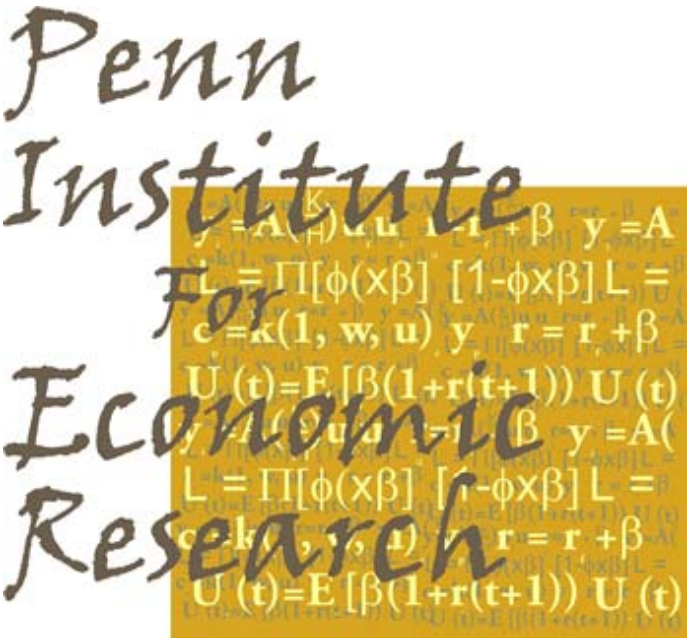

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"Venture Capital Meets Industrial Sector and Location"

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Venture Capital Meets Industrial Sector and Location

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Abstract

This paper examines venture capital investment activity in the United States during the period 1995 to the first quarter 2009, taking into consideration both location and industry sector. The research question is whether industry and region are important factors in determining venture capital investment. Furthermore, the paper explores the effects of macroeconomic variables on investment activity. Consequently, the venture capital data are augmented by Gross Domestic Product (GDP), Federal Funds Rate, three, five and ten year interest rates. By examining long term trends, the effect of the current economic crisis on venture capital investment may be better understood.

JEL Classification: C12, D81, D92, E22, G12, G24, G3, M13, M21, O16, O3

Key Words: Venture Capital; Economic Geography; Location; Biotechnology; Business Products and Services; Computers and Peripherals; Consumer Products and Services; Electronics and Instrumentation; Financial Services; Healthcare Services; Industrial and Energy; Information Technology Services; Media and Entertainment; Medical Devices and Equipment; Networking and Equipment; Retailing and Distribution; Semiconductors; Software; Telecommunications.

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The second author dedicates this paper to the memory of his parents.

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Venture Capital Meets Industrial Sector and Location

I. Introduction

This paper examines venture capital investment activity in the United States (U.S.) during the period 1995 to the first quarter 2009, taking into consideration both location and industry sector. The research question is whether industry and region are important factors in determining venture capital investment. Furthermore, the paper explores the effects of macroeconomic variables on investment activity. Consequently, the venture capital data are augmented by Gross Domestic Product (GDP), Federal Funds Rate, three, five and ten year interest rates. By examining long term trends, the effect of the current economic crisis on venture capital investment may be better understood.

Motivated in part by the current recession, it is worthwhile to examine the venture capital market, which heavily relies on expectations of future GDP. Recently, economic geography has risen to the frontier of research due to the works of the 2008 Nobel laureate, Paul Krugman, who was awarded the Prize for his "analysis of trade patterns and location of economic activity." Although economic geography is a focus of both international economists and industrial organization researchers, it has received limited consideration in venture capital literature.

The unique data on venture capital investment activity in the United States, spanning from 1995 until 2009, quarter I (2009Q1), are from The MoneyTree Survey. The survey is a quarterly study of venture capital investment activity in the United States and is considered to be a credible source of information on emerging companies that receive financing from venture capital firms. The database allows for stratifications of the data by seventeen industries and nineteen regions. The statistical analysis confirms that, in addition to the effects of Gross Domestic Product and interest rates, both regions and industry sectors are significant factors in explaining investment in the venture capital market of the U.S. economy.

The remainder of the paper is organized as follows. Section II presents a brief review of the literature. Section III presents the data. Section IV derives the empirical results, and Section V concludes.

II. Literature Review

The reemergence of economic geography theory can be attributed to the pioneering works of Krugman (1991a, 1991b, 1998), Fujita and Krugman (2004), and Venables (1996, 1998, 2003). Krugman (1991a) examines the uneven economic development of regions, emphasizing the importance of economic geography in explaining divergent regional development. Krugman (1991b) develops a simple model in which a country can endogenously become differentiated into an industrialized "core" surrounded by an agricultural "periphery." Krugman (1998) discusses the emergence of a new area of

research, labeled as the 'new economic geography'. It differs from traditional work in economic geography by incorporating a modeling strategy that uses the same rigorous technical and mathematical tools. Furthermore, these models utilize recent developments in industrial organization that explicitly consider the notion of economies of scale, found in the 'new trade' and 'new growth' theories.

The study of industrial location is fundamental to understanding the field of economic geography. Behrens (2005) investigates the importance of market size as a determinant for industrial location patterns. Midelfart, Overman, and Venables (2000) estimate a model of industrial locations across countries. The model combines factor endowments and geographical considerations, showing how industry and country characteristics interact to determine the location of production. Furthermore, transport costs are shown to have an impact on industrial locations by Alonso-Villar (2005). He studies the location decisions of upstream and downstream industries when transport costs in each sector are analyzed separately. He concludes that the effects of cost reductions in transporting final goods are different from those in intermediate goods.

In addition to geographical location, another important consideration is industry choice. In the context of venture capital literature, the pioneering study, based on one hundred start-up firms, is Murphy (1956). The importance of industry choice in achieving start up success has also been studied by others. Shachmurove A. and Shachmurove Y. (2004) explore annualized and cumulative returns on venture-backed public companies categorized by industry. Annual and cumulative returns of publicly traded firms who were backed by venture capital are studied in series of papers by Shachmurove, Y. (2001), and Shachmurove, A. and Shachmurove, Y (2004). Shachmurove, Y. (2006) examines venture capital investment activity in the United States for the years 1996 – 2005. Shachmurove (2007) relates issues in international trade to entrepreneurship, innovation, and the growth mechanism of the free-market economies.

III. Data

The data on venture capital investment activity in the United States are from The MoneyTree Survey. The survey is a quarterly study of venture capital investment activity in the United States (U.S.) which measures cash for equity investments by the professional venture capital community in private emerging U.S. companies. The survey is a collaboration among PricewaterhouseCoopers, Thomson Venture Economics and the National Venture Capital Association, and is the only source endorsed by the venture capital industry. Table 1 displays the annual data for U.S. venture capital investment activity from 1995 to 2009, Quarter 1. Figures 1 and 2 present the data graphically. The figures clearly show that the year 2000 has the highest values for all the measures presented in Table 1. Note that since 2003, investment has exhibited steady growth, until the recent recession in 2008.

Table 2 presents summary statistics of the data. There are 10,723 quarterly observations of venture capital investment, with a mean per investment deal of about 39 million dollars and a standard deviation of approximately 104 million dollars. In addition to the venture capital data, the following macroeconomic variables are included in the study: Gross Domestic Product (GDP), federal fund rate, 3, 5 and 10-year interest rates (IR3, IR5, and IR10, respectively). The federal funds rate is the interest rate at which depository institutions lend to each other at the Federal Reserve overnight. The 3, 5, and 10 year interest rates represent U.S. treasury bonds of the same relative lengths. Table 3 presents the number of deals for each of the nineteen regions and the seventeen industries in terms of both frequency and proportion of total deals. Silicon Valley has the highest venture capital investment with a frequency of deals more than two times higher than any other region. Also note that the software sector accounts for the greatest proportion of deals of any industry, representing an impressive 27 percent of all deals in the venture capital market.

Figure 3 presents the data for total investment in venture capital by regions for 1995 – 2009Q1. The most interesting feature of the figure is that throughout the period, regions with historically large venture-capital investment have not changed their ranking with respect to the amount of venture capital investment. Regions that received a large proportion of investment in 1995 continue to receive a relatively higher proportion of total venture capital investment. This feature of the data supports the importance of history and increasing returns emphasized by the international trade and industrial organization literature discussed in the literature review section. Generally, only regions that were not exposed to major investment in venture capital changed ranking over the period.

The effect of the current recession on venture capital investment has been dramatic. The year 2008 was the first year in which investment decreased since 2003, which represents a marked deviation from trend. Investment in dollar terms fell dramatically by 47 percent and the number of deals decreased by 37 percent in the fourth quarter of 2008, resulting in the smallest quarterly venture capital investment activity since 1997. In the first quarter of 2009, only three billion dollars were invested in 549 deals throughout the U.S. The financial crisis negatively impacted investment in all regions and all industries. Although there are significant variations across industry and region during the current economic crisis, geography and industry remain important determinants of venture capital investment.

IV. Empirical Results

Table 4 presents the Pearson Correlation Coefficients and their corresponding significant values for the variables used in the study. Investment and number of venture capital deals are highly correlated, with a correlation coefficient of 0.86. Every measure of GDP is strongly negatively associated with all interest rates. The very short run overnight federal funds rate is more correlated with IR3 than IR5 and IR10 (0.92, 0.87, and 0.77, respectively). The correlation between IR3 and IR5 is high (0.99). The

correlation coefficients between capital venture investment and each interest rate measure decreases as the length of the interest rate term increases.

Table 5 presents the regression results for the natural log of venture capital investment as a function of the quarter of the transaction, number of deals, the sixteen dummy variables for the different industries, measured relative to the biotech industry, and the eighteen dummies for the different regions, measured relative to the Alaska/Hawaii/Puerto Rico region. The estimated equation includes GDP and the four measures of interest rates: the overnight federal funds rate, and the three, five, and ten year interest rates.

As shown in Table 5, the Adjusted R^2 is equal to 0.43. As expected, a rise in the number of deals increases the amount of capital invested. Except for the telecommunication sector, all other industries are highly statistically significant. Furthermore, all regional coefficients are statistically significant except for the Unknown region.

As displayed in Table 5, with all other variables held constant, an increase in GDP raises the amount of investment in venture capital. Interestingly, the effects of the interest rates are all statistically significant. While one expects all these coefficients to be negative, both the overnight interest rate and the 5-year interest rate are positively affecting the amount of venture capital investment. However, the coefficient on the overnight interest rate is relatively small, which indicates that it only marginally affects the venture capital investment. The coefficient for the 5-year interest rate is positive and has a larger impact on venture investment. However, if one adds the coefficients for three, five and ten annual interest rates, one gets, as expected, a statistically significant negative coefficient of -0.125. To conclude, Table 5 confirms the importance of both location and industry in affecting venture capital investment in addition to the macroeconomics variables.

V. Conclusion

This paper investigates investment activity of venture capital in the United States for the years 1995 through 2009Q1, stratified by both locations and industries. The statistical results confirm the importance of both regions and industries in explaining the investment in venture capital. Even when faced with the multitude of effects caused by the current recession, industry and region are still a dominate factor in determining venture capital investment activity. A future study may illuminate the factors which determine relocation of venture capital outside of the U.S. due to potential trends of avoiding the consequences of pending onerous new regulations and taxes.

Table 1: U.S. Venture Capital Investment and Number of Deals by Year 1995-2008

Company Disbursement Year	Number of Deals	Avg. per Deal (USD Mil)	Sum Investment (USD Mil)

1995	1837	4.19	7691
1996	2469	4.36	10762.3
1997	3080	4.74	14591.99
1998	3550	5.84	20718.89
1999	5396	9.91	53487.98
2000	7812	13.36	104379.88
2001	4451	9.11	40537.78
2002	3053	7.11	21692.68
2003	2876	6.82	19613.81
2004	2991	7.28	21768.86
2005	3027	7.35	22261.59
2006	3616	7.32	26485
2007	3967	7.77	30841
2008	3984	7.09	28227

Table 2: Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
Date	10723	28.91644	16.1347	310071	1	57
Investment	10723	39,458,420	9.6E+07	4.23E+11	0	2,641,099,200
Number of Deals	10723	4.989	8.8066	53497	1	207
Real GDP	10723	10015	1110	1.07E+08	7974	11727
Nominal GDP	10723	10643	2145	1.14E+08	7298	14413
GDP Deflator	10723	105.23422	9.7193	1128427	91.53	124.113
Federal Fund Rate	10723	4.03199	1.84038	43235	0.23333	6.52
IR3	10723	4.46074	1.51637	47832	1.27	7.26667
IR5	10723	4.72967	1.2852	50716	1.76333	7.39333
IR10	10723	5.09344	0.99879	54617	2.73667	7.48333

Table 3: Number of Deals by Regions and by Industries 1995 – 2009Q1

Region	Region	Frequency	Percent	Industry	Industry	Frequency	Percent
1	Alaska, Hawaii, and Puerto Rico	103	0.19	1	Biotech	4786	8.95
2	Colorado	1452	2.71	2	Business Products and Services	1964	3.67
3	DC Metroplex	2882	5.39	3	Computers and Peripherals	1158	2.16
4	LA Orange County	3044	5.69	4	Consumer Products and Services	1772	3.31
5	Midwest	3346	6.25	5	Electronics/ Instrumentation	925	1.73
6	NY Metro	6701	12.53	6	Financial Services	1497	2.80
7	New England	1263	2.36	7	Healthcare Services	1346	2.52
8	North Central	2408	4.50	8	IT Services	2733	5.12
9	Northwest	4189	7.83	9	Industrial/ Energy	3358	6.28
10	Philadelphia Metro	1671	3.12	10	Media and Entertainment	4511	8.43

11	Sacramento/ N. Cali	200	0.37	11	Medical Devices and Equipment	3963	7.41
12	San Diego	1837	3.43	12	Networking and Equipment	2788	5.21
13	Silicon Valley	15527	29.02	13	Other	101	0.19
14	South Central	378	0.71	14	Retailing/ Distribution	1200	2.24
15	Southwest	4089	7.64	15	Semiconductors	2483	4.64
16	Southeast	1085	2.03	16	Software	14219	26.58
17	Texas	2884	5.39	17	Telecommunications	4693	8.77
18	Unknown*	70	0.13				
19	Upstate NY	368	0.69				

*Through 2005 only

Table 4: Pearson Correlation Coefficients

Pearson Correlation Coefficients, N = 10723, Prob > |r| under H0: Rho=0

	Date	**Investment**	**NUOFDEALS**	**Real GDP**	**Nominal GDP**	**GDP Deflator**	**Federal FundIR**	**IR3**	**IR5**	**IR10**
Date	1	0.01816	0.0159	0.99125	0.99434	0.98639	-0.5540	-0.7177	-0.7745	-0.8401
		0.06	0.0997	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Investment	0.0182	1	0.85745	0.04529	0.01863	-0.0018	0.08401	0.07325	0.06637	0.0459
	0.06		<.0001	<.0001	0.0537	0.853	<.0001	<.0001	<.0001	<.0001
NUOFDEALS	0.0159 0.0997	0.85745 <.0001	1	0.03286 0.0007	0.01694 0.0794	0.00443 0.6462	0.05236 <.0001	0.0434 <.0001	0.03812 <.0001	0.02425 0.012
Real GDP	0.9913 <.0001	0.04529 <.0001	0.03286 0.0007	1	0.98781 <.0001	0.96795 <.0001	-0.4909 <.0001	-0.6620 <.0001	-0.7243 <.0001	-0.8038 <.0001
Nominal GDP	0.9943 <.0001	0.01863 0.0537	0.01694 0.0794	0.98781 <.0001	1	0.99492 <.0001	-0.4833 <.0001	-0.6591 <.0001	-0.7228 <.0001	-0.7976 <.0001
GDP Deflator	0.9864 <.0001	-0.00179 0.853	0.00443 0.6462	0.96795 <.0001	0.99492 <.0001	1	-0.4924 <.0001	-0.6652 <.0001	-0.7274 <.0001	-0.7957 <.0001
FederalFundIR	-0.5540 <.0001	0.08401 <.0001	0.05236 <.0001	-0.49088 <.0001	-0.48331 <.0001	-0.4924 <.0001	1	0.9176 <.0001	0.86931 <.0001	0.77413 <.0001
IR3	-0.7177 <.0001	0.07325 <.0001	0.0434 <.0001	-0.66201 <.0001	-0.65911 <.0001	-0.6652 <.0001	0.91755 <.0001	1	0.98962 <.0001	0.93959 <.0001
IR5	-0.7745 <.0001	0.06637 <.0001	0.03812 <.0001	-0.72425 <.0001	-0.72284 <.0001	-0.7274 <.0001	0.86931 <.0001	0.98962 <.0001	1	0.97784 <.0001
IR10	-0.8401 <.0001	0.0459 <.0001	0.02425 0.012	-0.80377 <.0001	-0.79758 <.0001	-0.7957 <.0001	0.77413 <.0001	0.93959 <.0001	0.97784 <.0001	1

Table 5: Regression Results for Log Investment in Venture Capital.

Dependent Variable: loginvestment1

Number of Observations Read	10,723
Number of Observations Used	10,597
Number of Observations with Missing Values	126

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	41	15274	372.54685	199.5	<.0001
Error	10555	19711	1.86741		
Corrected Total	10596	34985			

Root MSE	1.36653	R-Square	0.4366
Dependent Mean	16.1799	Adj R-Sq	0.4344
Coeff Var	8.44587		

	Parameter Estimates		Parameter	Standard		
Variable	Label	DF	Estimate	Error	t Value	Pr > |t|
Intercept	Intercept	1	996.66428	61.14081	16.3	<.0001
observation1		1	-0.05	0.00311	-16.08	<.0001
NUOFDEALS		1	0.06868	0.00197	34.83	<.0001
industry2	Business Products and Services	1	-0.96253	0.07306	-13.18	<.0001
industry3	Computers and Peripherals	1	-1.27145	0.08175	-15.55	<.0001
industry4	Consumer Products and Services	1	-1.09518	0.07375	-14.85	<.0001
industry5	Electronics/Instrumentation	1	-1.47302	0.07949	-18.53	<.0001
industry6	Financial Services	1	-0.89397	0.07695	-11.62	<.0001
industry7	Healthcare Services	1	-1.02335	0.07502	-13.64	<.0001
industry8	IT Services	1	-0.63886	0.07016	-9.11	<.0001
industry9	Industrial/Energy	1	-0.65995	0.068	-9.7	<.0001
industry10	Media and Entertainment	1	-0.51664	0.06859	-7.53	<.0001
industry11	Medical Devices and Equipment	1	-0.34584	0.06838	-5.06	<.0001
industry12	Networking and Equipment	1	-0.40283	0.07296	-5.52	<.0001
industry13	Other	1	-1.88703	0.1675	-11.27	<.0001
industry14	Retailing/Distribution	1	-1.28136	0.0791	-16.2	<.0001
industry15	Semiconductors	1	-0.73327	0.07443	-9.85	<.0001
industry16	Software	1	-0.17038	0.06925	-2.46	0.0139
industry17	Telecommunications	1	-0.11093	0.06795	-1.63	0.1026
region2	Colorado	1	1.78069	0.15763	11.3	<.0001
region3	DC Metroplex	1	1.85148	0.1563	11.85	<.0001
region4	LA Orange County	1	2.3776	0.15541	15.3	<.0001
region5	Midwest	1	1.9511	0.1553	12.56	<.0001
region6	NY Metro	1	2.37526	0.15533	15.29	<.0001
region7	New England	1	2.55638	0.15513	16.48	<.0001
region8	North Central	1	1.42282	0.15832	8.99	<.0001
region9	Northwest	1	2.02742	0.15615	12.98	<.0001
region10	Philadelphia Metro	1	1.39122	0.15759	8.83	<.0001
region11	Sacramento/ N. Cali	1	0.84635	0.18091	4.68	<.0001
region12	San Diego	1	1.96156	0.15815	12.4	<.0001
region13	Silicon Valley	1	2.91622	0.15794	18.46	<.0001
region14	South Central	1	0.56725	0.16926	3.35	0.0008
region15	Southwest	1	1.35521	0.15926	8.51	<.0001
region16	Southeast	1	2.31921	0.15525	14.94	<.0001
region17	Texas	1	2.16289	0.15555	13.9	<.0001
region18	Unknown	1	-0.23857	0.23983	-0.99	0.3199
region19	Upstate NY	1	0.49989	0.16876	2.96	0.0031
Real GDP		1	0.00193	0.00011	17.5	<.0001
FederalFundIR		1	0.03367	0.0253	1.33	0.1833
IR3		1	-1.23744	0.21341	-5.8	<.0001
IR5		1	2.39329	0.38797	6.17	<.0001
IR10		1	-1.28047	0.2189	-5.85	<.0001

Figure 1: Total Venture Capital Investment in the United States 1995 – 2009Q1

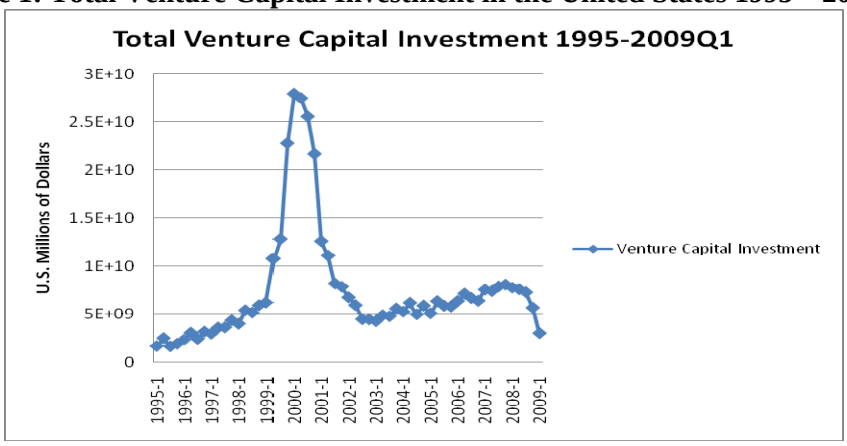


Figure 2: Total Number of Deals in Venture Capital Investment in the United States 1995 – 2009Q1

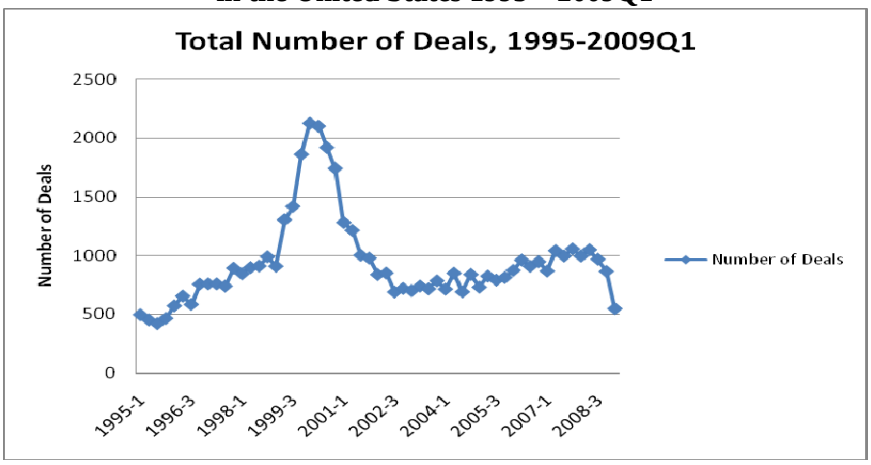
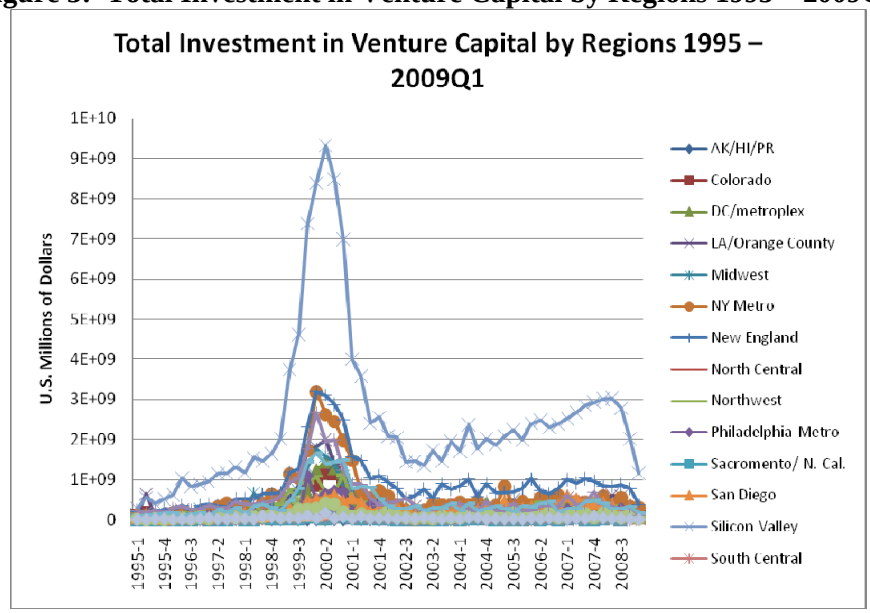


Figure 3: Total Investment in Venture Capital by Regions 1995 – 2009Q1



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