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ABSTRACT
This paper analyzes the location and interrelationship of three measures of innovation commercialization across the 50 largest metropolitan areas in the United States and estimates a model of the factors explaining variations in the location of innovation commercialization. In general innovation commercialization tends to be highly geographically concentrated, suggesting the presence of substantial external economies in these functions. Beyond these scale effects, however, I find that the university science and engineering capacity and local patenting activity both help to account for intercity differences in the level of innovation commercialization activity.

Keywords: innovation, agglomeration, urban economics

Introduction

Innovation is widely regarded as one of the chief engines of modern economic growth. Since the Industrial Revolution, the introduction of new products and more efficient processes of production has been the key to rising standards of living and economic prosperity in the United States and other developed economies. In past two decades fostering innovation has become an increasingly important element in the local economic development strategies of communities throughout the country. According to Michael Porter, for example, "The central economic goal. . . should be to attain and sustain a high and rising standard of living for. . . citizens. The ability to earn a high and rising standard of living depends on increasing productivity which in turn depends on innovation. The central challenge then in enhancing prosperity is to create the conditions for sustained innovation output" (Massachusetts Technology Collaborative 2003).

A widely held view is that an active higher education sector is an essential ingredient in creating high-technology based economic development. According to Jaffe (1989, p. 957): "It is conventional wisdom that 'Silicon Valley' near San Jose, California, and Route 128 around Boston owe their status as centers of commercial innovation and entrepreneurship to their proximity to Stanford and MIT." Other communities, such as Raleigh-Durham, North Carolina, and Austin, Texas have sought to consciously emulate this strategy by using university clusters to attract high-technology industries. But the connection between university research and the innovation economy remains more conjectural than proven at this point.

It seems reasonable to suppose that ideas are more easily communicated between researchers in close proximity to one another, and there is by now a relatively large literature documenting the fact that knowledge spillovers from higher education remain highly localized (see Audretsch and Feldman 1993 for a review of the literature). Jaffe (1989) for example shows that variations in industrial patenting across states are explained by differences in state levels of industry research and development (R&D) expenditures and university research expenditures. Jaffe, Trajtenberg and Henderson's (1993) analysis of patent citation patterns suggests one mechanism for the localization of innovative activity, demonstrating that researchers are more likely to cite innovations produced nearby than those produced further away. Yet the literature on the geography of innovation has concentrated almost exclusively on the location of patenting and R&D expenditures while ignoring the subsequent commercialization of innovations, which is essential in creating local economic development. Past study of innovation commercialization has been confined primarily to analysis of data collected in 1982 by the Small Business Administration based on product announcements in collection of scientific and technical journals (Feldman 1994; Feldman and Audretsch 1999). This information is now relatively dated, and in any event, the focus on new product innovations and reliance on published reports introduce a variety of potential biases in the data.

In this paper I extend the study of the geography of innovative activity by analyzing three previously unstudied measures of innovation commercialization across the largest 50 cities in the United States. As is true of other innovation measures I find that all three measures of commercialization are highly concentrated in a few cities.

Turning to the factors that explain the concentration of innovation commercialization, I find that variations in university science and engineering capacity and patenting rates can account for a significant fraction of intercity differences. Even after accounting for these factors, however, there is still a considerable degree of concentration in innovation commercialization, suggesting the presence of important agglomeration economies in these activities.

Measuring Innovation Commercialization

Innovation performance cannot be measured directly or in one single dimension. While past research has focused on measures of patenting and research and development expenditures, two relatively well documented measures of idea generation, there are also a number of readily available measures of innovation commercialization. Three that are available at the city level are Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants, Venture Capital Investments, and Initial Public Offerings (IPOs).[1] The SBIR program, administered by the Small Business Administration, is reputed to be the largest seed capital fund for development of new products and processes in the world. It provides competitive grants to entrepreneurs seeking to conduct "proof-of-concept" research (Phase I) and prototype development (Phase II). The STTR program makes competitive awards to small business and public sector partners to promote technology transfer activities. SBIR and STTR grant awards

[1] These measures have been widely used in so-called "innovation indexes" which have been constructed to benchmark innovative activity in different cities or states. See, for example, Burress, Rosenbloom and Manzoor (2004), Massachusetts Technology Collaborative (2003), Progressive Policy Institute (2001), Maryland Technology Development Corporation (2001), Maine Science and Technology Foundation (2002).

to businesses are thus an indicator of the level of innovative activity of small businesses in each city. Venture capital investments provide a second indicator of the extent of commercialization activity in a city. Venture capital is a small but crucial part of the financial market, providing capital infusions in the early stages of business development. Because venture capitalists generally provide close supervision to the ventures in which they invest the location of venture capital funds may play an important role in promoting the geographic concentration of emerging industries. Initial Public Offerings (IPOs) of stock, in which privately held companies are taken public, experienced a dramatic expansion as a means of financing new ventures during the Information Technology boom of the 1990s. The number of companies going public headquartered in a city provides a third measure of the extent of commercialization efforts in the community.

My focus is on innovation in the 50 largest metropolitan areas in the United States. The Census Bureau refers to these areas as Metropolitan Statistical Areas (MSAs).[2] When two or more MSAs are contiguous with one another and have substantial economic interactions the Census Bureau designates the combined unit as a Consolidated Metropolitan Statistical Areas (CMSAs), referring to the entire entity by its primary city name. For brevity, however, I will refer to all of the places in this study as metropolitan areas, or simply as cities. Together the 50 CMSAs/MSAs in this study account approximately 60 percent of the nation's workforce and economic activity.

Because of my interest in studying spillovers from higher education to innovation commercialization I have had to augment five of the MSA definitions to encompass adjacent counties that contain a major research university within 50 miles of the city

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[2] Each MSA consists of one or more counties whose economies are closely related to each other.

center. The MSAs that have been adjusted in this way are: Indianapolis (joined with Bloomington, with Indiana University), Salt Lake City (joined with Provo, with Brigham Young University), Birmingham (joined with Tuscaloosa, with the University of Alabama), Kansas City (joined with Lawrence, with the University of Kansas), and Grand Rapids (joined with East Lansing, with Michigan State University).

Table 1 reports the three measures of innovation commercialization for the 50 largest MSAs/CMSAs in the United States. In addition the table includes each city's population in 2000, the number of patents issued to inventors in each city between 1996 and 2000—which can be interpreted as a measure of the level of idea generation in each city—and the number of science and engineering doctorates awarded in the city in 2001—which can be viewed as a measure of the science and engineering capacity of universities in the city.

Not surprisingly, variations in commercialization, patenting and the number of doctorates awarded all broadly parallel differences in city size. Table 2 reports correlation coefficients between the variables reported in Table 1. While all of the commercialization measures display a high degree of correlation with metropolitan population, the table also suggests the presence of important differences. The location of IPOs appears to follow population much more closely, for example, than do SBIR/STTR grants or Venture Capital funds. Both patenting and doctorates awarded are even more highly correlated with population across cities than IPOs. Looking at other relationships, it is apparent that there is a strong connection between all of the commercialization measures and both patenting and doctorates awarded.

Figure 1 presents the distribution of innovation commercialization from a somewhat different perspective, plotting the Lorenz curves for each measure of innovation and comparing their distribution to the distribution of population, patenting and doctorates awarded across metropolitan areas.[3] The further below the diagonal line the Lorenz curve lies, the more unequal the distribution of the variable in question. This divergence can also be summarized quantitatively in the Gini coefficient, which measures the ratio of the area under the Lorenz curve to the area under the diagonal line. The Gini coefficient ranges from zero (complete inequality) to one (perfect equality).[4] As the figure makes clear, the three measures of commercialization are all substantially more geographically concentrated, and hence more unequally distributed, than is population. More than half of SBIR/STTR grants, venture capital funds, and IPOs are concentrated in the top 5 cities for each category of innovation commercialization, while the 5 largest cities in population contain only about one-third of the total population. Doctorates awarded (40 percent in the top 5 cities) and patents issued (43 percent in the top 5 cities) lie somewhere between population and the commercialization measures in terms of the level of concentration.

Clearly it is important in analyzing innovation measures to control for city size. By virtue of their larger population, bigger cities ought to have more economic and innovative activity than smaller cities. In Table 3 I report a ranking of cities in terms of a

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[3] Lorenz curves are commonly used in studies of wealth or income distribution. In that case households are ordered from lowest to highest income and their cumulative share of total income is plotted as a function of their cumulative share of households. Here the unit of analysis is a metropolitan area, so I plot the cumulative share of each measure of innovation as a function of the cumulative share of metropolitan areas.

[4] The Gini coefficient is the ratio of the area below the Lorenze curve to the ratio under the diagonal line representing complete equality.

single combined measure of per capita innovation commercialization. To obtain this ranking I first expressed each of the innovation series in per capita terms. The next step was to convert the three series to a common scale by expressing the level in each city as a percentage of the level in the city with the highest value. Thus, Boston, which received the highest level of SBIR/STTR grants per capita, $1.6.66 has an index value of 100 for this measure while Denver, which received the next highest amount, $10.33, has an index value of 62. Finally, I constructed an unweighted average of all three index values, which I converted to a 100 point scale by again expressing the value for each city relative to the highest ranked city: San Francisco. After San Francisco, the rest of the top 5 cities, in declining order, are Boston, Denver, San Diego, and Austin. Comparing the index values for these cities, it is clear that the extent of commercialization is highly unequal across cities, with index values for Austin being only slightly more than forty percent of those in San Francisco.

Figure 2 plots the relationship between the summary measure of commercialization from Table 3 and the per capita patenting rates in the different cities. As this figure makes clear there is some connection between innovation commercialization and the rate of idea generation. On the other hand, it is also apparent that for four of the five cities with the highest rates of commercialization, levels of commercialization are substantially higher than can be explained on the basis of patenting alone. At the same time it is clear that there are some cities—such as Columbus, Detroit, Cincinnati, and Minneapolis, which appear to be doing a relatively poor job of converting patents into commercial innovations.

A model of the determinants of innovative activity

Additional insight about the determinants of innovation commercialization can be gained by considering the data in a multivariate framework. Underlying this analysis is a simple causal model that is premised on the idea that spillovers from patenting and university science and engineering activity localized in their impact on commercialization activity. Expressed mathematically the model takes the form:

$$C_{it} = F(P_{it-1}, U_{it-1}, I_{it-1}, \varepsilon_{it}) \quad (1)$$

where i indexes cities, t indexes time periods, C is a measure of innovation commercialization activity, P is population, U is university science and engineering capacity, I is patenting, and ε reflects other unmeasured influences. The rationale for including patenting in this equation is the supposition that the greater the number of innovations available locally the more of them that are likely to be commercialized. University science and engineering capacity may operate through several different channels. On the one hand it may capture dimensions of idea generation that are not adequately reflected in patenting statistics. On the other hand, to the extent that newly trained scientists and engineers are likely to remain close to the places from which they graduate, a larger university presence may contribute to a disproportionately large technical workforce in a community. All of the independent variables are lagged one period to account for time lags between the generation of new ideas and their commercialization. Using lagged values of the explanatory variables also removes the possibility of reverse causation in the regression.[5]

[5] In practice I use 1990 population, the average number of patents issued during 1990-1995 and the number of science and engineering doctorates awarded in 1994 in the regressions.

Theory provides no guidance as to the appropriate form of the function F( ). In what follows I assume that the relationship can be approximated as linear in the logarithms of all of the variables. A convenient feature of this assumption is that the resulting coefficients can readily be interpreted as elasticities.

Tables 4 through 6 report Ordinary Least Squares Regression estimates of several specifications of equation (1) for each measure of innovation commercialization. I begin by regressing each commercialization measure on population alone, and then add the other two independent variables separately and then together. In each case inclusion of the measures of idea generation and university science and engineering capacity substantially improve the model's explanatory power. In the case of SBIR/STTR grants and venture capital investments population alone can account for about half of the variation in commercialization, but inclusion of the other explanatory variables increases the R-squared in the regression to around 0.7. The gain in explanatory power is less pronounced in the case of IPOs, but when the rate of patenting or doctorates awarded is entered into the regression by themselves they are both highly statistically significant. Economically the effects appear to be quite large. The coefficient estimates on Science and Engineering Doctorates awarded indicate that a ten percent increase in university science and engineering capacity would increase SBIR/STTR grants by 5 to 6 percent, venture capital funds by 6.5 to 7.5 percent and IPOS by 1.7 to 2.9 percent. The effects of an increase in patenting generally fall in a similar range.

Comparing the different specifications it appears that SBIR/STTR grants and venture capital investments are more closely related to doctorates awarded than they are to rates of patenting. When both of these explanatory variables are included simultaneously, the number of patents issued is not statistically significant, even at the 10% level. On the other hand, IPOs seem to be more closely related to patenting than to the number of doctorates awarded. When both variables are included in the regression (model 4) only the number of patents issued remains statistically significant at conventional levels.

These results are consistent with previous research on innovation that has found that the spillovers from patenting and local university science and engineering activity tend to be localized to a significant degree. Controlling for population, cities with higher levels of patenting and greater university science and engineering capacity have higher levels of innovation commercialization. Although the regression estimates were constructed to eliminate the possibility of reverse causality, it remains possible that the relationships exhibited in Tables 4-6 reflect a longer-term chain of cumulative causation, in which positive feedbacks between innovation commercialization, patenting, and university science and engineering capacity have tended to reinforce one another. To examine this issue it would be necessary to trace the history of innovation in these locations over the last century or more to determine when and how the current geographic pattern of variation in innovative activity emerged.

One final point to note is that even after controlling for population, patenting and doctorates awarded, there is a high degree of correlation in distribution of the different dimensions of innovation commercialization. This relationship suggests that there are localized spillovers across the different dimensions of innovation commercialization considered here. Table 7 reports correlation coefficients of the residuals calculated from estimates of equation (1) including all of the independent variables. The relationship is especially strong between venture capital investments and IPOs, but there is also a strong correlation between venture capital investments and SBIR/STTR grants. In contrast, the relationship between SBIR/STTR grants and IPOs appears relatively weak. Both the spatial concentration of innovation commercialization, and the correlation of the levels of the different measures within cities attest to the presence of strong external economies tending to promote the localization of innovative activity.

Conclusions

Innovation is widely seen as the key to regional economic development, and cities around the country are seeking to identify economic development strategies that will encourage increased innovation in their area. A crucial foundation for developing such strategies is an understanding of the current state of innovative activity across metropolitan areas. While a good deal of attention has been focused on understanding spatial patterns of idea generation (R&D spending and patenting), innovation commercialization has largely been ignored. Yet understanding the determinants of commercialization is essential if communities are going to be able realize the benefits of economic development strategies based on the encouragement of high-technology industries.

In this paper I have described and analyzed three of the major indicators of innovation commercialization. Several important points emerge from this analysis. The first is that high rates of idea generation do not necessarily imply high rates of innovation commercialization. While there is an overall positive relationship between patenting and commercialization, some cities have been relatively unsuccessful in converting patents into commercial innovations, while other cities have been able to achieve rates of commercialization substantially better than would be predicted based on patenting alone.

The second point that emerges from this analysis is that, consistent with the conventional wisdom, university science and engineering capacity does promote innovation commercialization. Increasing the number of science and engineering doctorates exerts a strong and statistically significant positive effect on SBIR/STTR grant funds and venture capital investments in a community. The link between local universities and the number of IPOs is also positive, but is not statistically significant after controlling for differences in the number of patents issued.

The third point is that the remaining unexplained differences in the different measures of commercialization are highly correlated. Thus places that attract higher levels of SBIR/STTR funds and receive more venture capital investments are also likely to be the homes of more newly established publicly traded companies.

Acknowledgements

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Table 1:
Population, Innovation Commercialization, Patenting and Doctorates Awarded, 2000

	2000 Population (in 1,000s)	SBIR/STTR grants (Annual Average Value for 1996-2000)	Venture Capital (Annual Average Value for 1996-2002)	Initial Public Offerings (Total Number 1996-2003)	Patents (Annual Average Value for 1996-2000)	Science and Engineering Doctorates Awarded (Number in 2001)
Atlanta[b]	4,112	6,902,711	810,157	25	934	421
Austin[b]	1,250	7,150,894	806,443	12	1,313	426
Birmingham[c]	1,086	1,044,192	47,465	3	80	150
Boston[a]	5,819	96,917,767	4,262,982	77	3,369	1,314
Buffalo[b]	1,170	3,064,047	39,153	4	306	179
Charlotte[b]	1,499	742,011	136,777	8	248	12
Chicago[a]	9,158	7,213,972	814,914	38	2,847	796
Cincinnati[a]	1,979	3,660,634	78,931	4	870	177
Cleveland[a]	2,946	7,022,632	119,106	5	976	323
Columbus[b]	1,540	3,135,546	119,769	3	334	395
Dallas[a]	5,222	3,331,376	982,121	32	1,761	321
Denver[a]	2,582	26,664,253	1,375,113	31	1,020	349
Detroit[a]	5,456	10,402,500	136,093	16	2,356	588
Grand Rapids[c]	1,541	433,494	6,422	3	448	28
Greensboro[b]	1,252	1,100,249	32,514	4	223	46
Hartford[b]	1,183	3,977,357	132,235	5	454	157
Houston[a]	4,670	4,732,659	430,121	41	1,556	310
Indianapolis[c]	1,728	633,642	63,552	9	579	179
Jacksonville[b]	1,100	0	35,976	3	119	0
Kansas City[c]	1,876	1,169,810	116,343	11	259	196
Las Vegas[b]	1,563	173,516	2,350	1	139	9
Los Angeles[a]	16,374	51,361,741	2,257,525	74	4,066	1,159
Louisville[b]	1,026	873,713	44,620	5	129	37
Memphis[b]	1,136	288,087	45,496	2	154	67
Miami[a]	3,876	1,092,774	380,893	21	568	161
Milwaukee[a]	1,690	666,553	23,972	3	566	106
Minneapolis[b]	2,969	7,244,580	483,636	21	1,920	430
Nashville[b]	1,231	981,529	166,752	7	130	152
New Orleans[b]	1,338	616,723	79,870	3	131	91
New York[a]	21,200	35,166,435	3,834,530	143	6,024	1,881
Norfolk[b]	1,570	2,169,107	12,697	2	135	0
Oklahoma City[b]	1,083	627,287	29,979	2	142	108
Orlando[b]	1,645	3,629,143	158,033	3	206	54
Philadelphia[a]	6,188	16,808,608	861,799	35	2,154	524
Phoenix[b]	3,252	4,318,039	260,913	11	1,040	147
Pittsburgh[b]	2,359	4,739,345	255,354	10	693	364

Table 1 continued

	2000 Population (in 1,000s)	SBIR/STTR grants (Annual Average Value for 1996-2000)	Venture Capital (Annual Average Value for 1996-2002)	Initial Public Offerings (Total Number 1996-2003)	Patents (Annual Average Value for 1996-2000)	Science and Engineering Doctorates Awarded (Number in 2001)
Portland[a]	2,265	3,023,205	342,007	8	870	38
Providence[b]	1,189	1,550,386	32,727	1	223	162
Raleigh[b]	1,188	5,843,116	480,755	10	774	662
Rochester[b]	1,098	1,399,861	104,797	3	1,501	129
Sacramento[a]	1,797	1,742,032	118,085	2	365	275
Salt Lake City[c]	1,702	6,236,512	237,156	10	541	186
San Antonio[c]	1,592	2,168,048	28,987	2	192	32
San Diego[b]	2,814	26,546,091	1,188,085	32	1,510	282
San Francisco[a]	7,039	42,348,339	13,109,134	211	7,930	1,291
Seattle[a]	3,555	13,622,394	1,110,215	30	1,245	349
St. Louis[b]	2,604	2,371,746	289,128	8	659	226
Tampa[b]	2,396	1,058,247	118,485	11	342	95
Washington, DC[a]	7,608	56,080,576	1,938,140	54	1,778	1,053
West Palm Beach[b]	1,131	381,041	169,706	13	384	24

[a] CMSA
[b] MSA
[c] Expanded MSA, see text for explanation of criteria used.

Notes and Sources: Population-U.S., Bureau of the Census <factfinder.census.gov> ; University Research and Development Expenditures-National Science Foundation, Division of Science Resources Statistics, *Academic Research and Development Expenditures: Fiscal Year 2001*, NSF 03-316, Project Officer, M. Marge Machen (Arlington, VA 2003) http://www.nsf.gov/sbe/srs/nsf03316/, Table B-32; Average annual number of patents awarded-special tabulation provided by Harvard University, Cluster Mapping Project; Average Annual Value of SBIR/STTR grants-computed from Small Business Administration award data http://tech-net.sba.gov/tech-net/search.html; Venture Capital Investments-Special tabulations provided by Thompson Investment Analytics Report; Number of Initial Public Offerings-tabulated by Policy Research Institute, University of Kansas based on reports on Hoover's Online http://www.hoovers.com/global/ipoc/index.xhtml.

Table 2:
Correlation Coefficients Between Population, Innovation Commercialization Patenting, and Doctorates Awarded

	Population	SBIR/ STTR Grants	Venture Capital	IPOs	Patents Issued	Science & Engineering Doctorates
Population	1					
SBIR/STTR Grants	0.5813	1				
Venture Capital	0.4610	0.6188	1			
IPOs	0.7207	0.6707	0.9356	1		
Patents issued	0.7833	0.6606	0.8659	0.9528	1	
Science and Engineering Doctorates	0.8531	0.7912	0.6846	0.8365	0.8744	1

Source: See Table 1

Figure 1:
Lorenz Curves for Innovation Commercialization, Population, Patents and Doctorates Awarded, 2000

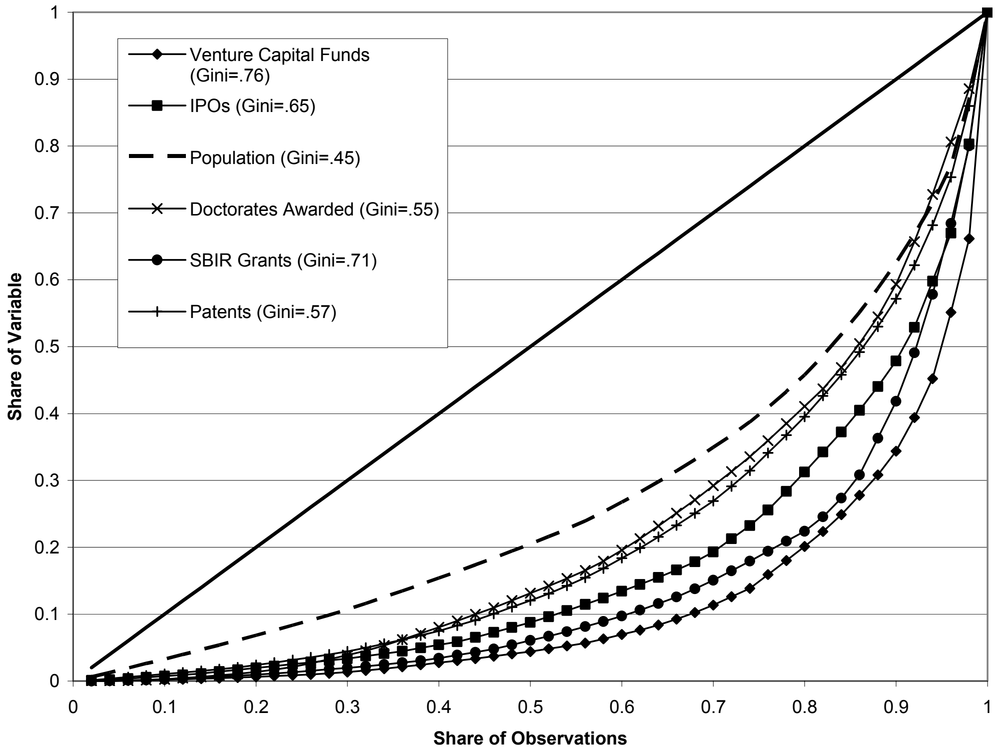

Table 3:
Index of Innovation Commercialization

MSA/CMSA	Rank	SBIR/STTR Grants Per Capita	Venture Capital Funds per Capita	IPOs Per capita	Innovation Commercialization Index
San Francisco[a]	1	36.1	100.0	100.0	100.0
Boston[a]	2	100.0	39.3	44.2	77.7
Denver[a]	3	62.0	28.6	40.1	55.3
San Diego[b]	4	56.6	22.7	37.9	49.7
Austin[b]	5	34.4	34.7	32.0	42.8
Washington, DC[a]	6	44.3	13.7	23.7	34.6
Raleigh[b]	7	29.5	21.7	28.1	33.6
Seattle[a]	8	23.0	16.8	28.2	28.8
Salt Lake City[c]	9	22.0	7.5	19.6	20.8
West Palm Beach[b]	10	2.0	8.1	38.3	20.5
Minneapolis[b]	11	14.7	8.7	23.6	19.9
Philadelphia[a]	12	16.3	7.5	18.9	18.1
New York[a]	13	10.0	9.7	22.5	17.9
Los Angeles[a]	14	18.8	7.4	15.1	17.5
Atlanta[b]	15	10.1	10.6	20.3	17.3
Houston[a]	16	6.1	4.9	29.3	17.1
Hartford[b]	17	20.2	6.0	14.1	17.1
Dallas[a]	18	3.8	10.1	20.4	14.6
Pittsburgh[b]	19	12.1	5.8	14.1	13.6
Nashville[b]	20	4.8	7.3	19.0	13.1
Buffalo[b]	21	15.7	1.8	11.4	12.2
Portland[a]	22	8.0	8.1	11.8	11.8
Kansas City[c]	23	3.7	3.3	19.6	11.3
Charlotte[b]	24	3.0	4.9	17.8	10.9
Miami[a]	25	1.7	5.3	18.1	10.6
Orlando[b]	26	13.2	5.2	6.1	10.4
Louisville[b]	27	5.1	2.3	16.3	10.0
Phoenix[b]	28	8.0	4.3	11.3	10.0
Chicago[a]	29	4.7	4.8	13.8	9.9
Columbus[b]	30	12.2	4.2	6.5	9.7
Detroit[a]	31	11.4	1.3	9.8	9.6
Cleveland[a]	32	14.3	2.2	5.7	9.4
Rochester[b]	33	7.7	5.1	9.1	9.3
St. Louis[b]	34	5.5	6.0	10.3	9.2
Indianapolis[c]	35	2.2	2.0	17.4	9.1
Tampa[b]	36	2.7	2.7	15.3	8.7
Cincinnati[a]	37	11.1	2.1	6.7	8.5
Greensboro[b]	38	5.3	1.4	10.7	7.3
Birmingham[c]	39	5.8	2.3	9.2	7.3
New Orleans[b]	40	2.8	3.2	7.5	5.7

MSA/CMSA	Rank	SBIR/STTR Grants Per Capita	Venture Capital Funds per Capita	IPOs Per capita	Innovation Commercialization Index
San Antonio[c]	41	8.2	1.0	4.2	5.7
Sacramento[a]	42	5.8	3.5	3.7	5.5
Norfolk[b]	43	8.3	0.4	4.3	5.5
Providence[b]	44	7.8	1.5	2.8	5.1
Oklahoma City[b]	45	3.5	1.5	6.2	4.7
Jacksonville[b]	46	0.0	1.8	9.1	4.6
Memphis[b]	47	1.5	2.2	5.9	4.0
Milwaukee[a]	48	2.4	0.8	5.9	3.8
Grand Rapids[c]	49	1.7	0.2	6.5	3.6
Las Vegas[b]	50	0.7	0.1	2.1	1.2

Sources and Notes: See text for an explanation of index construction.

Figure 2:
Relationship Between Innovation Commercialization and Patenting, 2000

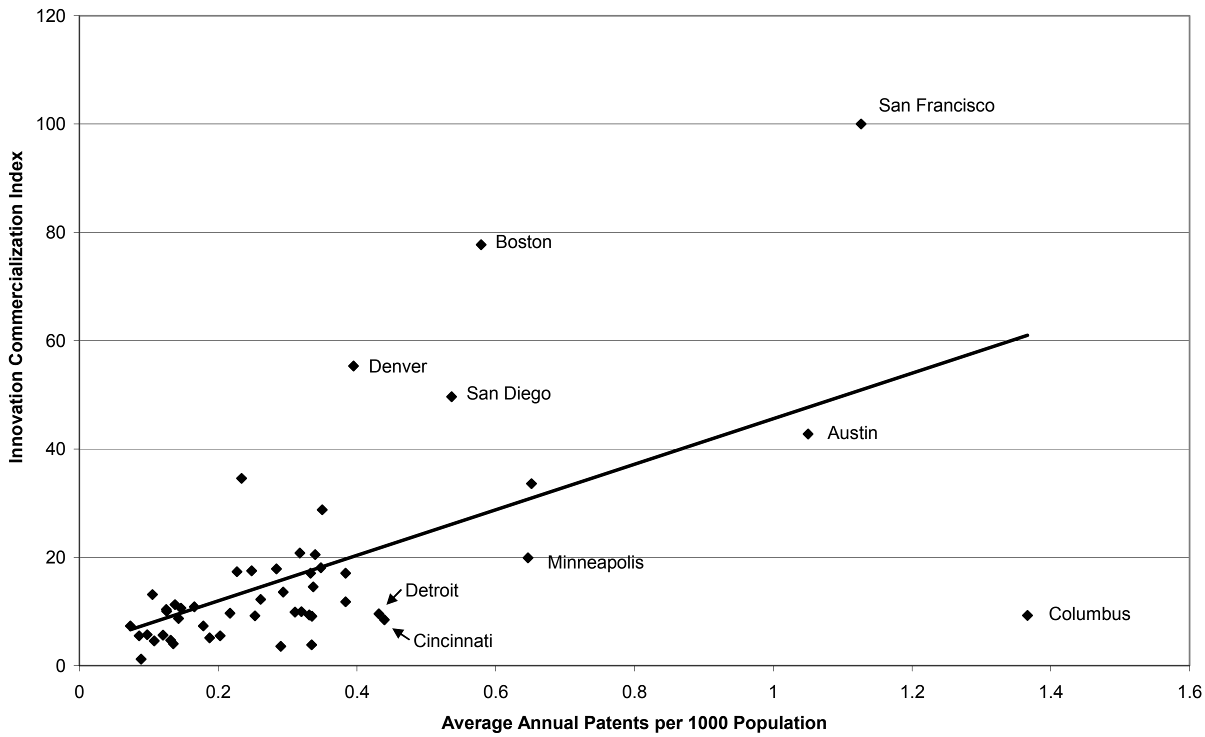

Table 4:
OLS Estimates of the Determinants of SBIR/STTR Grants

Independent Variable	Model 1		Model 2		Model 3		Model 4	
	Coeff	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	**4.014**	1.471	**6.697**	1.327	**6.514**	1.522	**7.461**	1.384
Population	**1.443**	0.192	**0.678**	0.221	0.491	0.331	0.343	0.298
S&E doctorates			**0.615**	0.126			**0.510**	0.140
Patents					**0.781**	0.231	0.381	0.233
Adj. R-Squared	0.54		0.69		0.62		0.70	

Note: Coefficients statistically significantly different from zero at the 95% confidence level or better are indicated in bold type.

Table 5:
OLS Estimates of the Determinants of Venture Capital Investments

Independent Variable	Model 1		Model 2		Model 3		Model 4	
	Coeff	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	**6.778**	1.743	**9.951**	1.596	**9.844**	1.840	**10.838**	1.668
Population	**1.615**	0.228	**0.682**	0.266	0.493	0.399	0.294	0.360
S&E doctorates			**0.765**	0.152			**0.643**	0.168
Patents					**0.901**	0.273	0.442	0.280
Adj. R-Squared	0.50		0.69		0.590		0.68	

Note: Coefficients statistically significantly different from zero at the 95% confidence level or better are indicated in bold type.

Table 6:
OLS Estimates of the Determinants of Initial Public Offerings

Independent Variable	Model 1 Coeff	Model 1 S.E.	Model 2 Coeff.	Model 2 S.E.	Model 3 Coeff.	Model 3 S.E.	Model 4 Coeff.	Model 4 S.E.
Constant	**-8.118**	1.070	**-7.002**	1.131	**-6.320**	1.140	**-6.138**	1.152
Population	**1.360**	0.140	**1.015**	0.189	**0.702**	0.247	**0.637**	0.248
S&E doctorates			**0.292**	0.108			0.173	0.116
Patents					**0.529**	0.169	**0.430**	0.194
Adj. R-Squared	0.66		0.70		0.71		0.72	

Note: Coefficients statistically significantly different from zero at the 95% confidence level or better are indicated in bold type.

Table 7:
Correlation of Unexplained Residuals of Innovation Commercialization Measures

	SBIR/STTR Grants	Venture Capital Investments	Initial Public Offerings
SBIR/STTR Grants	1		
Venture Capital Investments	0.4605	1	
Initial Public Offerings	0.2565	0.7769	1