in industrially dispersed locations receive 3.2 times the number of citations as those received by company town inventions.

The results in the fifth row reveal that we find no significant difference in the breadth of geographic influence from inventions across the two types of locations. The average invention from either location type is subsequently cited by inventors from approximately five unique MSAs. This may include assignee self-cites from multiple locations in the case where firms conduct research in more than one location. However, when we drop assignee self-citations (Row 8), the result persists: The average number of unique MSAs that have built upon the focal invention falls, but the difference between locations remains insignificant. Thus, even though a larger fraction of the impact from company town inventions is realized by the inventing firm itself, the geographic scope of the impact from these inventions does not appear to be diminished.

6 Conclusion

Company towns are an interesting feature of the geography of innovation: Inventive activity in some locations is dominated by a single organization, which may have important implications for the economics of localized knowledge spillovers. We find that in these locations, large firms tend to be more myopic than those in locations where the inventive activity is less concentrated. However, smaller entrepreneurial firms located in company towns do not exhibit myopic behavior, suggesting that geography need not dictate access to knowledge produced elsewhere. Instead, geographic isolation may facilitate the development of certain attitudes towards innovation to which inventors in large-firm environments might be particularly susceptible.

The causes of this myopia are unclear. One hypothesis is that it reflects the “Not Invented Here Syndrome,” the alleged tendency of R&D workers to discount or ignore knowledge from sources external to their organization or work team. In company towns, this propensity may be particularly strong.

The NIH Syndrome is generally thought to have a negative impact on the productivity of R&D; if this is true, then the myopia we observe should have a negative effect on the impact of these inventions. Interestingly, however, we see no evidence of this, at least as captured by the number of citations received by the patents belonging to the firms in our sample. Myopic inventors tend to produce patents that are less likely to be cited externally, but this is made up for by higher levels of internal citations.

Furthermore, we find little evidence that the geographic breadth of citations to these firms’ patents is diminished. Of course, it may be that the economic value of patents that are disproportionately self-cited is lower, such that myopia does in fact have a negative impact. But this finding also points to potential benefits associated with “in group favoritism” as a mechanism supporting efficient internal exchange and coordination.

The forward citation patterns we observe are also consistent with firms in company towns having a higher ability to appropriate returns from R&D. Choosing to be geographically

isolated may be an effective way to limit spillovers to competitors. In other words, geographic isolation may lower the cost of appropriating knowledge developed in-house while at the same time increase the cost of accessing externally generated knowledge. The fact that some firms choose to locate in company towns while others do not reveals differences in the relative costs and benefits associated with knowledge appropriation and access across firms. Identifying the firm characteristics that underlie these differences is the next logical step in this line of inquiry.

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Table 1: Company Towns

MSA	Dominant Firm	Dominant Technology	Total Patents in MSA	No. of Patents Assigned to Dominant Firm in MSA	% of MSA's Patents Assigned to Dominant Firm	Number of Patents Assigned to Dominant Firm Worldwide	% of Dominant Firm's Total Patents in this MSA	% of MSA's Patents Assigned to Entrepreneurial Firms
Rochester (NY)	Kodak	chemicals	10,950	5,304	48.4	6,793	78.1	20.2
Albany (NY)	GE	electronics	5,255	3,773	71.8	9,073	41.6	20.6
Saginaw (MI)	Dow	chemicals	3,441	1,740	50.6	3,916	44.4	22.5
Baton Rouge (LA)	Ethyl Corp.	chemicals	2,010	718	35.7	836	85.9	64.3
Harrisburg (PA)	AMP	electronics	1,835	1,096	59.7	1,784	61.4	40.3
Ottawa (ON)	Nortel	computers	1,637	498	30.4	966	51.6	69.6
Rockford (IL)	Sundstrand	electronics	1,599	756	47.3	1,063	71.1	52.7
Boise City (ID)	Micron	electronics	1,344	558	41.5	576	96.9	58.5
Binghamton (NY)	IBM	computers	1,266	814	66.4	8,850	9.2	33.6
Johnson City (TN)	Kodak	chemicals	1,118	627	56.1	6,793	9.2	43.9
Melbourne (FL)	Harris	electronics	1,080	467	43.2	706	66.1	56.8
Peoria (IL)	Caterpillar	mechanical	976	639	65.5	820	77.9	34.5

We base the sample on US patents issued to non-government organizations between 1985-1995, inclusive, where at least one inventor is located in the US or Canada.

Table 2: Descriptive Statistics

	All MSAs		Company Towns	Other Locations
	Mean	Median	Mean	Mean
1. No. patents by MSA	3,668 (5,470)	1,392	1,917 (2,421)	4,018 (5,845)
2. No. Citations Made	9.665 (1.583)	9.638	8.568 (1.499)	9.885 (1.517)
Diversity				
3. Assignee	0.871 (0.163)	0.935	0.550 (0.149)	0.935 (0.053)
4. Technological	0.916 (0.050)	0.931	0.841 (0.086)	0.931 (0.014)
Self-Citation				
5. Assignee	0.097 (0.047)	0.091	0.144 (0.073)	0.087 (0.034)
6. Technological	0.641 (0.034)	0.639	0.652 (0.057)	0.638 (0.028)
7. MSA	0.301 (0.117)	0.290	0.377 (0.182)	0.286 (0.094)
Percentage of New Citations				
8. All Citations	0.917 (0.020)	0.912	0.915 (0.032)	0.917 (0.017)
9. Excluding Self-Citations	0.919 (0.019)	0.914	0.923 (0.029)	0.918 (0.016)
10. No. Cites Rcvd by Patent	14.422 (4.591)	13.586	14.843 (8.098)	14.337 (3.619)
11. No. of Patents	264,078		23,007	241,071

Standard deviations in parenthesis.

Table 3: Decomposition of Prior Art

	Citations Made	MSA Self-Cites		MSA Non-Self-Cites		MSA Non-Self-Cites	
		Assignee Self-Cites	Assignee Non-Self-Cites	Assignee Self-Cites	Assignee Non-Self-Cites	Assignee Self-Cites	Assignee Non-Self-Cites
Absolute Number							
All Patents	6.891	0.684	0.441	0.267	5.498		
Company Towns	6.815	1.246	0.204	0.351	5.014		
Other Locations	6.899	0.631	0.464	0.259	5.545		
Share of Citations							
All Patents	7.323	0.114	0.066	0.036	0.785		
Company Towns	7.138	0.195	0.028	0.046	0.731		
Other Locations	7.340	0.106	0.070	0.035	0.790		

Table 4: Creative Myopia: Company Towns versus Other Locations

	Matched Pairs (I)	Company Towns (II)	Other Locations (III)	Difference (II) - (III)	t-statistic
A. Large Lab					
Self-Citation Rate					
1. Assignee	15,036	0.28	0.16	0.12***	37.85
2. Technology	15,036	0.66	0.65	0.003	0.74
3. MSA	15,036	0.25	0.15	0.10***	33.81
4. Lab	15,036	0.23	0.10	0.13***	47.61
Percentage of New Citations					
5. All Citations	13,768	0.79	0.86	-0.07***	-37.96
6. Excluding Self-Citations	13,768	0.83	0.88	-0.05***	-24.76
Citation Lag (Years)					
7. All Citations	15,036	6.15	6.47	-0.32**	-1.98
8. To Most Recent Patent	15,036	2.83	2.97	-0.14***	-3.24
Excluding Assignee Self-Citations					
Self-Citation Rate					
9. Technology	13,524	0.65	0.65	-0.001	-0.12
10. MSA	13,524	0.03	0.06	-0.03***	-15.84
Citation Lag (Years)					
11. All Citations	13,524	6.50	6.54	-0.04	-0.47
12. To Most Recent Patent	13,524	3.52	3.37	0.15***	4.40
B. Small Lab					
Self-Citation Rate					
13. Assignee	5,110	0.12	0.14	-0.02***	-4.58
14. Technology	5,110	0.69	0.67	0.02***	2.29
15. MSA	5,110	0.13	0.16	-0.02***	-4.69
16. Lab	5,110	0.09	0.09	-0.01***	-2.13
Percentage of New Citations					
17. All Citations	4,554	0.91	0.87	0.04***	9.77
18. Excluding Self-Citations	4,554	0.92	0.88	0.04***	8.81
Citation Lag (Years)					
19. All Citations	5,110	6.37	6.33	0.04	0.54
20. To Most Recent Patent	5,110	3.22	3.06	0.16***	3.10
Excluding Assignee Self-Citations					
Self-Citation Rate					
21. Technology	4,793	0.68	0.67	0.01**	1.91
22. MSA	4,793	0.05	0.07	-0.02***	-5.83
Citation Lag (Years)					
23. All Citations	4,793	6.54	6.53	0.01	0.16
24. To Most Recent Patent	4,793	3.57	3.43	0.15***	-5.56

*** = significant at 1%, ** = significant at 5%.

Table 5: Conditional Logit Regression: Marginal Effects

	Lab Level Self-Citation	Citation within MSA (non-self-cite)	Citation Outside MSA
Citing-cited pair specific variables			
Company town dummy	0.028* 33.41	0.042* 30.17	-0.070* -45.59
Number of patents	0.0004* 21.26	0.005* 70.83	-0.006* -74.67
Number of university patents (1000s)	-0.002* -4.55	-0.033* -28.50	0.035* 28.87
MSA population (millions)	-0.0002* -6.48	-0.005* -37.61	0.005* 38.41
MSA technology dispersion	-0.033* -9.89	-0.044* -4.10	0.077* 6.91
Citing-cited patent citation lag	-0.001* -52.05	-0.009* -116.06	0.010* 128.12
Technology class effects	x	x	x
Choice specific variables			
Number of citable patents in MSA	1.4E-10* 8.92	-9.00E-09* -8.92	8.90E-09* 8.92
Number of citable patents outside MSA	8.3E-10* 8.92	8.90E-09* 8.92	-9.70E-09* -8.92
Number of potential self-cites	-9.70E-10* -8.92	1.40E-10* 8.92	8.30E-10* 8.92

Robust standard errors. * = significant at 1%. N = 4,923,693.

Table 6: Conditional Logit Regression: Marginal Effects, Disaggregated by Lab Size

	Lab Level Self-Citation	Citation within MSA (non-self-cite)	Citation Outside MSA
Citing-cited pair specific variables			
Company town dummy	-0.003* -4.25	-0.013* -5.74	0.015* 6.77
Large lab size dummy	0.003* 12.79	0.050* 66.50	-0.053* -68.04
Company town dummy X Large lab size dummy	0.038* 14.87	0.034* 11.95	-0.072* -20.82
Number of patents	0.0003* 17.13	0.005* 62.95	-0.005* -65.89
Number of university patents (1000s)	-0.001* -1.69	-0.025* -21.71	0.025* 21.41
MSA population (millions)	-0.0001* -3.33	-0.004* -31.79	0.004* 31.91
MSA technology dispersion	-0.049* -15.02	-0.093* -8.49	0.141* 12.34
Citing-cited patent citation lag	-0.001* -51.40	-0.009* -114.29	0.010* 126.13
Technology class effects	x	x	x
Choice specific variables			
Number of citable patents in MSA	1.70E-10* 10.62	-1.10E-08* -10.62	1.10E-08* 10.62
Number of citable patents outside MSA	9.80E-10* 10.62	1.10E-08* 10.62	-1.20E-08* -10.62
Number of potential self-cites	-1.10E-09* -10.62	1.70E-10* 10.62	9.80E-10* 10.62

Robust standard errors. * = significant at 1%. N = 4,923,693.

“Large” refers to labs with 400 or more patents.

Table 7: Impact Measured by Citations Received

	Matched Pairs (I)	Company Towns (II)	Other Towns (III)	Difference (II) - (III)	t-statistic
A. Large Lab Patents Matched					
Includes Assignee Self-Citations					
1. Total Citations Received	16,382	13.19	13.33	-0.14	-0.69
2. Self-Citations Received (same Assignee)	16,382	3.72	1.62	2.11***	26.68
3. Citations Received from same Technology	16,382	7.63	7.48	0.15	1.19
4. Citations Received from Focal MSA	16,382	3.85	4.77	-0.93***	-5.99
5. Citations Received from Same Lab	16,382	3.29	2.96	0.32***	2.47
6. Number of Unique Citing MSAs	16,382	4.55	5.08	-0.53***	-12.48
Excludes Assignee Self-Citations					
7. Citations Received from same Technology	16,382	5.36	6.48	-1.12***	-10.75
8. Citations Received from Focal MSA	16,382	0.56	1.81	-1.25***	-19.60
9. Number of Unique Citing MSAs	16,382	3.81	4.66	-0.85***	-20.69
B. Small Lab Patents Matched					
Includes Assignee Self-Citations					
10. Total Citations Received	5,750	12.97	13.37	-0.40	-1.18
11. Self-Citations Received (same Assignee)	5,750	0.95	1.37	-0.41***	-5.36
12. Citations Received from same Technology	5,750	8.04	8.04	0.001	0.01
13. Citations Received from Focal MSA	5,750	2.02	2.82	-0.80***	-5.40
14. Citations Received from Same Lab	5,750	0.69	1.26	-0.58***	-7.78
15. Number of Unique Citing MSAs	5,750	5.33	5.54	-0.21***	-2.69
Excludes Assignee Self-Citations					
16. Citations Received from same Technology	5,750	7.38	7.15	0.23	1.06
17. Citations Received from Focal MSA	5,750	1.33	1.56	-0.23**	-1.95
18. Number of Unique Citing MSAs	5,750	5.02	5.20	-0.19***	-2.43

*** = significant at 1%, ** = significant at 5 %.

Figure 1 – Concentration of Inventive Activity

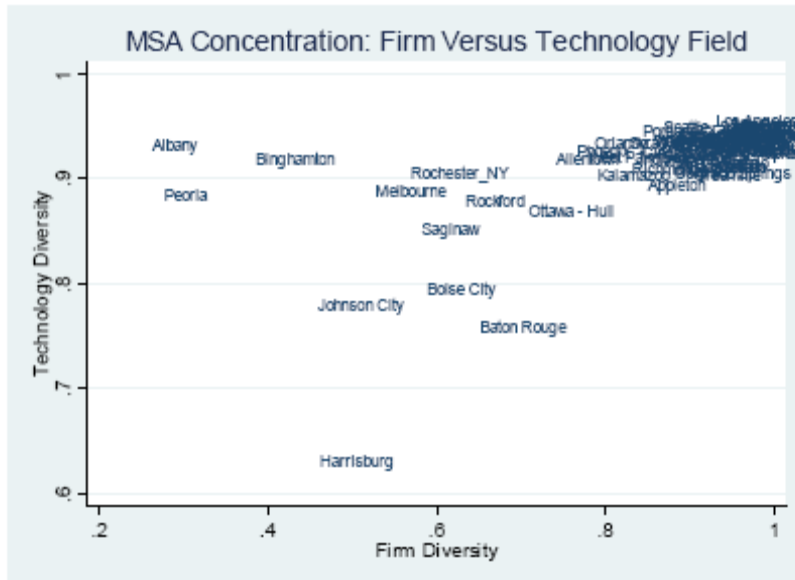


Figure 2 – Map of Company Towns

