Urbanization and Manufacturing: Are There Ideas In the Air?[1]
(Revision for the *Journal of Urban Economics*)

Marcus Stanley
Case Western Reserve University
marcus.stanley@case.edu

Susan Helper
Case Western Reserve University and NBER
susan.helper@case.edu

August 2006

Abstract

One explanation for urbanization effects on productivity is that ideas are more easily communicated in densely-populated areas. Using survey data on U.S. parts-manufacturing firms, we find that both urbanization and networking are associated with increased productivity for many firms. But, this networking is not correlated with urbanization. Parts-makers that do product design (an idea-dependent production practice) are more productive in urban areas. However, they are not more likely to locate in cities, probably because such firms appear to pay significantly higher wage premia there. Our findings differ significantly by corporate structure: single-plant firms seem more dependent on external resources like networking and skilled urban designers.

Running title: Urbanization and Manufacturing: Are There Ideas In the Air?

Key words: Networking, Agglomeration Economies, Urbanization Economies, Clusters, Industrial Districts, Social Capital

[1] We thank Dan Luria and Edie Wiarda of the Michigan Manufacturing Technology Center for providing us with data and many years of insight into manufacturing; the Alfred P. Sloan Foundation for financial support for our research, including partial funding of joint data collection with MMTC; and Scott Shane, Randy Schutt, Wayne Gray, Dan Luria, and especially Will Strange for helpful discussion.

1. Introduction

Studies of a large variety of industries and regions have found better performance by establishments which are located near many other establishments. These neighbor establishments may be in related industries (localization), or in unrelated industries (urbanization). Economists since Alfred Marshall have pointed to the importance of knowledge spillovers in cities as a potential explanation for this phenomenon. But empirical examination of the sources of these spillovers has lagged behind its significance as a theoretical explanation (Rosenthal and Strange, [37, 38]).

In this paper, we take advantage of a national dataset that we collected in conjunction with the Michigan Manufacturing Technology Center. This dataset allows us to look inside small and medium-sized parts manufacturing plants to examine how their networking strategies and production practices differ depending upon their location. We link this survey data with Zip Code Business Patterns data on these firms' neighbors to generate measures of urbanization.

We find that plants in a mature industry (parts manufacturing) benefit from economically and statistically significant urbanization economies. In our sample, this benefit is most associated with location in an urbanized area and not with same-industry "clustering" or localization.

Our major contribution to the literature is that we have gathered survey data which allows us to directly test one possible mechanism for this urbanization advantage, namely knowledge spillovers through inter-firm networking. We use our data to directly examine whether networking levels are higher in urban areas, and whether networking in urban areas produces what firms perceive to be more valuable ideas.

We find that such networking is associated with increased productivity, but only for single-plant firms. (Successful multi-plant firms appear to rely more on information transfers within the firm.) However, we also find that the extent of networking is not correlated with urbanization, and urban firms who network do not report higher perceived value of their information networks than less urban firms do. Thus in our data, networking and inter-firm spillovers do not have any power in explaining the urban productivity effect. We interpret this finding as indicating that firm networks in this industry are not geographically localized, a conclusion that is supported by our in-person interviews with CEOs of parts manufacturing firms.

Our data set also contains considerable information on firm production techniques and specialization. Some production techniques – such as product design – are more idea-dependent than others, and require greater innovation. We hypothesize that if one advantage of urban location is easier access to ideas, then urban location should complement idea-rich specializations like product design. We find that design-intensive firms do experience higher benefits from urbanization. But design firms that locate in urban areas must also pay substantial wage premiums, significantly greater than the urban wage premium associated with firms that do not do design. Perhaps for this reason, we do not find that firms that do product design are more likely to locate in urban areas, nor do design firms in urban locations appear to earn higher profits.

This finding is compatible with a number of different channels by which product design ideas could be transmitted to urban firms. The finding of higher wage premiums for urban design firms suggests that greater access to skilled product designers in urban areas plays some role.

We also find that the degree of firms' dependence on external environments to generate ideas, whether through networking or access to local skilled labor markets in product design, appears highly related to their internal structure. Multiple plant firms with more complex corporate structure appear less dependent on networking, and also do not show as strong a relationship between design productivity and urban location.

Section 2 places our work within the context of previous literature. We describe our survey data in Section 3. Section 4 briefly describes some of the results of our qualitative interviews.Section 5 provides empirical results, as well as discussion of those results, and Section 6 concludes.

2. Literature Overview and Discussion

The empirical literature on urbanization economies is truly vast (see Rosenthal and Strange, [37, 38] for a survey). It is nearly unanimous in finding that urbanization positively affects productivity, wages, and rents. Sometimes this effect is associated mainly with location near similar firms (clustering), and sometimes it is more associated with location in diverse and dense urban areas (urbanization).

If the effect of agglomeration on productivity is Hicks-neutral, the existence of productivity effects is unlikely to shed much light on exactly what causes these effects. Regardless of the original source of the agglomeration economy, urban location will have similar effects on the productivity of most or all inputs to the firm production function, and also similar impacts on their observed price (Rosenthal and Strange, [36]). Exactly what causes the productivity effects is therefore not entirely clear.

However, there is no lack of theoretical candidates (see Duranton and Puga [10] for a useful classification). Economists since Marshall have postulated that knowledge spillovers are one of the major candidates for an explanation of why agglomeration economies exist. There are of course other potential causes of urbanization effects that have nothing to do with information exchange (e.g. geographic proximity to transportation hubs, shared access to natural resources). Since our survey provides direct evidence on information exchange, we focus here on information exchange explanations.

The simplest informational spillover stories emphasize the advantages that may come from simple physical proximity to new ideas being generated, which results in a greater likelihood of learning (Kuznets, 1962). Physical proximity presumably lowers the cost of informal social networking (Jacobs [24]; Saxenian [39]; Gordon and McCann [18]).

Recent theoretical work has formalized the idea that skill and idea acquisition by workers can be more rapid because they interact with skilled peers more frequently in the denser urban environment (Glaeser and Kohlhase[17]). Urban workers are therefore more skilled and urban firms have access to a larger pool of skilled workers than non-urban firms do.[2]

Empirical examinations of the information exchange aspects of agglomeration have been less common. Jaffee, Trajtenberg, and Henderson [25] find that patent citations are geographically localized. A number of recent papers have examined correlations between rates of patent generation and urban density (Feldman and Audretsch [12]; Carlino, Chatterjee, and Hunt [4]). This research finds a positive relationship between city size and density and patenting. A large number of labor economics papers have examined whether proximity to other educated workers leads to human capital spillovers in wages (Moretti [33]); these spillovers presumably occur through some form of information exchange between workers that drives the observed skill complementarities. This literature is almost unanimous in finding spillovers. However, neither the patent nor the wage literature can specify the exact mechanisms by which the presumed information sharing occurs.

We can use our survey evidence to directly examine one possible mechanism for information sharing. We test the proposition that higher levels of information exchange through inter-firm networking is one of the causes of the productivity benefits of cities. Because our survey directly asks about networking practices and ideas gained from it, we do not need to infer higher levels of

[2] Of course, even if learning is not easier in cities, there are a number of reasons why more skilled workers might be found there. Pools of skilled workers can be larger in urban areas simply because there is a larger pool of workers overall, or skilled workers may be differentially more attracted to urban amenities (Krugman, [28]).

information exchange from some other output (such as patents) that is presumed to result from networking. If urban firms benefit from networking that is made possible by geographic proximity to other firms, then they ought to report greater levels of inter-firm networking, as well as more valuable ideas gained through such networking. We test this proposition directly in the results section below.

There appears to be very little previous research that uses direct survey evidence to ask whether information exchange is more common in cities. Charlot and Duranton [5] is an exception. Using a survey of French workers, they find that individual workers report levels of communication within the workplace that are significantly higher in larger and more educated cities. Their work differs from ours in that they look at only at communication within the workplace, and not information spillovers across firms. Their survey is also quite different than ours, as it is at the worker instead of the firm level, does not ask about the perceived value of communication, and is not focused on manufacturing.

We also perform an indirect test of the hypothesis that cities are more productive at idea exchange by using firm design intensity (the percentage of sales that consists of products designed by the firm) as a proxy for the significance of intellectual capital to the firm. We test the hypothesis that design work is unusually productive in urban areas, as would be expected if it is easier to learn new ideas in such areas. We also test the hypothesis that firms with high levels of design intensity are more likely to locate in urban areas. The use of this kind of proxy for the significance of urbanization to ideas is not uncommon (Rosenthal and Strange [35]). But a positive finding is compatible with a number of different channels for access to new ideas for design-based firms. For example, greater productivity could be due purely to the presence of more skilled or qualified design workers in urban areas.

At several points in our empirical work we break out smaller (single plant) firms separately from others. Our justification for doing this is the belief that these firms are more dependent on external economies. Large firms have entire departments dedicated to such tasks as recruiting new employees with specialized skills (and to convincing those employees to move to small towns far from home in hopes of steady, well-paid work), buying new equipment, scanning for new technology--all things that small firms depend on relationships and serendipity for. Several previous studies support this belief (Scherer [40]; Kelley and Helper, [26]).

3. Data Description

Our research focuses on a group of firms we call component manufacturers. Firms in this sector fabricate and/or assemble goods made of metal and plastic, principally for sale to other manufacturers. The sector stands at the base of such industries as automobiles and other transportation equipment; industrial, farm, and construction machinery; electrical appliances; and medical instruments. It accounts for more than 10 percent of U.S. manufacturing employment. The sector is heavily concentrated geographically, with 45 percent of total employment in the Great Lakes states of Wisconsin, Illinois, Indiana, Michigan, and Ohio (compared with 36 percent of U.S. manufacturing generally). In contrast to the Original Equipment Manufacturers (OEMs) they serve, most of these firms have fewer than 500 employees. This sector is not considered “high-tech”, though many firms carry out activities generally thought of as innovative, such as product design, hiring scientists and engineers, and using computers.

To investigate the role of social networking in driving urbanization economies among these firms, we designed a special survey instrument that was combined with the ongoing performance benchmarking project managed by the Michigan Manufacturing Technology Center (MMTC). The MMTC project enlists a panel of component manufacturing plants to submit benchmarking data to the MMTC. The information submitted includes detailed data on revenues, costs, employment, wages, and production practices. The panel is not a random sample (firms must volunteer to participate), but comparisons with data from the Census of Manufacturers show that it is representative of the component manufacturing industry in productivity, sales, and employment. While the sample is national, Michigan firms (both rural and urban) are over-represented.

The survey data are carefully reviewed for consistency and reasonableness by MMTC staff. "Because of the more than 600 computer checks performed on each record following data entry, MMTC data are also cleaner than Census data, which in 1994 reported, improbably, nearly 5% of plants with *negative* value added" (Luria [30]). If answers did not make sense, the staff worked with respondents to clarify the responses. For example, respondents initially often entered a figure for cost of goods sold in answer to a question about value-added. MMTC staff worked with firms to correct these entries (Luria [30], personal communication).

During the winter of 2003 we designed and submitted a supplemental survey to the MMTC panel firms that included detailed questions about the nature of their ties to other firms, including customers and competitors. Some 249 surveys were returned, for a response rate of 65%. Our analysis sample for this paper consists either of 614 firms (full MMTC benchmarking project sample) or 249 U.S. firms (the subsample that responded to our survey on networking).[3]

We derive the following measures from the MMTC benchmarking full sample of 614 firms: *VAFTE* is value-added per full-time equivalent worker. Value added is calculated by subtracting from sales a plant's non-wage expenses, including purchased materials, energy costs, insurance, etc. Importantly, these expenses do not include rent and property taxes.[4] Full-time equivalent workers are calculated based on a weighted average of "typical weekly hours" for that plant in that year for shop

[3] Since some firms did not answer all questions, analyses in this paper often have fewer than 249 observations. We also omitted data from firms located in Canada.

[4] Thus, our productivity measure includes only payments to employees and owners; it does not include payments to landlords. To the extent that rents and taxes are higher in urban areas, *VAFTE* understates the productivity advantage of urban firms.

personnel, and a 40-hour week for white-collar employees.

KFTE is capital per full-time equivalent worker, where capital is the replacement value of the equipment used at the plant (both owned and leased).

EMP is total employment at the surveyed plant, including both shop and office workers; the variable includes temporary workers.

PAYBEN is the plant's total payroll + total benefits expense divided by total FTEs.

NETMARGIN is equal to the (plant's revenue minus its cost of goods sold) divided by revenue.

DESIGNPCT is the percent of the plant's sales accounted for by products designed at that plant. The exact question asks, "Approximately what percent of sales were from jobs where you designed the part or assembly?"[5]

We also defined a number of variables based on our networking survey. These variables are only available for our 249 firm subsample that responded to this survey:

COMMEXTENT is a common factor derived from the responses to 9 separate questions on the extent of communication or networking with other firms engaged in by the respondent plant. The exact questions, response coding, and the factor analysis results are shown on Table 2.

COMMVALUE is a common factor derived from the responses to 6 separate questions on the perceived value gained through communication or networking with other firms.

As explained above and in Tables 2-3, the COMMEXTENT and COMMVALUE measures are based on a factor analysis of a number of survey responses. The questions are designed to measure both the extent of inter-firm contacts and the degree to which these ties are perceived as transferring valuable information to the firm. One can view these measures as indicators of firm social capital, or

[5] The question is thus somewhat ambiguous for multi-plant firms, as to whether product design occurred at the surveyed plant, or at another location (it depends on whether the respondent interprets "you" as referring to the plant or the firm).

alternatively the extent of a firm's information sharing network and the degree to which valuable information is transferred over the network linkages.

We linked the survey data to the U.S. Census Bureau's Zip Code Business Patterns file released in the year 2000. This file contains information on the number of establishments by detailed industry in every zip code in the United States as of 1998. Merging the sample by zip code allowed us to measure urban density at the zip code level.

Our measures of agglomeration are based on this Zip Code Business Patterns Data. (See Table 1 for a summary of our variable definitions):

Total number of nearby plants (URBAN): For each respondent plant in the survey, we determined how many establishments with 10 or more employees were located within a ten-mile radius of that plant's zip code.[6] We used this as our measure of agglomeration or urbanization. We used number of establishments rather than employment because Rosenthal and Strange [36] show that small establishments contribute disproportionately (relative to their employment) to the quality of the economic environment as measured by entry of new firms.[7]

Number of nearby plants in same industry (CLUSTER). This was calculated in the same manner as the URBAN variable, except only plants in the same 3-digit industry as the respondent firm were counted. We used this as our measure of same-industry clustering. Note that this cluster measure relies only on the raw number of same-industry establishments in the area, not on whether an industry is over

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[6] The distance is determined using the distance between zip code centroids. For example, if the center of zip code 44118 is within ten miles of the center of zip code 44106, then firms in zip code 44118 are included in the cluster measure for a firm located in zip code 44106. As a practical matter, this means that the radius for the cluster distance is determined by the various zip code boundaries and is only approximately ten miles (it will almost always be somewhat greater). The regression results shown here include only establishments with 10 or more employees. (Our results did not change if we used all establishments).

[7] The Zip Code Business Patterns file did not include exact employment, but we could define an employment-weighted measure by assigning each plant the midpoint of its employment size category. This weighted measure was highly collinear with our plant count, and it did not significantly change our results to use it.

represented in a region compared to the rest of the nation.

Weighted employment at nearby suppliers and customers (SUPPLIERIND and *CUSTOMERIND).* Following Glaeser [14], we used the 1997 input-output tables to weight employment among 4-digit industries in the respondent's county. *SUPPLIERIND* measures the weighted employment in industries that supply the respondent's plant; *CUSTOMERIND* measures weighted employment in customer industries.

Several of the theories discussed above imply that the key source of economies associated with cities is the *heterogeneity* of the establishments they contain (not the quantity of establishments, which is captured by URBAN). Following Duranton and Puga [11] we defined the diversity of a plant's environment as the inverse of a Herfindahl index of sectoral concentration of employment. First we computed the inverse of the sum of the shares of two-digit SICs for zip codes within a 10-mile radius of each establishment. We then defined *DIVERSITY* as the z-score of this measure, so the regression coefficient measures the effect of a one standard deviation change.

4. Qualitative Research

As part of our survey design process, we conducted in-depth interviews with 8 CEOs and 3 engineers at local Cleveland component manufacturers. We paid special attention to networking practices reported by these interviewees.[8]

Some of the types of networking were clearly local, and depended on urban concentration. One of our interviewees, an engineer at a Cleveland stamping firm, described how he figured out how to make a particularly difficult part. This part had a very deep draw (i.e., the metal had to be formed into a very deep cavity, which is difficult to do without tearing the steel because of the extreme stretching of the material that occurs in the press.) He asked a number of people both at his firm and others, and

[8] We also drew on dozens of interviews we conducted for other purposes in this sector over 20 years.

found out that a person named John at a nearby stamping firm was an expert in designing such parts. John agreed to give some tips to him for free, in exchange for an implied promise that he would be more likely to tap John's firm as a supplier in the future.

Localization was important in this case for two reasons. First, the low costs of meeting due to geographic proximity meant that there was enough routine interaction among people in firms in similar lines of business that the engineer we interviewed was able to overcome bounded rationality and learn about John (whom he had not previously met). There was a serendipitous element to the search; the engineer simply asked everyone he met in the course of business, who might be able to help with a deep draw problem? Second, once he had located John, the costs of meeting him in person (a 10-minute drive to his plant) were also low.

However, some kinds of networking did not seem to depend on proximity. This seemed to be especially true at the CEO level, even for small firms. We found that the CEOs of even 25-employee firms traveled to China to pursue business contacts.

When they wanted to explore new technology, top executives could also afford to draw on geographically distant contacts. For example, one company president we talked to wanted to look into installing sensors on his stamping presses. He hired a consultant that he had read about in a trade magazine, and they chartered a plane for 3 days to visit plants around the nation where the consultant had installed similar technology. In this case, the president was learning from other firms, but these firms were not local.

We also learned from our interviews and plant tours two ways in which urban location may affect the productivity of firms that do product design: pooling of skilled workers, and improved match quality. Urban firms that design their own products benefit from both access to pools of skilled labor and proximity to suppliers and customers. For example, one multi-plant producer of sensors and actuators has a plant in Boston and one in rural Ohio. These plants are both in the same SIC code, sell similar sensors to the same customers, and have production workers that appear to be doing the same jobs. Yet the value-added per employee of the Boston plant is 50% higher (Helper and Kleiner [20]). The reason, in part, appears to be that Boston is a more conducive place to design higher-tech, patentable products, because it is easier to hire electronics engineers, and to meet with suppliers of electronic products in Boston.

The productivity of product design might also be improved by improved match quality in urban areas. Duranton and Puga [11] present models in which match quality increases with the number of agents trying to match.) For example, the Boston plant manager argued that there are complementarities between design engineers and production workers, because together they can figure out how to work the bugs out of new products so they can be produced efficiently. (The Boston plant's profits are higher than the rural Ohio plant's, despite wages that are one-third higher.). That is, in a plant that makes the same products repeatedly, it is possible to train just a few engineers to design a 'foolproof' production process, and have the rest of the workforce run the plant according to routines codified by these engineers. In contrast, if new product introductions are frequent, a plant will be more productive (have less down time) if workers coordinate with each other to quickly work out the bugs in the new production process. That is, when a plant is frequently changing over to new products, more contingencies arise, contingencies that yield a higher payoff to having the entire workforce be highly skilled. The production function in such plants thus takes on a multiplicative, "O-ring" character (Kremer [27]).

Finally, we examined whether stand-alone firms might be more dependent on external economies, compared to firms with a more elaborate corporate structure. We found (consistent with Scherer [40]; Kelley and Helper [26]) that large firms have entire departments dedicated to such tasks as recruiting new employees with specialized skills (and to convincing those employees to move to small towns far from home in hopes of steady, well-paid work[9]), buying new equipment, scanning for new technology--all things that small firms depend on relationships and serendipity for.

The smaller firms don't have the expense of a corporate office, but also don't get the strong ties (Granovetter [19]) that this hierarchy would provide. Small firms can economize, but cannot be sure of their command over resources. We visited several firms in Detroit that had key employees who were either moonlighting or retired from jobs at large automakers or suppliers. Because of proximity to the small firm, the moonlighters could participate in meetings at 7:30 am or 5:30 pm, and still work a normal day at their primary employer. They charged the small firm half or less of their normal rate, in part because of the fun of working in a less-bureaucratic environment. "I can suggest things here that we'll do tomorrow that would never in a million years be approved at Visteon [a multi-billion dollar autoparts supplier], said one engineer participating in an early-morning meeting at a machine-tool producer with an innovative approach to cutting intricate tools. On the other hand, the meeting had to end when he needed to leave for work at his regular job.

5. Results

We first present summary statistics and confirm that significant urbanization economies exist for our sector. We then test the hypothesis that information exchange through inter-firm networking is a source of these information economies. We also examine whether firms that seem particularly dependent on new ideas (design-intensive firms) gain special advantages from urban location, and if so whether these firms must pay unusually high wages to get these advantages.

Table 1 shows the definitions and sample means of the variables we analyzed. Table 2 shows

[9] For example, Borg Warner (a multinational firm) found and hired an engineer who was leaving the Navy in California to work in its transmission plant in Blythedale, Arkansas, a tiny town surrounded by cotton fields and 90 minutes from Memphis.

the distributions of our basic measures of urbanization and of manufacturing clusters. The table shows there is substantial variation in both measures. As one would expect, urbanization and clustering are quite significantly correlated, but the correlation coefficient is only .45.

Our first result, shown in Table 3, is that urbanized firms show superior productivity to those in less urbanized areas. This is a commonplace finding, but not all research distinguishes between urbanization and various measures of clustering based on proximity to similar firms or partners in the supply chain. The "urban" variable has a consistent and significant effect on value-added per worker. By contrast, our various measures of clustering have no effect on productivity once urbanization is controlled for.[10] Neither the number of nearby same-industry establishments nor the supply-chain based measures of clustering in the *SUPPLIERIND* or *CUSTOMERIND* variables are associated with higher productivity once urbanization is included. We also tested a variable measuring urban diversity in these equations; it also became insignificant once urbanization was included. (These results are not shown.)

These urbanization results are significant economically as well as statistically. For example, the results in column 2 imply that a move from the 25th to the 75th percentile on the urban variable (with other variables constant at their means) would increase productivity per worker by 12% or almost $8,800 per worker year. Some of the impacts in the other columns are even greater.

All of these results are completely robust to redefining the *URBAN* and *CLUSTER* variables on an employment-weighted basis. The employment-weighted regressions are not shown as they are very similar to the ones shown in Table 3. We also tested urban diversity, defined as a Herfindahl index of sectoral employment, as another alternative urbanization measure. We do not show the results as they were quite similar to Table 3 – the diversity measure on its own was significant, but became small and insignificant when placed in a regression with our plant count urban measure.

[10] We get the same result if the cluster is defined at the three-digit SIC level or the two-digit level.

Next, we consider whether urbanization economies are at least partially explained by inter-firm networking. For the learning benefits of social networks to be an important source of the urbanization benefits we have found, two things must be true. The first is that social networking must be related to the outcomes we seek to explain (in this case productivity). The second is that social networking must be related to urbanization, in the sense that it is easier to undertake or more productive in urban areas.

As a measure of social networking and the learning that results from it, we included a set of 15 questions on the Critical Relationships Survey administered to a subset of our MMTC sample. These questions can be broken into two sections, one of which asks about the extent of social networking and the other about the perceived value of such networking. We asked firms to focus on networking with firms other than their key customers.[11]

We used factor analysis to reduce each section (on extent of networking and on perceived value of knowledge gained through networks) to a single variable. In each case, the primary factor could account for over 90% of the variance in the scale. The statistics from the factor analysis and the text of the survey questions are shown in Tables 4 and 5. We defined two variables: *COMMEXTENT* measures the extent of the firm's networks (Table 4), and *COMMVALUE* measures the value of information gained through networks as perceived by the survey respondent (Table 5). Both of these variables are the first factor (accounting for the great majority of the variance) from the relevant set of variables.

Table 6 shows the results of regressing firm productivity on the same variables used in Table 3, plus a social networking measure, using only the Critical Relationships Survey subsample[12]. We present results mainly for the networking scale that measures the perceived value of information gained

[11] We looked separately at a variety of measures of networking with customers, and did not find any that were robustly significant.
[12] Results for the basic specifications in Table 3 are the same for the 249-firm sub-sample as for the full sample.

through networking, since the actual value of information would seem to be the most relevant for productivity. We did also regress productivity against the extent of networking, and against both extent and value in the same regression (results not shown). We found that the extent of networking measure was not robustly related to productivity, and it was never related to productivity at all when the value measure was included in the same regression.

When productivity is simply regressed against COMMVALUE plus control variables for the sample as whole, there is no significant effect of the social networking variable. If anything, the value of information gained through networking appears to be negatively related to productivity.

But modeling social networks in this way assumes that they will have similar effects for all firms in the sample. Based on previous research (Kelley and Helper, [26]), we believe that smaller and less "corporate" firms are more likely to be affected by their external environment. Larger and more complex firms with an extensive corporate structure may take their lead from internally defined corporate strategies and procedures as opposed to learning through networking with external actors. When managers at these firms feel the necessity to move outside the corporate structure and network externally to learn new techniques, this can actually be a sign that the firm suffers from poor management.[13]

For this reason, we ran a separate regression for single plant or stand-alone firms, to test for a separate effect of social capital on different types of firms. Our only employment measure is employment in the specific establishment we are surveying; we do not have total employment for the entire corporation that owns the establishment. But we do have a question that asks whether the establishment is part of a multi-plant corporation. We have used the response to this question as our

[13] We actually do find that the communications value scale is negatively related to productivity for multiple plant firms; this result is not shown on the table.

indicator of corporate structure. Some 47% of establishments responding to the Critical Relationships Survey belonged to a multi-plant corporation.

Columns 2 and 3 of Table 6 show that single-plant firms do show a positive correlation between productivity and the perceived value of information gained through networking with other firms. This effect is economically significant; the point estimate implies that an increase of 1 standard deviation in COMMVALUE increases productivity per worker by over 7%.

So successful networking does increase productivity for single plant firms. But if it is to help account for the urbanization effect then networking must be either easier or more productive in urban areas. The results in Columns 4 through 8 of Table 6 show that there appears to be no correlation at all between networking and urbanization in our sample, whether we use our extent or our perceived value measure. This result also holds true for single plant firms (columns 6 through 8). We tested the robustness of this finding in many other regressions that we have not presented, and found very similar results. Regressions of the perceived value of communication on urbanization which controlled for the extent of communication also showed that when networking extent was held fixed, networking in urban areas was not perceived to be more valuable. As another test of whether networking was more productive in urban areas, we also regressed productivity against an interaction between urbanization and both of our networking variables; the coefficients on the interactions were not significant either singly or jointly.

The lack of a relationship between urbanization and networking is a somewhat surprising result. However, it is supported by our interviews discussed in the previous section. Most of the respondents to the networking survey were firm CEOs. In our interviews we found that many CEOs traveled extensively, and did not have localized networks of contacts. They often used broad resources such as trade magazines to find networking partners, and these resources covered the industry on a national or international scale.

In the final two tables of our findings, we examine whether firms that do extensive product design (a proxy for the importance of innovation and new ideas to their production process) have higher productivity in urban areas. If they do, then urban location does in fact appear to make ideas more accessible to these firms, even if it does not take place through inter-firm networking. This could occur if skilled design workers are easier to find in cities. As discussed in Section 2 above, there are many theoretical reasons to think this might be the case, and it is well established that general worker skill measures tend to be higher in cities. It could also occur through shared access to a common urban level resource, such as a university.

Table 7 shows that firms which are design-intensive appear to benefit especially strongly from urban location.[14] This benefit appears to be most concentrated among single plant firms; single plant firms who do design work in urban areas show significantly higher productivity than those who are located outside of urban areas. The complementarity between product design and urban location for single plant firms is a very robust finding and a large and economically significant one. For example, an increase from 0 to 35% in the fraction of sales accounted for by products designed in-house is predicted to double the urban advantage experienced by single plant firms.

It is remarkable that this finding is robust to the inclusion of dummies for 131 CBSAs (Column 3).[15] We presented these results for illustrative purposes only, as the inclusion of over 100 independent variables in a sample of less than 300 single-plant firms is probably excessive. But it indicates that at least in this sample, urban density within a particular local area is correlated to design productivity. So these effects appear to be highly localized, at least judging from these CBSA results. This finding does

[14] Product design intensity is defined as the percent of sales accounted for by products designed in-house. See section 3.
[15] Core based statistical areas; these are essentially MSAs but also include Micropolitan Statistical Areas centered around small rural cities with populations of less than 50,000.

not support the shared urban resource (e.g. university) explanation for higher design productivity in cities, since one would expect that such a resource would have common effects throughout the CBSA.

The fact that we did not find a benefit for multi-plant firms could be due to their lesser dependence on their external environment, since it is often possible to transfer engineers and design personnel between plants in larger corporations, including plants outside of urban areas. It could also result from ambiguity in the question (respondents might have included design work done inside the firm but at another, less-urban, location). Given the large productivity effects of urban location for single-plant firms that do design work, it is surprising that the last two columns of Table 7 show that there is no correlation between urban location and design intensity for either the entire sample or single plant firms. This finding is robust to the inclusion of additional controls (not shown); design intensive firms are not more urban.

One can get a sense for why this might be in Table 8. This table regresses wages and profit margins against urban location, design intensity, and the interaction between the two. Table 8 shows that urbanized firms pay higher wages (as is universally found in the literature), and on average earn higher profits. However, design intensive firms suffer an even larger wage penalty for locating in cities, as the coefficient on the design and urban interaction is quite large. This is especially true for single plant firms, where the point estimate is actually larger than the urban coefficient. Thus design-intensive firms choosing to locate in cities pay a much higher level of additional wages to do so than other manufacturing firms. Probably because of this high wage cost, there is no clear profit benefit for design firms in locating in urban areas (Column 6). However, it should be noted that the high standard error on the coefficient makes it difficult to draw firm conclusions here.

The results in Table 8 may indicate that the complementarity between design and urbanization is due to the quality of the local labor force. Certainly it appears that workers capture many of the benefits from this complementarity. This provides a potential explanation for the failure of small design firms in our sample to locate in more urbanized areas. Still, given the magnitude of the productivity effect this is still a somewhat surprising finding.

6. Conclusions

We have found significant urbanization economies in our sample of US component manufacturers. Thus, urbanization economies are found even in mature industries, even in this age of dramatically reduced transportation and communication costs. We also tested for economies of localization and of diversity; these coefficients became insignificant when urbanization was included.

We gathered survey data that allowed a direct test of at least one informational explanation for this urbanization economy – the potentially greater ease and value of inter-firm networking in cities. This networking presumably makes it easier to gather new ideas. First, we found that CEO networking is associated with increased productivity by single-plant firms. However, this networking does not appear to be associated with urban location at all. Thus, it cannot explain the urbanization economies we found. This result suggests that urbanization economies are not due to this type of learning. Our interviews with CEOs suggested that their networks were often not local, which can help to explain the finding that urbanization and networking are uncorrelated.

We were able to explain about 20% of the urban coefficient for single-plant firms by the greater productivity of design work by those firms if it is done in an urban area; a result that could be interpreted as supporting theories of agglomeration based on greater ease of learning new or innovative ideas in urban areas. Since most of the benefits of this complementarity between design intensity and urbanization appeared to be captured by workers, we hypothesized that it was due to more access to skilled design workers in cities.

In our final table, we did find robustly higher profits in urban manufacturing. This may seem an anomalous result, but on closer examination it seems less so. First, the reports of the death of urban manufacturing have perhaps been exaggerated. According to Census data, the proportion of manufacturing establishments that are located in urban areas (as defined by the Census) was 53% in 1995, and 55% in 2001. Similarly, the MMTC data does not show a pattern of disinvestment in urban areas. Plants above the median on our urbanization variable have 18% of their equipment less than 5 years old, while 21% of equipment in plants below the median urban firms is less than 5 years old—an insignificant difference. While total manufacturing employment fell 15% between 2001 and 2004, the sector is no longer losing jobs, given the recovery and the weak dollar.

Second, our regressions capture the profitability of the average firm; equilibrium with mobile firms requires only that profits of the *marginal* urban and rural firms be equated. Inframarginal firms may earn positive profits. This may be what is occurring in our sample.

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TABLE 1: Variable Definitions

Variable Name	Definition	Mean (SD)
CLUSTER	Number of establishments (10+ employees) in same 3-digit industry within a ten mile radius of firm zip code.	21.8 (41.1)
URBAN	Number of establishments (10+ employees) located within a ten mile radius of firm zip code	3306 (3785)
SUPPLIERIND	Input-weighted average of employment among supplying industries in plant's county (including own industry)	2614 (3378)
CUSTOMERIND	Output-weighted average employment among customer industries in plants county (exclude own industry)	1279 (2169)
VAFTE	Value added (revenue minus costs) per full-time equivalent worker, in dollars	73156 (33034)
KFTE	Capital (value of plant and machinery) per full-time equivalent worker, in dollars	60079 (61888)
EMP	Total employment in the surveyed plant	91 (102)
PAYBEN	Average annual pay and benefits per FTE worker, in thousands of $	45.7 (16)
NETMARGIN	Revenue margin (revenue-costs/revenue)	.15 (.14)
SINGLEPLANT	Responding establishment represents the only plant or facility in the company (1=Yes, 0=No).	.529 (.50)
COMMEXTENT	Standardized (mean 0, SD 1) result of factor analysis for extent of communications (see Table 4)	
COMMVALUE	Standardized (mean 0, SD 1) result of factor analysis for perceived value of communications (see Table 5)	
PURCHSRV	Purchases of services divided by total sales	.10 (09)
PURCHGD	Purchases of goods divided by total sales	.29 (.17)
DESIGNPCT	Percent of sales volume accounted for by goods or parts designed in-house at the plant.	.22 (.34)

Many regressions use natural log of variables, indicated in tables by LN(variable name).

TABLE 2: Distribution of Clustering and Urbanization Variables

CLUSTER

Percentile in Distribution	Clustering Variable (Number of Nearby Same-Industry Establishments*)
10th Percentile	1
25th Percentile	2
50th Percentile	7
75th Percentile	23
90th Percentile	61
Maximum	374

*Count of other establishments in the firm's 3-digit SIC (Standard Industry Classification) code located in zip codes within ten mile radius of plant zip code.

URBAN

Percentile in Distribution	Urbanization Variable (Number of Nearby Non-Manufacturing Establishments**)
10th Percentile	129
25th Percentile	465
50th Percentile	1857
75th Percentile	5082
90th Percentile	8725
Maximum	38365

** Number of establishments (10+ employees) in zip codes w/in 10 miles of plant zip code.

TABLE 3: Urbanization, Clustering, and Productivity

Dependent Variable	LN (VAFTE)	LN (VAFTE)	LN (VAFTE)	LN (VAFTE)	LN (VAFTE)	LN (VAFTE)	LN (VAFTE)	LN (VAFTE)
Independent Variables	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
LN (KFTE)	.15*** (.017)	.17*** (.019)	.14*** (.018)	.15*** (.018)	.17*** (.0254)	.148*** (.02)	.144*** (.02)	.166*** (.022)
LN (EMP)	.053*** (.017)	.041*** (.018)	.042*** (.018)	.05*** (.019)	.042*** (.018)	.051*** (.02)	.055*** (.02)	.044*** (.02)
LN (CLUSTER)	___	___	.033*** (.022)	– .017 (.017)	– .015 (.022)	___	___	___
LN (URBAN)	.054*** (.011)	.049*** (.0193)	___	.067*** (.016)	.059*** (.02)	___	.06*** (.019)	.048*** (.018)
LN (SUPPLIER)	___	___	___	___	___	.032* (.019)	.013 (.02)	.016 (.02)
LN (CUSTOMER)	___	___	___	___	___	.022 (.023)	– .014 (.025)	– .021 (.025)
Constant	8.94 (.21)	8.76 (.23)	9.39 (.304)	8.89 (.274)	8.74 (.300)	8.97 (.25)	8.93 (.25)	8.85 (.27)
Industries		17 2-Digit SIC controls			17 2-Digit SIC controls			17 2-Digit SIC controls
Adjusted R-Square of Model	.16	.26	.12	.15	.23	.14	.16	.29
Model Sample Size	561	561	561	561	561	438	438	438

*** Variable significant at 1% level
** Variable significant at 5% level
* Variable significant at 10% level

TABLE 4: Extent of Communications Questions And Factor Analysis

"In this section, we are interested in how much you communicate on business issues with shops *other than* your key customers. These other shops might include your suppliers, competitors, minor customers, other nearby manufacturers, or other shops you know through industry connections.

In the past three years, to how many of these shops did the following statements apply?
[Response choices are 0 shops, 1 shop, 2-3 shops, 4-6 shops, 7 or more shops]

E1: Our managers and/or engineers socialize outside of work with their employees.
E2: Our engineers and/or skilled workers are comfortable calling them to discuss a manufacturing issue.
E3: We have helped them hook up with other shops to address a problem or respond to an opportunity.
E4: We share solutions to general business issues.
E5: We have toured their facility and/or they have toured ours.
E6: We have cooperated closely with them to solve our difficult technical and/or design problems.

Please give your reaction to each of the following statements about the types of interactions you have with these shops:
[1 = Strongly disagree, 7 = strongly agree]

E7: We don't really interact much with employees at shops that are *not* our important customers or suppliers.
E8: Our engineers and managers are well-connected to the industry "grapevine": they hear about innovative products or cutting-edge techniques before most people in the industry.
E9: We often receive information from former employees even after they have moved on to other shops.

	Factor 1	Factor 2	Factor 3
Eigenvalue	2.78	.48	.31
Proportion of Variance	.94	.16	.11
Factor Loadings – Questions	Factor 1	Factor 2	Factor 3
E1	.53	.37	.02
E2	.73	-.25	.06
E3	.71	.13	-.11
E4	.47	.33	-.11
E5	.68	-.13	-.12
E6	.74	-.33	-.05
E7	-.27	-.15	.05
E8	.35	.07	.39
E9	.22	.03	.32

Scale reliability coefficient (Cronbach's alpha): .78

Variable COMMEXTENT is the standardized (mean 0, SD 1) score for Factor 1.

<u>TABLE 5: Perceived Value of Communication Questions and Factor Analysis</u>

"In this section, we are interested in how much you communicate on business issues with shops *other than* your key customers. These other shops might include your suppliers, competitors, minor customers, other nearby manufacturers, or other shops you know through industry connections.

Please give your reaction to each of the following statements about the types of interactions you have with these shops:

[1 = Strongly disagree, 7 = strongly agree]

PV1: When we have a tough problem to solve, paid consultants are more helpful than our contacts at other shops.
PV2: We have rarely gotten any ideas that we would not have thought of ourselves from people other than our important customers.
PV3: We have learned a lot from shops other than our important customers about reducing setup time.
PV4: We have learned a lot from shops other than our important customers about reducing inventory.
PV5: We have learned a lot from shops other than our important customers about new products that we might introduce.
PV6: We have learned a lot from shops other than our important customers about new manufacturing processes.

<u>Factor Analysis Results For Perceived Value of Communication</u>

	Factor 1	Factor 2
Eigenvalue	2.39	.37
Proportion of Variance	.97	.15
Factor Loadings – Questions	Factor 1	Factor 2
PV1	.03	.42
PV2	-.22	.38
PV3	.84	-.15
PV4	.87	.04
PV5	.63	.17
PV6	.69	.06

Scale reliability coefficient (Cronbach's alpha): .68

Variable COMMVALUE is the standardized (mean 0, SD 1) score for Factor 1.

TABLE 6: Networking, Productivity, and Urbanization (networking subsample)

Sample	All Firms	Single Plant Firms	Single Plant Firms	All Firms	All Firms	Single Plant Firms	Single Plant Firms	Single Plant Firms
Dependent Variable	LN (VAFTE)	LN (VAFTE)	LN (VAFTE)	COMM EXTENT	COMM VALUE	COMM EXTENT	COMM VALUE	COMM VALUE
Independent Variables	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
LN (KFTE)	.153*** (.026)	.156*** (.036)	.165*** (.047)	-.072 (.073)	.11 (.07)	-.146 (.108)	-.009 (.106)	-.011 (.13)
LN (EMP)	.051* (.027)	-.02 (.037)	-.006 (.037)	.143* (.072)	.155** (.07)	.172 (.126)	.28*** (.104)	.283*** (.11)
LN (URBAN)	.063*** (.016)	.077*** (.021)	.078*** (.02)	–.026 (.044)	– .006 (.043)	–.067 (.066)	–.076 (.061)	-.061 (.062)
COMMVALUE	-.017 (.028)	.073** (.036)	.072** (.036)	—	—	—	—	—
COMMEXTENT	—	—	—	—	—	—	—	—
Constant	8.82 (.327)	8.92 (.51)	8.77 (.55)	.375 (.36)	-1.75 (.87)	1.40 (1.43)	-.502 (1.32)	-.59 (1.65)
Industry Controls	—	—	8 2 digit SIC controls	—	—	—	—	8 2 digit SIC controls
Adjusted R-Square of Model	.187	.217	.234	.014	.017	.027	.05	.011
Model Sample Size	214	113	113	214	214	110	113	113

*** Variable significant at 1% level
** Variable significant at 5% level
* Variable significant at 10% level

TABLE 7: Urbanization, Design, and Productivity For Single and Multiple-Plant Firms

Sample	All Firms	Single Plant Firms	Single Plant Firms	Multiple Plant Firms	All Firms	Single Plant Firms
Dependent Variable	LN (VAFTE)	LN (VAFTE)	LN (VAFTE)	LN (VAFTE)	DESIGNPCT	DESIGNPCT
Independent Variables	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
LN (KFTE)	.163*** (.016)	.15*** (.025)	.157 (.033)	.165*** (.036)	___	___
LN (EMP)	.052*** (.017)	.04* (.024)	.042 (.03)	.094** (.04)	___	___
LN (URBAN)	.046*** (.012)	.042** (.017)	-.013 (.03)	.063** (.025)	-.0009 (.009)	.0057 (.013)
DESIGNPCT	-.153 (.22)	-.722** (.34)	-.82* (.48)	.192 (.446)	___	___
DESIGNPCT * LN(URBAN)	.055* (.031)	.124** (.045)	.134** (.06)	.015 (.063)	___	___
Constant	8.78 (.21)	9.02 (.31)	9.28	8.4 (.46)	.228 (.07)	.175 (.096)
Industry Controls	15 2 Digit SIC controls	15 2 Digit SIC controls	13 2 Digit SIC controls	13 2 Digit SIC controls	___	___
CBSA Controls	___	___	131 CBSA Dummies	___	___	___
Adjusted R-Square of Model	.243	.24	.30	.247	0	0
Model Sample Size	480	300	286	140	531	335

*** Variable significant at 1% level
** Variable significant at 5% level
* Variable significant at 10% level

TABLE 8: Impact of Urbanization and Design on Pay and Margins

Sample	All Firms	All Firms	All Firms	All Firms	Single Plant Firms	Single Plant Firms
Dependent Variable	LN (PAYBEN)	NET MARGIN	LN (PAYBEN)	NET MARGIN	LN (PAYBEN)	NET MARGIN
Independent Variables	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
LN (KFTE)	.093*** (.015)	-.008 (.007)	.099*** (.016)	-.005 (.008)	.106*** (.022)	-.022* (.011)
LN (EMP)	.052*** (.014)	.003 (.007)	.059*** (.015)	.004 (.008)	.058*** (.021)	-.007 (.01)
LN (URBAN)	.046*** (.009)	.015*** (.004)	.041*** (.011)	.013** (.005)	.036** (.015)	.013* (.007)
DESIGNPCT	___	___	-.118 (.19)	.005 (.098)	-.21 (.30)	-.17 (.15)
DESIGNPCT * LN(URBAN)	___	___	.049* (.026)	.0007 (.014)	.066* (.04)	.022 (.02)
Constant	2.23 (.19)	.112 (.094)	2.23 (.19)	2.12 (.19)	2.12 (.27)	.312 (.137)
Industry Controls	17 2 Digit SIC Controls	16 2 Digit SIC Controls	17 2 Digit SIC Controls	17 2 Digit SIC Controls	15 2 Digit SIC Controls	14 2 Digit SIC Controls
Adjusted R-Square of Model	.27	.01	.33	.01	.29	0
Model Sample Size	523	497	478	453	298	282

*** Variable significant at 1% level
** Variable significant at 5% level
* Variable significant at 10% level