

## Appendix to “Assessing the Contribution of Venture Capital to Innovation”

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### 1. *The Industry Data Set*

*Patent applications.* The patent data by industry are from Kortum [1992], updated using information on U.S. patent awards by technology class in a variety of databases prepared by the U.S. Patent and Trademark Office (USPTO). We compile from these databases the number of successful patents applied for by U.S. inventors in each year. Because of variations in the speed with which the USPTO handles patent applications (in particular, the periodic slow-downs associated with budget crises), it is preferable to compile the number of successful applications filed each year, rather than the awards granted annually. This information is not known until all patents filed in a given year are issued. Thus, while we can be confident about essentially how many successful patent applications were filed in 1980, the number of successful applications filed in 1995 is still quite uncertain.

Concerns about data incompleteness determined the last year of the analysis. While we can project from preliminary data (e.g., the number of patent applications filed in 1992 that were awarded through 1996) how many applications filed in each year will ultimately be granted, we do not wish to have to make large imputations. Consequently, we only extend the analysis through 1992.

In addition to defining the time frame of the analysis, we have to consider which patents to include in the analysis. USPTO databases compile not only awards to U.S. inventors, but also those to foreign firms and individuals seeking protection in the U.S. market. Because we seek a proxy for the innovative output of the United States, we drop patents that were not originally filed in the United States.

As discussed in the text, the USPTO does not compile total patent applicants by industry. Even though we know the names of the applicants, many of these firms have multiple lines-of-business. Thus, we rely instead on a concordance that relates the primary classification to which the patent is assigned to the most likely industry of the inventing firm. This concordance, based on a study of Canadian patenting behavior, employs the International Patent Classification to which the patent is assigned to determine the industry where it is likely to be used.

One challenge with both compilations of patent awards is the need to adjust the number of recent patent awards. While we exclude from the sample (as discussed above) patent applications from recent years, a few patents applied for in the early 1990s will not be awarded until the first decade of the 21<sup>st</sup> century. We adjust the observed counts of patent awards between 1987 and 1992 upward to reflect the number of patents that can be expected to be awarded based on historical patterns. The patent data are summarized in Table A-1.

*Venture capital disbursements.* The consulting firm Venture Economics compiles investments by venture capital funds (also known as disbursements). Venture capital organizations and major institutional investors provide quarterly reports to Venture Economics on their portfolio holdings, in exchange for summary data on investments and returns. These data have been collected since the formation of Venture Economics' predecessor entity, S.M. Rubel and Co., in 1961. While Venture Economics does not obtain reports on all funds, because multiple venture groups invest in a typical venture-backed firm, the database identifies at least 85% of all venture capital transactions [Gompers and Lerner, 1999].

We obtain Venture Economics tabulations that list total disbursements by the industry of the firm receiving the financing. The industry codes are classified according to a proprietary scheme developed by Venture Economics. We map these codes into our industry classification scheme, with the help of a concordance between the Venture Economics and the Standard Industrial Classification (SIC) codes.

One complex question is what constitutes a venture capital investment. Until the late 1970s, there were not distinct funds set up to make investments in leveraged buyout transactions. Rather, venture capital groups would invest into a wide variety of transactions: seed and early-stage financings, expansion rounds of rapidly-growing entrepreneurial firms, and buyouts and other special situations (e.g., purchases of blocks of publicly traded securities). Since the 1970s, most buyout investing by private equity funds has been done through specialized funds dedicated to these transactions (e.g., Kohlberg, Kravis, and Roberts). Some venture capital funds, however, have continued to invest in buyouts (this was a particularly common phenomenon in the mid-1980s) and other special situations. Meanwhile, some groups frequently classified as buyout specialists (such as Welch, Carson, Anderson, and Stowe) also make a considerable number of venture capital investments.

We wish to focus our analysis on the relationship between innovation and investments in growing firms where the types of information problems that venture capitalists address are most critical. While many buyouts create value by eliminating inefficiencies and improving cash flows, these types of transactions are outside the focus of this paper. The standard tabulation of venture capital investments prepared by Venture Economics includes investments by venture capital funds into both venture transactions and buyouts, as well as venture investments by groups classified as buyout funds. We undertake a special tabulation of the venture capital investments only, whether made by groups classified as venture capital or buyout funds. To insure compatibility with the other data series, we include only investments into firms based in the United States (whether the venture fund was based domestically or not). In order to test the robustness of our results, we also compile the seed and early-stage investments by these funds using a similar approach. We collect both the dollar amount invested and the number of companies funded in each year. The venture capital data are summarized in Table A-2.

*R&D expenditures.* We compile information on privately and federally funded R&D performed by industry from the U.S. National Science Foundation (NSF). Both data series have been compiled since 1957 as part of the "Survey of Research and Development in Industry," using an industry scheme based on two- and three-digit SIC codes. Occasionally, data series for smaller industries are suppressed in particular years. In these cases, it is necessary to extrapolate

based on the relative level of R&D spending in previous years.<sup>1</sup> We slightly collapse the NSF industry scheme to insure comparability with the patent classification discussed above, for a total of twenty industries. The R&D data are summarized in Tables A-3 and A-4.

*Gross industry product.* The Department of Commerce's Bureau of Economic Analysis has estimated gross product by industry for the two-digit SIC classes, as well as some important three-digit classes, using the current definitions of these industries. Not all three-digit SIC codes necessary for this analysis are compiled in their database. For the missing industries, we collect this information from the printed volumes of the *Annual Survey of Manufacturers* (ASM). While the ASM does not report gross product by industry, it does compile a related measure, value added. In each case, we examine the distribution of value added across the three-digit industry classes, and then assign the two-digit industry's gross product in a proportionate manner. Where necessary, we adjust the categories reported in these volumes to reflect today's classification structures. (For instance, prior to 1972, guided missiles were included in SIC 19, "ordnance and accessories." When that category was disbanded, they were moved to SIC 37, "transportation equipment").

## 2. *The Firms Data Set*

In order to assess the behavior of firms at a more disaggregated level, we examine firms whose headquarters are in a single county, Middlesex County, Massachusetts. We include in the sample all 130 manufacturing firms based here that were publicly traded between January 1990 and June 1994, as well as a random sample of 400 such firms that were privately held. By using a sample of firms in one region, rather than a diverse array of locations, we can examine their innovative activities in more depth.<sup>2</sup>

Middlesex County includes much of the "Route 128" high-technology complex, as well as concentrations of more traditional manufacturers. The first four columns of Table A-5 contrast the mix of industrial establishments and employment in the U.S. and Middlesex County in 1990. The comparison indicates that the mixture of traditional industry in the county is fairly representative of the nation as a whole. Technology-intensive sectors, however, are disproportionately represented.

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1. The NSF will not report data when one or two firms account for the majority of the R&D in an industry or when firms representing more than one-half the R&D spending do not respond to the survey. Ideally, we would also have compiled expenditures by universities relevant to each industry. Associating the classes of academic research with particular industries, however, proved problematic.

2. In particular, we can examine not only patent filings but also intellectual property litigation. In both the federal and state court systems, intellectual property cases are often not identified as such by the courts' internal tracking systems. They are often recorded simply as "miscellaneous tort" or "contract" disputes, depending upon the circumstances of the case. We do not use the firms' 10-K filings with the U.S. Securities and Exchange Commission to identify litigation for two reasons. First, we wish to include in our sample privately held firms, which need not make such filings. Second, while firms are required to report any material litigation in these filings, they are often highly selective in the suits that they actually disclose.

We include all firms in Compustat with headquarters in Middlesex County that file financial data with the U.S. Securities and Exchange Commission for any quarter between the first quarter of 1990 and the second quarter of 1994. Following the analysis above, we confine our analysis to manufacturing firms (Standard Industrial Codes 20-39), but also include firms in SIC codes 7372 and 7373, who make packaged software and operating systems for mainframe computers.<sup>3</sup> We exclude shell companies that are established merely to make an acquisition and "SWORDs," publicly traded subsidiaries that finance R&D. After these deletions, the sample consists of 130 firms.

Publicly traded firms are likely to have different characteristics than other companies. Thus, we seek to include a representative sample of private firms as well. There is no single directory that lists all the firms in the county. Conversations with economic development officials, however, indicate that two directories taken together provide quite comprehensive coverage of manufacturing firms. *George D. Hall's Directory of Massachusetts Manufacturers*, which is prepared with the cooperation of the Associated Industries of Massachusetts, provides the most detailed listing of traditional manufacturers, while the *Corporate Technology Directory* specializes in high-technology firms. We draw 200 firms based in Middlesex County each from these directories. In both cases, the information is collected via a survey (and, in the case of *Hall's*, through consultation with the records of the Associated Industries of Massachusetts). All firms were required to have been in business by the end of 1989, though some exit (e.g., through bankruptcy or liquidation) during the sample period.

The fifth and sixth columns of Table A-5 compare the firms in the sample with those in the nation and county. We classify the public firms in our sample into industries using the primary SIC provided by Compustat; for the other firms, we employ the SIC code of the first-listed line-of-business in the *Hall's* and *Corporate Technology* directories. (Both directories list lines-of-business in order of importance, as reported by the firm.)<sup>4</sup>

We obtain a variety of information about these firms. From Compustat or the two business directories, we determine the sales and employment in 1990, as well as the year in which the firm was founded. From CRSP, we determine if and when the firm went public. We determine whether the firm was venture-backed from Venture Economics. We also use the

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3. Our rationale is that while software manufacturers are classified as service providers, their relationship with customers is more akin to that of manufacturers. The analyses below are robust to the deletion of these observations.

4. The comparison of the sample with the federal and county data is not precise for three reasons. First, the tabulation of the sample firms shows the distribution of firms; the U.S. and county columns present the pattern of establishments. (Many firms will have multiple establishments.) Second, firms with less than twenty employees are only sampled in *County Business Patterns*, and thus are underrepresented. The two directories appear to have quite comprehensive coverage of smaller firms, who generally welcome the visibility that a listing provides. Consequently, industries with many small firms may have greater representation in the sample. Finally, the tabulation of employment in the sample firms includes employees that work in Middlesex County and elsewhere. The county tabulation presents the distribution of employees working in Middlesex County, regardless of where the parent firm has its headquarters.

number of patents that the firm has been awarded in the period 1969 through 1994 (as well as citations to these awards), which we identify using Mead's LEXIS/PATENT/ALL file and the USPTO's CASSIS CD-ROM database. (We include awards to subsidiaries, R&D limited partnerships, and earlier names, which we identify through the data sources cited below.)

We finally identify all litigation involving these firms in the federal and state judicial districts that include their headquarters: the Federal District for Massachusetts and the Commonwealth of Massachusetts' Middlesex Superior Court. Both systems include every lawsuit that was open during the sample period, even if the suit was settled almost immediately after the initial complaint was filed. We identify 1144 cases that were open on January 1, 1990 or were filed between January 1, 1990 and June 30, 1994. After eliminating those cases that are very unlikely to involve intellectual property issues, we examined the remaining case files.<sup>5</sup> The docket records also allow us to compute the total number of docket filings by the plaintiffs, defendants, and other parties in the dispute between January 1, 1990 and June 30, 1994. (This approach to characterizing disputes was also used in the Georgetown antitrust study [White, 1988].) The records do not provide information on the extent of activity at the appellate level. Thus, they may tend to understate the magnitude of litigation in cases that are appealed.

Table A-6 characterizes the venture-backed and non-venture-backed firms in the sample. The 122 venture-backed firms are significantly larger in sales and employment than the 408 non-venture-backed firms, and are more likely to be publicly traded. They tend to have been founded later, and (as a result) have accumulated a smaller stock of patents. The venture-backed firms are concentrated in high-technology industries. The average ratio of R&D-to-sales of all public firms that reported R&D data in 1990 with a primary assignment in Compustat to the same four-digit SIC code as the venture-backed firms is higher than the ratios of the companies matched to the non-venture-backed firms.

Table A-7 presents the supplemental regressions discussed in section 3.D of the paper.

### 3. *Data Sources*

#### *Patent Applications:*

Case-Western Reserve University, Center for Regional Economic Issues, 1997, Unpublished patent database (Cleveland).

Kortum, S., 1992, *Inventions, R&D, and industry growth*, Unpublished Ph.D. dissertation, Yale University.

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5. In addition, we could not examine nine dockets that may or may not have involved intellectual property issues. These cases had been either lost or sealed. (While most of the case files were accessible at the clerk of the court's offices at the two courthouses, we found many case files in off-site storage archives, in courthouses elsewhere in the county or state, or in the possession of judges' docket clerks.)

U.S. Patent and Trademark Office, Office of Electronic Information Products, Technology Assessment and Forecast Program, 1996, Unpublished tabulation of patenting trends in the United States (Washington).

U.S. Patent and Trademark Office, Office of Electronic Information Products, Technology Assessment and Forecast Program, 1997, All technologies report, [http://www.uspto.gov/web/offices/ac/ido/oeip/taf/all\\_tech.pdf](http://www.uspto.gov/web/offices/ac/ido/oeip/taf/all_tech.pdf)

*Venture Capital Disbursements:*

Securities Data Company, Venture Economics, Inc., 1997, Venture intelligence database (Boston).

*R&D Expenditures:*

U.S. National Science Foundation, Division of Science Resource Studies, 1980, *Research and development in industry—1979* (U.S. Government Printing Office, Washington).

U.S. National Science Foundation, Division of Science Resource Studies, 1997, Survey of research and development in industry, <http://www.nsf.gov/sbe/srs/sird/start.htm>.

*Gross Industry Product:*

Friedenberg, H.L., and R.M. Beemiller, 1997, Comprehensive revision of gross state product by industry, 1977-94, *Survey of Current Business* 77 (June) 15-41.

U.S. Department of Commerce, Bureau of the Census, 1996 and earlier years, *Annual survey of manufacturers* (U.S. Government Printing Office, Washington).

U.S. Department of Commerce, Bureau of Economic Analysis, 1997, Unpublished data file: Gross state product by industry—Original experimental estimates, 1963-1986, (Washington).

Yuskavage, R.E., 1996, Improved estimates of gross product by industry, 1959-94, *Survey of Current Business* 76 (August) 133-155.

*Identifying Sample of Middlesex County Firms:*

Corporate Technology Information Services, 1994 and earlier, *Corporate technology directory* (Corporate Technology Information Services, Woburn, Mass.).

G.D. Hall Company, 1995 and earlier, *George D. Hall's directory of Massachusetts manufacturers* (G.D. Hall Company, Boston).

Standard and Poors' Compustat Services, 1997, Compustat database (New York).

*Supplemental Data on Middlesex County Firms:*

Commerce Register, 1995 and earlier, *Massachusetts directory of manufacturers* (Commerce Register, Hokokus, NJ).

Dun's Marketing Services, 1995 and earlier, *Million dollar directory* (Dun's Marketing Services, Parsippany, NJ).

Files of the Commonwealth of Massachusetts' Middlesex Superior Court (Cambridge) and the Federal District for Massachusetts.

Gale Research, 1995 and earlier, *Ward's business directory of U.S. private and public companies* (Gale Research, Detroit).

Mead Data Central, LEXIS/NEXIS, Inc., 1994, PATENTS/ALL database (Dayton).

Moody's Investor Service, 1995 and earlier, *Moody's OTC industrial manual* (Moody's Investor Service, New York).

National Register Publishing Company, 1995 and earlier, *Directory of leading private companies, including corporate affiliations* (National Register Publishing Company, Wilmette, Illinois).

Predicasts, Inc., 1995 and earlier, *Predicasts F&S index of corporate change* (Predicasts, Inc., Cleveland).

Securities Data Company, Venture Economics, Inc., 1997, Venture intelligence database (Boston).

U.S. Department of Commerce, Bureau of the Census, 1991, *Country business patterns, 1990* (U.S. Government Printing Office, Washington).

U.S. Patent and Trademark Office, Office of Electronic Information Products, 1995, Cassis patents BIB CD-ROM database (Washington).

**Table A-1**

**Patenting activity of U.S. manufacturing industries, by industry and five-year period.** Patent applications refer to the number of ultimately successful patent applications filed in each year. Industries marked with a \* had an R&D-to-sales ratio above the median in 1964. These industries define a “High R&D” sub sample used for some of the later regressions.

#	Industry	SIC Codes	1965-69	1970-74	1975-79	1980-84	1985-89	1990-92
1	Food and kindred	20	1,790	1,957	1,365	1,201	1,555	1,138
2	Textile and apparel	22,23	3,246	3,004	2,639	2,339	3,787	2,923
3	Lumber and furniture	24,25	3,028	3,052	2,877	2,160	3,149	2,539
4	Paper	26	2,738	2,312	1,924	1,626	2,493	1,859
5	Industrial chemicals*	281,282,286	22,124	22,353	18,507	15,612	15,882	11,673
6	Drugs*	283	2,099	2,873	3,561	4,399	8,262	6,281
7	Other chemicals	284,285,287-289	14,559	14,403	11,760	10,461	11,283	8,405
8	Petroleum refining and extraction*	13,29	892	794	850	827	744	450
9	Rubber products	30	8,504	8,169	6,726	5,823	9,028	6,641
10	Stone, clay and glass products	32	2,677	2,671	2,366	2,062	2,790	2,147
11	Primary metals	33	2,245	2,183	1,689	1,340	1,710	1,156
12	Fabricated metal products	34	19,805	19,484	18,479	14,894	18,359	13,211
13	Office and computing machines*	357	5,487	5,752	4,931	4,922	6,638	5,905
14	Other non-electrical machinery*	351-356,358-359	60,790	61,139	52,426	42,634	48,135	35,534
15	Communication and electronic*	366,367	30,838	28,380	24,679	24,302	30,417	25,793
16	Other electrical equipment*	361-365,369	23,768	22,403	19,213	16,995	19,736	14,197
17	Transportation equipment*	371,373-375,379	10,829	12,119	9,715	7,096	8,579	6,610
18	Aircraft and missiles*	372,376	1,634	1,434	1,200	905	1,113	835
19	Professional and scientific instruments*	38	18,690	19,244	17,287	15,683	21,026	17,235
20	Other manufacturing	21,27,31,39	13,769	15,050	15,054	12,237	16,582	13,521
	Total		249,512	248,775	217,247	187,518	231,268	178,053

Table A-2

**Number and dollar amount of venture capital disbursements for U.S. manufacturing industries, by industry and five-year period.** The count of venture capital investments in each five-year period is the sum of the number of firms receiving investments. All dollar figures are in millions of 1992 dollars.

<b>Panel A: Venture Capital Investments (#s)</b>							
#	<i>Industry</i>	1965-69	1970-74	1975-79	1980-84	1985-89	1990-92
1	Food and kindred	1	9	6	23	80	41
2	Textile and apparel	4	12	9	19	27	33
3	Lumber and furniture	2	8	6	24	62	16
4	Paper	2	2	2	2	12	4
5	Industrial chemicals	1	1	1	6	18	10
6	Drugs	1	12	34	245	554	337
7	Other chemicals	1	7	8	10	52	25
8	Petroleum refining and extraction	3	3	26	92	27	8
9	Rubber products	1	5	6	19	11	3
10	Stone, clay and glass products	0	1	3	14	48	23
11	Primary metals	0	3	5	20	44	15
12	Fabricated metal products	0	0	0	2	1	1
13	Office and computing machines	39	84	108	744	641	205
14	Other non-electrical machinery	12	12	32	254	280	98
15	Communication and electronic	23	65	60	497	736	298
16	Other electrical equipment	0	6	16	36	52	28
17	Transportation equipment	1	7	5	6	24	10
18	Aircraft and missiles	0	0	0	12	20	2
19	Professional and scientific instruments	13	37	70	383	549	252
20	Other manufacturing	7	14	16	62	89	39
	Total	111	288	413	2,470	3,327	1,448
<b>Panel B: Venture Capital Disbursements (millions of 1992 \$s)</b>							
#	<i>Industry</i>	1965-69	1970-74	1975-79	1980-84	1985-89	1990-92
1	Food and kindred	4	19	7	25	212	128
2	Textile and apparel	6	15	14	27	45	83
3	Lumber and furniture	4	17	9	26	200	30
4	Paper	1	8	3	3	22	1
5	Industrial chemicals	0	1	1	41	34	16
6	Drugs	0	15	136	623	1,869	1,317
7	Other chemicals	1	40	4	9	155	27
8	Petroleum refining and extraction	12	6	92	359	110	12
9	Rubber products	1	3	15	28	8	8
10	Stone, clay and glass products	0	1	5	34	99	40
11	Primary metals	0	8	11	25	67	19
12	Fabricated metal products	0	0	0	1	0	1
13	Office and computing machines	67	404	288	3,253	2,491	613
14	Other non-electrical machinery	64	17	37	677	669	140
15	Communication and electronic	44	189	82	1,746	2,646	1,042
16	Other electrical equipment	0	8	53	78	107	41
17	Transportation equipment	0	10	4	9	47	42
18	Aircraft and missiles	0	0	0	19	19	7
19	Professional and scientific instruments	13	86	114	811	1,449	606
20	Other manufacturing	7	28	22	113	176	102
	Total	\$225	\$874	\$895	\$7,907	\$10,423	\$4,273

**Table A-3**

**R&D expenditures by U.S. manufacturing industries, by industry and five-year period.** All figures are in millions of 1992 dollars.

#	Industry	1965-69	1970-74	1975-79	1980-84	1985-89	1990-92
1	Food and kindred	3,271	3,741	4,333	5,643	7,231	4,032
2	Textile and apparel	962	909	869	1,002	1,376	781
3	Lumber and furniture	269	945	1,204	1,111	936	670
4	Paper	2,419	2,871	3,554	4,019	3,980	3,520
5	Industrial chemicals	14,780	13,582	14,376	18,587	22,023	15,518
6	Drugs	6,384	9,033	12,365	17,870	25,730	21,395
7	Other chemicals	3,191	4,105	4,504	6,776	10,826	7,086
8	Petroleum refining and extraction	7,135	7,423	8,784	13,657	12,207	7,270
9	Rubber products	3,089	3,738	3,559	4,330	4,054	3,572
10	Stone, clay and glass products	2,430	2,535	2,734	3,625	4,898	1,521
11	Primary metals	4,293	4,231	5,070	4,916	4,222	2,006
12	Fabricated metal products	2,812	3,664	3,578	4,343	4,390	2,278
13	Office and computing machines	10,802	17,045	23,398	35,485	53,779	33,061
14	Other non-electrical machinery	8,455	10,226	12,543	15,849	14,596	9,445
15	Communication and electronic	16,902	20,262	22,106	37,661	50,187	20,711
16	Other electrical equipment	12,483	13,903	13,764	13,597	8,560	7,722
17	Transportation equipment	19,713	25,133	30,340	34,324	46,152	28,489
18	Aircraft and missiles	19,104	16,631	17,043	27,177	34,692	18,113
19	Professional and scientific instruments	6,958	10,259	14,748	24,186	30,321	21,101
20	Other manufacturing	1,580	2,094	2,417	3,094	2,342	1,763
	Total	\$147,032	\$172,328	\$201,288	\$277,251	\$342,501	\$210,055

Table A-4

**Ratio of venture capital disbursements to R&D expenditures for U.S. manufacturing industries, by industry and five-year period.** All dollar figures are in millions of 1992 dollars. The ratios of venture capital disbursements to R&D expenditures are computed using all venture capital disbursements and early-stage venture disbursements only.

		<b>Panel A: All Venture Capital Disbursements/R&amp;D Spending</b>					
#	<i>Industry</i>	1965-69	1970-74	1975-79	1980-84	1985-89	1990-92
1	Food and kindred	0.14%	0.50%	0.16%	0.44%	2.93%	3.18%
2	Textile and apparel	0.57%	1.68%	1.59%	2.72%	3.24%	10.59%
3	Lumber and furniture	1.44%	1.77%	0.72%	2.32%	21.39%	4.40%
4	Paper	0.06%	0.28%	0.10%	0.08%	0.56%	0.03%
5	Industrial chemicals	0.00%	0.00%	0.01%	0.22%	0.15%	0.10%
6	Drugs	0.01%	0.17%	1.10%	3.49%	7.26%	6.16%
7	Other chemicals	0.03%	0.98%	0.09%	0.13%	1.43%	0.38%
8	Petroleum refining and extraction	0.16%	0.08%	1.04%	2.63%	0.90%	0.17%
9	Rubber products	0.04%	0.07%	0.42%	0.64%	0.20%	0.21%
10	Stone, clay and glass products	0.00%	0.02%	0.19%	0.93%	2.01%	2.62%
11	Primary metals	0.00%	0.19%	0.21%	0.51%	1.59%	0.94%
12	Fabricated metal products	0.00%	0.00%	0.00%	0.03%	0.01%	0.03%
13	Office and computing machines	0.62%	2.37%	1.23%	9.17%	4.63%	1.85%
14	Other non-electrical machinery	0.75%	0.16%	0.30%	4.27%	4.58%	1.48%
15	Communication and electronic	0.26%	0.93%	0.37%	4.64%	5.27%	5.03%
16	Other electrical equipment	0.00%	0.06%	0.38%	0.57%	1.25%	0.53%
17	Transportation equipment	0.00%	0.04%	0.01%	0.03%	0.10%	0.15%
18	Aircraft and missiles	0.00%	0.00%	0.00%	0.07%	0.05%	0.04%
19	Professional and scientific instruments	0.19%	0.84%	0.77%	3.35%	4.78%	2.87%
20	Other manufacturing	0.46%	1.34%	0.90%	3.65%	7.51%	5.81%
		<b>Panel B: Early-Stage Venture Capital Disbursements/R&amp;D Spending</b>					
#	<i>Industry</i>	1965-69	1970-74	1975-79	1980-84	1985-89	1990-92
1	Food and kindred	0.14%	0.22%	0.05%	0.14%	1.69%	2.17%
2	Textile and apparel	0.36%	0.90%	0.79%	0.67%	1.46%	3.05%
3	Lumber and furniture	0.00%	0.74%	0.51%	1.19%	11.23%	2.07%
4	Paper	0.00%	0.28%	0.00%	0.08%	0.21%	0.01%
5	Industrial chemicals	0.00%	0.00%	0.00%	0.21%	0.04%	0.07%
6	Drugs	0.01%	0.14%	0.92%	2.53%	4.40%	3.39%
7	Other chemicals	0.00%	0.62%	0.03%	0.10%	0.55%	0.21%
8	Petroleum refining and extraction	0.13%	0.08%	0.56%	1.40%	0.59%	0.11%
9	Rubber products	0.00%	0.05%	0.32%	0.41%	0.17%	0.00%
10	Stone, clay and glass products	0.00%	0.02%	0.00%	0.50%	1.37%	1.46%
11	Primary metals	0.00%	0.15%	0.12%	0.46%	1.35%	0.17%
12	Fabricated metal products	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
13	Office and computing machines	0.55%	1.32%	0.73%	4.21%	1.74%	0.87%
14	Other non-electrical machinery	0.68%	0.08%	0.12%	2.08%	2.11%	0.49%
15	Communication and electronic	0.19%	0.46%	0.16%	2.68%	2.69%	1.97%
16	Other electrical equipment	0.00%	0.04%	0.20%	0.33%	0.69%	0.27%
17	Transportation equipment	0.00%	0.03%	0.00%	0.00%	0.04%	0.01%
18	Aircraft and missiles	0.00%	0.00%	0.00%	0.02%	0.01%	0.04%
19	Professional and scientific instruments	0.10%	0.65%	0.26%	1.95%	2.86%	1.39%
20	Other manufacturing	0.31%	1.12%	0.36%	2.34%	3.54%	1.84%

**Table A-5**

**The distribution of firms in the analysis of venture-backed and non-venture-backed firms.** We compare the number of firms and employees across manufacturing industries (two-digit Standard Industrial Code classes). We compare all firms in the United States, all those in Middlesex County, Massachusetts, and the 530 in the sample. The U.S. and Middlesex County figures are based on U.S. Department of Commerce [1991]. These present the number of establishments (one firm may have multiple establishments). Not all firms with fewer than twenty employees are included. The county figures are only for those employees actually working in the county. The sample columns present the number of firms, and include all employees of these firms, whether or not they work in Middlesex County.

<i>SIC Class</i>	<u>United States</u>		<u>Middlesex County</u>		<u>Sample</u>	
	<i>Percent of Establishments</i>	<i>Percent of Employees</i>	<i>Percent of Establishments</i>	<i>Percent of Employees</i>	<i>Percent of Firms</i>	<i>Percent of Employees</i>
20: Food & kindred products	5.5%	8.0%	3.7%	4.3%	2.6%	8.3%
21: Tobacco products	0.0	0.2	0.0	0.0	0.0	0.0
22: Textile mill products	1.7	3.6	1.1	1.7	0.6	0.1
23: Apparel & other textiles	6.4	5.7	2.9	1.6	1.5	0.3
24: Lumber & wood products	9.3	3.9	2.2	0.7	1.3	0.1
25: Furniture & fixtures	3.2	2.8	1.7	0.5	0.8	0.0
26: Paper & allied products	1.7	3.5	1.9	3.7	0.6	0.1
27: Printing & publishing	16.8	8.6	17.7	9.4	3.2	2.8
28: Chemicals & allied products	3.3	4.8	3.8	3.3	9.1	3.2
29: Petroleum & coal products	0.6	0.6	0.5	0.1	0.2	0.0
30: Rubber & misc. plastics	4.1	4.9	3.5	3.5	2.5	0.7
31: Leather & leather products	0.5	0.7	0.4	0.1	0.2	2.7
32: Stone, clay & glass	4.3	2.9	2.1	1.0	0.8	0.1
33: Primary metal industries	1.8	4.0	1.0	1.4	1.3	0.5
34: Fabricated metal products	10.1	8.2	9.3	4.8	5.1	1.3
35: Industrial machinery	13.8	10.6	14.8	14.5	19.1	24.8
36: Electronic equipment	4.6	8.6	11.1	16.8	14.7	12.3
37: Transportation equipment	2.9	9.9	1.4	5.1	0.8	0.3
38: Instruments	2.7	5.3	9.7	19.4	16.4	24.9
39: Miscellaneous	4.8	2.2	4.3	1.8	2.3	1.9
7372 & 7373: Software	1.9	0.9	7.0	6.4	17.2	15.4

**Table A-6**

**Characteristics of venture-backed and non-venture-backed firms.** The sample consists of 530 firms based in Middlesex County, Massachusetts. The tabulation presents the summary statistics for the 122 firms that had received venture capital financing prior to January 1990, and the 408 that did not. The “Publicly Traded at End of 1989?” variable is a dummy that takes on the value 1.0 if the firm was publicly traded. The final item in each panel is the average ratio of R&D-to-sales of all publicly traded firms that reported R&D data in 1990 with a primary assignment in Compustat to the same four-digit SIC code as the firm.

<b>Panel A: 122 Venture-Backed Firms</b>					
	<i>Mean</i>	<i>Median</i>	<i>Stan. Dev.</i>	<i>Minimum</i>	<i>Maximum</i>
Firm Sales in 1990 (\$ millions)	173	11	1199	0	12942
Firm Employment in 1990	526	106	2103	8	20184
Year Firm was Founded	1977	1981	15	1880	1989
Publicly Traded at End of 1989?	0.30			0	1
Patent Awards, 1969-1989	10	0	41	0	375
R&D/Sales Ratio of Industry in 1990	0.11	0.10	0.08	0.00	0.38
<b>Panel B: 408 Non-Venture-Backed Firms</b>					
	<i>Mean</i>	<i>Median</i>	<i>Stan. Dev.</i>	<i>Minimum</i>	<i>Maximum</i>
Firm Sales in 1990 (\$ millions)	44	2	477	0	9268
Firm Employment in 1990	184	19	940	2	11768
Year Firm was Founded	1967	1974	25	1842	1989
Publicly Traded at End of 1989?	0.11			0	1
Patent Awards, 1969-1989	13	0	149	0	2644
R&D/Sales Ratio of Industry in 1990	0.06	0.04	0.06	0.00	0.38

**Table A-7**

**Ordinary least squares regression analysis of the patent production function.** The regression specification is the same as in the first two columns of Table 3 in the text. In the first two columns we employ the amount of seed and early-stage venture financings rather than the total amount of venture financings. In the last two columns, we employ annual observations only of those ten industries with a R&D-to-sales ratio above the median in 1964 (these industries appear with a \* in Table A-1). Standard errors (in brackets) are based on the Newey-West autocorrelation-consistent covariance estimator (with a maximum of three lags). In all regressions, the standard errors for the parameter b are calculated using the delta method. Year and industry dummy variables are included in each regression.

	<i>Using Early-Stage Financing</i>		<i>Using High R&amp;D Industries Only</i>	
Privately funded industrial R&D ( $\alpha$ )	0.24 [0.06]	0.24 [0.06]	0.38 [0.09]	0.37 [0.09]
Venture capital / Privately funded R&D ( $\alpha b$ ):				
Firms receiving funding	3.74 [1.30]		6.98 [1.68]	
Venture disbursements		2.50 [1.09]		5.14 [1.59]
Federally funded industrial R&D	0.02 [0.01]	0.01 [0.01]	-0.07 [0.04]	-0.07 [0.04]
R <sup>2</sup>	0.99	0.99	0.99	0.99
R <sup>2</sup> relative to dummy variable only case	0.21	0.19	0.45	0.43
Number of observations	560	560	280	280
Implied potency of venture funding ( $b$ )	15.44 [5.35]	10.50 [4.74]	18.22 [5.95]	13.76 [5.69]