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The driving forces of venture capital investments

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Abstract We have examined the volatility and macroeconomic drivers of venture capital (VC) investments in the past 17 years from 1995 to 2011. We find that VC investments in the United States (US) by the total amount, by the number of deals, and by the average amount per deal are significantly affected by macroeconomic factors and public market signals. The fundamental changes in economic situations (i.e. the 2000 high-tech bubble; the 2008 global financial crisis) had substantial impact on the US VC industry. In response to these dramatic changes, venture firms adjust their risk preferences and investment strategies by securing fewer deals with a smaller average amount per deal in general, increasing their allocations to the expansion and later-stage investments, and injecting a lower percent of cash in the first several financing sequences as opposed to their total committed investments to a company. We also find the impact of 2008 global financial crisis and economic recession on the VC industry is somewhat different from that of the 2000 dot-com bubble.

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1 Introduction

Venture capital (VC) is a type of private equity (PE) capital for financing early-stage, high-potential companies. In the past decades, VC investments worldwide have exploded, and venture-backed business has emerged as an important driving force of global technological innovations, economic growth, and employment in many developed nations and emerging countries. As a leader in the global VC community, the United States (US) has a well-developed system and market to support VC activities. In 2008, US venture-backed companies employed more than 12.1 million people, which accounted for 11 % of the private sector employment. Those companies generated nearly $2.9 trillion in revenue, representing the equivalent of 21 % of the US GDP in 2008.[1] Many big-name multinational corporations, such as Microsoft, Google, Intel, Apple, Starbucks, Facebook, etc., were founded with VC financing.

[1] The data is obtained from "Venture Impact: The Economic Importance of Venture Capital-Backed Companies to the US Economy (2009, 5th edition)" provided by IHS Global Insight.

Prior studies on VC in the literature are mostly in the microeconomic fields, such as venture firms' governance, structures, networks, and contracts with entrepreneurs. Those studies examine the theoretical and practical relationships among start-ups, venture firms, and investors (i.e. Sahlman 1990; Lerner 1995; Kaplan and Stromberg 2003, 2004), how different types of VC firms affect the performance of venture-backed companies (Megginson and Weiss 1991; Hellman and Puri 2000; Sorensen 2007; Nahata 2008; Croce et al. 2014), the conditions, duration, forms, and timing of VC investments (e.g. Giot and Schwienbacher 2007; Cumming 2008), and the operating efficiencies of VC firms and management companies (Haro-de-Rosario et al. 2014).

However, the research on VC from a macroeconomic perspective is relatively rare. Several papers document the impact of VC on industrial innovations, economic and employment growth from a macroeconomic view. For example, Kortum and Lerner (2000) examine the influence of VC on patented inventions in the US across 20 industries over three decades. They find that VC might have accounted for 8 % of industrial innovations in the sample period. Hellman and Puri (2000) find that venture-backed firms follow more innovative strategies than non-venture-backed firms in general. Alhorr et al. (2008) examine the impact of EU economic integration on the cross-border VC investments and find that the broad economic integration policies influence the extent of foreign VC investments on other member countries.

Given the growing importance of VC to the economy, employment, and innovation, an interesting research issue is the variations and driving factors of VC investments in the past decades that witnessed two major market storms: the 2000 high-tech bubble and 2008 global financial crisis. This issue could be a concern to policymakers, venture capitalists, and entrepreneurs seeking venture financing. If they have more insight on the variations of the VC market and the driving forces behind it, they can take deemed steps in a response to the changes on the market.

This study examines the macroeconomic drivers of VC investments at an aggregate level, which has been rarely studied in prior literature. Using the data of the VC investments in the US over 17 years from 1995 to 2011, we develop and test three hypotheses in this study. The Macroeconomic Situation Hypothesis states that an expanding economic situation has a positive impact on the aggregate VC investments. The Public Market Hypothesis assumes that a superior performance in the stock and bond market affect the aggregate VC activities. The Crisis Hypothesis states that fundamental changes in economic situations, such as the 2000 dot-com bubble and 2008 financial crisis, have a significant impact on venture capitalists' risk preferences and investment strategies.

The trend analysis of VC activities in total, by stages of development, and by industry indicate that US venture industry is significantly affected by the 2000 dot-com bubble and the 2008 financial crisis. The impact is evidenced by the decline of the aggregate venture investments, the investments at all stages of financing, and in almost all sectors. During the past decades, US VC investments, measured by the amount and the number of deals, peaked in 2000, declined sharply in the subsequent 3 years, rebounded slowly from 2004 to 2007, dropped again in 2008, and slowly recovered since then.

We find that an expanding economy with a higher GDP growth rate, a greater industry production index, and a lower unemployment rate (UR) has a positive impact on the VC industry characterized with a larger amount of investments, a greater number of deals, and a higher average amount per deal. This supports our proposed macroeconomic Situation Hypothesis. The Public Market Hypothesis that states the good performance in the stock and bond markets can favorably affect the VC industry and drive up VC activities is also supported. We also find that venture firms became more cautious and risk averse after the 2000 dot-com bubble and 2008 financial crisis, supporting the Crisis Hypothesis. These fundamental changes in the macroeconomic conditions have forced venture capitalists to reconsider their risk preferences and investment strategies by investing less funds in fewer deals, shifting a larger proportion of their money and deals to later-stage companies, and injecting a lower proportion of cash in the first several financing sequences as opposed to their overall committed venture funds. We further find that the impact of the 2008 financial crisis is somewhat different from that of the 2000 high-tech bubble. The impact of the 2008 financial crisis on the venture industry was less dramatic than that of the 2000 high-tech crash, possibly because venture firms are still on the way to recover from the dramatic downfall from the 2000 peak and this adjustment continued to the 2008 financial crisis. We further find

that while a lower proportion of venture funds and fewer deals go to start-ups and early-stage companies after the 2000 high-tech bubble, a greater proportion of the funds and deals were actually allocated to the earlier-stages projects after the financial crisis occurred in 2008. A possible explanation for this difference might be the dramatic rise and success of social media industry and it has attracted venture capitalists to invest more deals and funds in the social media start-ups during that period.

Our study contributes to the literature by exploring the macroeconomic driving factors of US VC investments. We examine the impact of macroeconomic and public market indicators on the aggregate VC activities and how the fundamental changes in economic conditions influence venture firms to adjust their risk and investment strategies. Our major findings have useful implications for venture capitalists who can adjust their risk and investment strategies based on economic and public market signals, and also useful for entrepreneurs who are seeking venture financing for their business.

We structure the paper into six sections. In Sect. 2, we review the literature and develop hypotheses. Data, variable definitions, and methodologies are described in Sect. 3. We perform trend examination of venture investments in Sect. 4, and report empirical regressions results and robustness tests in Sects. 5 and 6. Section 7 has the conclusions, discussions, and limitations.

2 Literature review and hypothesis development

Venture capital, which is a type of equity financing for high-growth early-stage start-ups, has developed as an important financial intermediary providing capital to typically small and young firms that might otherwise have difficulty attracting financing due to high levels of uncertainty and the asymmetric information that exists between entrepreneurs and investors (Gompers and Lerner 2001).

This study examines the variation and driving factors of US venture investments. In this section we develop three hypotheses regarding how macroeconomic and public market indicators might influence venture industry based on the demand and supply theory documented by Poterba (1989) and Gompers and Lerner (1998). We also discuss how dramatic changes in economic situations, such as the 2000 high-tech bubble and 2008 financial crisis, can change venture firms' risk and investments strategies.

2.1 The macroeconomic situation hypothesis

Poterba (1989) argues that changes of VC fundraising are caused by the changes of the supply of or the demand from VC. Gompers and Lerner (1998) further this line of discussions through illustrating the equilibrium in the VC market. The expected return on new venture investments affects the willingness of investors to commit funds to venture firms, therefore, determine the supply of VC. Investors are expected to have a greater desire to supply VC with a higher expected return. On the other side, the demand schedule of VC is determined by the number of entrepreneurial firms seeking equity financing that can generate a particular expected rate of return. A higher expected return required by venture investors leads to fewer demand of VC by entrepreneurs because the number of projects satisfying the hurdle rates declines. The equilibrium in the VC market can be determined at the crossover point of the supply and demand curves. Any factors that affect the supply of or the demand from VCs will finally shift the equilibrium in the VC market, thus determining VC investments.

Generally, a higher expected return on VC is more likely to happen in an expanding economy, which makes investors more optimistic about their investments, therefore, commit more money to venture firms from the supply side. At the same time, economic growth and technological innovations can also provide entrepreneurs more attractive investment opportunities and new projects that can meet the required threshold return, thus, leading to more demand of VC from entrepreneurs. Therefore, we expect an expanding economy can shift both the supply and demand curves upwards and therefore increase venture investments at the aggregate level.

Prior empirical studies examine the influence of macroeconomic conditions and regulation changes on the VC industry. Acs and Audretsch (1991) find that macroeconomic expansions lead to an increase in the number of start-ups, which can increase the demand for VC. Gompers and Lerner (1998) use GDP growth, R&D spending, and interest rate as explanatory

variables in their models to explain VC fundraising. They find that a higher GDP growth and an increase in R&D spending lead to more VC activities. However, when Jeng and Wells (2000) consider a variety of factors, including GDP, IPOs, market capitalization growth, labor market rigidities, financial reporting standards, pension funds, and government programs, to analyze the determinants of growth in the VC industry in 21 countries, they find no evidence that GDP and market capitalization are significant determinants of VC investing, though IPOs, private pension fund levels, and government policies are identified to be important in their studies.

This study uses real GDP growth rate, Industrial Production Index (IPI), UR, and the annual inflation rate (CPI) to measure the state of the macroeconomic situation in the US. We expect that an expanding economy characterized with a greater GDP growth rate, a higher IPI, and a lower UR can boost overall venture investments, more deals, and a greater average amount of financing for each deal.

A high inflation rate can reduce the expected real rate of return on alternative investments (i.e. bonds) thus make them less attractive to investors, and this can encourage investors to pour their money into VC funds to hedge the potential high inflation risk. So we assume a positive relation between annual CPI and VC investments. We develop the Macroeconomic Situation Hypothesis as follows:

H1: An expanding economic situation characterized by a higher GDP growth rate, a larger industry production index, and a lower UR have a positive impact on the aggregate VC investments.

2.2 The public market hypothesis

The success of IPOs and the good returns on the stock market are favorable market signals to investors that a higher rate of return on their investments is more likely, so they might increase their supply of VC. At the same time, the success stories in the IPO market also encourage entrepreneurs to create more start-ups and take a higher risk, which in turn, increase the demand from VC (Gompers and Lerner 1998). Therefore, a favorable market condition, measured by the superior stock market performance and IPOs, can affect VC investments in a positive way.

Gilson and Black (1997) document that VC play a vital role in the stock market-centered capital market. They conclude that VC investments require active stock markets. For example, the United States has both an active VC industry and well-developed stock markets, which Japan and Germany do not have. Rin et al. (2005) further argue that appropriate public policies, including open stock markets for entrepreneurial companies, can contribute to increase the share of early stage and high-tech VC investments, therefore helping the development of an active VC market. Their arguments are consistent with the findings in several empirical studies. Gompers and Lerner (1998) find that a higher recent stock return leads to a greater commitment to new venture funds. Kaplan and Scholar (2005) show that PE fund flows are positively related to their past performance because the better performing funds are more likely to raise follow-on funds and larger funds. Gompers et al. (2008) examine how the changes in public market signals affected VC investing between 1975 and 1998. They find that venture capitalists with the most industry experiences increase their investments the most when public market signals became more favorable, supporting the notion that the shifts in fundamentals are an important consideration of VC investing.

We use the number of IPOs, NASDAQ Composite, Russell 2000 index, and 10-year Treasury bond yields to measure the performance of stock and bond markets. A favorable stock market characterized with more IPOs and a higher market return is expected to positively influence total amount of venture investments, more deals, and also a greater average investing amount per deal. Bond is an alternative investment to VC. Gompers and Lerner (1998) argue that lower interest rates, which move inversely to bond prices, can increase the attractiveness of investing in venture funds, thus, investors supply more capital to venture funds. We develop the *Public Market Hypothesis* as follows:

H2: A superior performance in the stock market measured by the number of IPOs, NASDAQ Composite, and Russell 2000 Index, and the bond market performance that is inversely related to bond yields, positively affect the aggregate venture capital investments.

2.3 The Crisis Hypothesis

Deloitte's 2009 Global VC Survey show by both sector and region how the most recent important macroeconomic conditions (e.g. the 2008 global financial crisis and economic recession) have affected venture firms' strategic decisions and how future investment is being planned. They received 725 responses from general partners of VC firms, with 44 % of the respondents being based in the United States. The survey results indicate that, in response to the global recession, venture firms were generally decreasing their overall level of investments, changing strategies to focus on the best companies, and increasing their allocation to later-stage investments. These survey findings provide evidence that macroeconomic conditions have indeed affected VC investments. But the report was based on survey data from only one year. Several academic studies also present similar findings. Kaplan and Scholar (2005) find that new PE partnerships are more likely to be started in periods when the venture industry has performed well. But the venture funds that are raised in boom times are less likely to raise follow-on funds and larger funds due to their poor portfolio performance caused by stock market crash, financial crisis, and economic recession.

We examine how the fundamental changes in economic situation, such as the 2000 dot-com bubble and the 2008 financial crisis, influence venture firms' risk and investment strategies which we design three types of variables to measure in this study. The first type of variables consists of the total amount of VC investments, the total number of deals, and the average amount of investments per deal. The second type of variables are Stage Funds (Deals) Ratios which are calculated based on the relative amount (or the relative number of deals) of VC investments to the companies at the Seed/Start-up Stage, Early-Stage, Expansion Stage, or Later Stage. The greater the Stage Funds (Deals) Ratios suggest a larger percent of venture dollars (deals) are invested in the early-stage projects carrying a higher risk. The third type of variables are VC Financing Sequence Ratios which are the relative amount of cash actually received by entrepreneurs in the earlier financing sequences as opposed to their total committed funds. A greater Financing Sequence Ratio suggests that a larger percentage of cash is actually received by the invested company in the first several financing sequences, and this means venture capitalists are more confident on their investments and willing to inject more cash at early-stage projects bearing a higher level of risk.

We expect that fundamental changes in economic conditions caused by the severe economic and financial crisis can significantly impact venture firms' investment strategies. Venture capitalists become more cautious by investing fewer deals with a smaller average amount of investments per deal, shifting their allocations to the later-stage projects, and reducing their cash in the first several financing sequences as opposed to the total committed funds. Therefore, we develop the *Crisis Hypothesis* as follows:

H3: The fundamental changes in economic situations (i.e. the 2000 dot-com bubble and 2008 financial crisis) have a significant impact on venture capitalists' risk and investment strategies characterized as decreasing overall venture capital investments, lower stage funds and deals ratios, and smaller financing sequence ratios.

3 Data, variables, and methodology

We collect quarterly data of US VC investments from Q1 1995 to Q4 2011 based on the *MoneyTree* Report from *PriceWaterhouseCoopers/National Venture Capital Association* where the data was provided by *Thomson Reuters*. The historical venture data include the total amount of venture investments and the total number of deals by region, by industry, and by stages of development. There are a total of 68 quarters (observations) from Q1 1995 to Q4 2011.

The database reports US VC investments in 16 industries: (1) Biotechnology; (2) Business Products and Services; (3) Computers and Peripherals; (4) Consumer Products and Services; (5) Electronics/Instrumentation; (6) Financial Services; (7) Healthcare Services; (8) Industrial/Energy; (9) IT Service; (10) Media and Entertainment; (11) Medical Devices and Equipment; (12) Networking and Equipment; (13) Retailing/Distribution; (14) Semiconductors; (15) Software; (16) Telecommunications; and (17) Others. We simplify these industries into five major business sectors: Information Technology (3, 9, 12, 14, 15, and 16), Business/Consumer/Retail (2, 4, 10, and 13), Healthcare (1, 7, and 11), Industrial/Energy (8), and Others (5, 6, and 17).

The VC financing in the *MoneyTree* Report is classified into four stages: *Seed/Start-Up Stage*, *Early Stage*, *Expansion Stage*, and *Later Stage*. The *Seed/Start-Up Stage,* which usually exists less than 18 months, is the initial stage when the company has a concept or product under development, but probably not yet fully operational. In the *Early Stage*, the company has a product or service in testing or pilot production. In some cases, the product may be commercially available. But these products and services may or may not be generating revenues. A company at this stage has generally been in business less than 3 years. At the *Expansion Stage*, the product or service of a venture-backed company is in production and commercially available. While the company demonstrates significant revenue growth, it may or may not be showing a profit. The firm has usually been in business more than 3 years. At the *Later Stage*, the product or service of a venture-backed firm is widely available, and the company is generating on-going revenue, probably with positive cash flow. The company is very likely to be, but is not necessarily, profitable. Generally, the earlier the investment stages mean the higher the risk on the investments.

Other than the total amount of investments and the total number of venture deals, we use another variable in the study, the average amount of investments per deal which is equal to the total amount of investments divided by the total number of deals. This variable can be used to measure the willingness and magnitude of a venture firm's investment in a single deal. When a venture firm is confident in a selected company, it is more likely they will invest more funds in the deal.

Other than the three dependent variables, this study uses another three sets of variables to test the three hypotheses. The first set of variables used to measure macroeconomic situation and test H1 include the real GDP Growth Rate, IPI, UR, and the annual Consumer Price Index (CPI). The real GDP is the inflation-adjusted value of total goods and services produced by residents and non-residents in the US in a given period. The *Industrial Production Index* is used to assess the country's industrial output and the changes in output from the manufacturing, mining, electric and gas industries. The indicator, which is released monthly by the Federal Reserve Board, reflects the level of the economy, but does not determine the direction of its development. The *Unemployment Rate* is the average number of unemployed citizens over 18 years of age relative to the total labor force. The *Consumer Price Index (CPI)*, which is an inflation indicator, shows the change of value of the consumer basket of goods and services.

The second set of variables used to gauge the public stock and bond market and test H2 consists of the number of IPOs, NASDAQ Composite index, Russell 2000 index, and 10-year Treasury bond yield. The number of IPOs is the number of firms that file IPOs in a given quarter. The NASDAQ Composite is an equity index that follows technology/growth stocks, and the Russell 2000 Index is the small-cap stock market index of the bottom 2,000 stocks. The 10-year T-bond yield is the yield on 10-year US. Treasury bonds, which are used to measure the long-term interest rate, are the benchmark borrowing costs of US firms. The summary statistics and correlations of the key variables are reported in Table 1.

Panel A in Table 1 displays the summary statistics (i.e. 25 percentile, median, 50 percentile, mean, and SD) of the quarterly VC investments in the total amount, the number of deals, the average amount per deal, macroeconomic variables, and market indicators in a quarterly basis from Q1 1995 to Q4 2011, for a total of 68 quarters. Panel B shows the correlations of some key macroeconomic and market variables. Some of the macroeconomic variables and public market indicators are highly correlated, so we need to carefully choose some of the variables for our models in order to avoid the potential multicollinearity problem.

Specifically in this study, we create several additional variables to measure venture firms' changing risk and investment strategies. These variables are used to test the *Crisis Hypothesis* (H3), which are VC Stage Funds Ratios, Stage Deals Ratios, and Financing Sequence Ratios. We define Stage Funds Ratios as the total venture dollars invested in the early stages (seed/start-up stage, early stage) to the dollars invested in the later stages (expansion stage, later stage).[2] For example, when we use Stage ① to denote the Seed/Start-up Stage, Stage ② as the Early Stage, Stage ③ as the Expansion Stage, and Stage ④ as the Later Stage of venture investments, we define *Stage Funds Ratio* ①/④ as the total amount of dollars invested in the Seed/

[2] The four stages of venture capital financing are defined and classified by *MoneyTree Report*. The definitions are described in the third paragraph of Sect. 3 in this study.

Table 1 Variable summary statistics and correlation table

Variables	25 %	Median	75 %	Mean	SD
A: Summary statistics of variables					
Quarterly VC investments					
Total amount ($M)	4,587.86	6,121.38	7,517.90	7,306.81	5,654.79
# of deals	761	904	1,022	955	346
Average amount ($M)	6.07	6.99	7.46	6.97	2.08
Macroeconomic variables					
Real GDP growth rate	3.73 %	4.90 %	6.15 %	4.55 %	2.95 %
Industry Production Index	85.53	90.40	93.95	89.04	7.59
Unemployment rate	4.60 %	5.30 %	5.98 %	5.84 %	1.77 %
Annual CPI	0.7569	0.8434	0.9624	0.8574	0.1056
Market indicators					
Russell 2000 return	−4.88 %	3.59 %	9.85 %	2.23 %	11.12 %
NASDAQ Composite return	−6.48 %	3.87 %	12.08 %	2.84 %	14.15 %
10-year T-Bond yield	3.87 %	4.65 %	5.59 %	4.68 %	1.20 %
The # of IPOs	26	50	104	65	53

Variables	GDP	IPI	UR	CPI	Russell	Nasdaq	TBY	IPO
B: Correlations of variables								
GDP	1.00							
IPI	−0.07	1.00						
UR	−0.43**	−0.01	1.00					
CPI	−0.36**	0.71***	0.66***	1.00				
Russell	0.33**	−0.15	0.02	−0.09	1.00			
Nasdaq	0.32**	−0.21	0.01	−0.15	0.83***	1.00		
TBY	0.38***	−0.59***	−0.71***	−0.89***	0.19	0.07	1.00	
IPO	0.40***	−0.57***	−0.43***	−0.66***	0.16	0.06	0.75***	1.00

Real GDP growth rate is the annualized growth rate for real GDP in 2009 dollars. The Industrial Production Index (IPI) is used to assess the country's industrial output and the changes in output from the manufacturing, mining, electric and gas industries. The unemployment rate (UR) is the average number of unemployed citizens over 18 years of age relative to the total labor force. Consumer Price Index (CPI) shows the annual change of value of the consumer basket of goods and services. NASDAQ Composite and Russell 2000 Index are equity indices which follow technology/growth stocks and 2000 small-cap stocks, respectively. The 10-year T-bond yield (TBY) is the yield on 10-year US Treasury bonds. The number of IPOs is the number of companies which filed IPO in a given quarter

***, **, * Significance at the 1, 5, and 10 % levels, respectively

Start-up Stage over the amount of dollars invested in the Later Stage. Similarly, we can define the other two *Stage Funds Ratios (① + ②)/④ and (① + ②)/(③ + ④)*. These ratios are used to measure the venture firms' risk preference by allocating a particular proportion of their capital at early-stages investments compared to later-stages investments. Based on the definitions, a greater Stage Funds Ratio indicates that a greater proportion of venture funds are invested in the early-stages projects that carry a much higher risk.

We define Stage Deals Ratios as the number of venture deals which succeed in early stages venture financing to the number of deals in later stages. This category of ratios can measure venture capitalists' risk preferences by allocating how many deals are in early-stages firms compared to that in the later-stages firms. For example, *Stage Deals Ratio* ①/④ is the total number of VC deals secured at the Seed/Start-up Stage over the number of deals in the Later Stage. Similarly, we can define the other two *Stage Deals Ratios*

(① + ②)/④ and (① + ②)/(③ + ④). Generally, a greater Stage Deals Ratio means there are more VC deals secured at early-stages projects that carry a much higher risk.

According to MoneyTree report, financing sequences record VC investments as the cash is actually received by the company as opposed to when a venture financing is committed. We define VC Financing Sequence Ratios as the relative amount of cash that is actually received by entrepreneurs in the first several sequences to the cash received in the later sequences of financing. For example, when we use Sequence ① to denote the first financing sequence, Sequence ② as the second sequence, Sequence ③ as the third sequence, we define *Financing Sequence Ratio ①/Others* as the total amount of cash received in the first financing sequence over the cash received in all other sequences. We define the other two *Financing Sequence Ratio*s (① + ②)/*Others* and (① + ②+③)/*Others* in the same way. Generally, a higher Financing Sequence Ratio indicates that a greater percentage of cash is actually received by the companies in the first several financing sequences, which means venture capitalists are more confident on the investment and willing to inject more cash at an early time.

We obtain the historical data for the macroeconomic variables from FRED (*Federal Reserve Economic Data*) that is maintained by the Federal Reserve Bank of St. Louis. The equity indices are retrieved from the CRSP database from the School of Business at the University of Chicago. The number of quarterly venture deals was obtained from the IPO data posted online by Professor Jay Ritter in the University of Florida.

We employ appropriate methods to test the proposed hypotheses in this study. We first perform trend analysis of the VC investments at an aggregate level, by the stage of development, and across major business sectors from 1995 to 2011. To test the Macroeconomic Situation Hypothesis (H1) and the Public Market Hypothesis (H2), we employ multiple regression models including the lagged-variables models to identify the macroeconomic driving factors of venture investments. We use the number of IPOs as the control variable for all regressions models due to several reasons. First, the exit strategy is usually a top priority for venture capitalists because they need to cash out their investments to reap the return and to raise funds for the next new projects. An ideal exit strategy for VC investors is to help venture-backed companies to go public through an initial public offering (IPO) process. So a major risk for venture capitalists is they might not be able to get their money back through IPOs. The success of the IPO market is an important driving factor for venture capitalists to make their decisions. Jeng and Wells (2000) find that IPOs is the most significant driver of VC investing using a sample of VC data from 21 countries. Gompers et al. (2008) use the number of VC-backed IPOs, which is used to measure the perceived investment opportunities, as a control variable in their models with the argument that the number of IPOs can attract both venture capitalists and entrepreneurs. In their robustness tests they expand their IPO activity measure to include all IPOs, not just those VC-backed deals. They obtain similar results due to the high correlation (0.81) between the number of the VC-backed IPOs and the total number of IPOs. In this study we control total number of IPOs in all regression models because the data for the number of venture-backed IPOs is not available. We expect the results are quantitatively similar based on the high correlation of the two measures (Gompers et al. 2008).

To test the *Crisis Hypothesis* (H3), we employ univariate tests to compare the measures of VC investments at an aggregate level, Stage Funds and Deals Ratios, and Financing Sequences Ratios during 5- and 7-year time windows around the 2000 high-tech bubble and the 2008 financial crisis, respectively. We also use regression models to study the impact of two major market storms on venture capitalists' adjustments to their risk and investment strategies in the past decades.

4 Analysis of US venture capital investments over time

This section examines the changes in the aggregate VC investments, by the stages of development, and across major business sectors over 17 years from Q1 1995 to Q2 2011 with a total of 68 quarters (observations).

4.1 The aggregate venture capital investments from 1995 to 2011

The United States has been a leader in VC financing in past decades and continues to lead

Table 2 The aggregate US venture capital investments from 1995 to 2011

Year	Total amount ($ million)	Number of deals	Average amount per deal ($ million)
A: The aggregate US venture capital investments[a]			
1995	8,001	1,895	4.22
1996	11,369	2,638	4.31
1997	14,922	3,225	4.63
1998	21,322	3,726	5.72
1999	54,652	5,590	9.78
2000	105,249	8,026	13.11
2001	41,032	4,579	8.96
2002	22,173	3,187	6.96
2003	19,683	3,005	6.55
2004	23,193	3,184	7.28
2005	23,594	3,270	7.22
2006	27,472	3,837	7.16
2007	31,848	4,140	7.69
2008	30,013	4,128	7.27
2009	20,132	3,080	6.54
2010	23,344	3,564	6.55
2011	29,119	3,762	7.76

Year	The seed/start-up stage			The early stage			The expansion stage			The later stage		
	Amount ($ M)	# of Deals	Average ($M)	Amount ($M)	# of Deals	Average ($M)	Amount ($M)	# of Deals	Average ($M)	Amount ($M)	# of Deals	Average ($M)
B: US venture capital investments (1995–2011) by stages of development[b]												
1995	1,273	431	2.95	1,733	519	3.34	3,562	705	5.05	1,447	241	6.00
1996	1,279	504	2.54	2,637	751	3.51	5,503	1,043	5.28	1,927	338	5.70
1997	1,368	541	2.53	3,455	897	3.85	7,584	1,400	5.42	2,599	385	6.75
1998	1,766	670	2.64	5,460	1,019	5.36	10,323	1,569	6.58	3,921	469	8.36
1999	3,625	811	4.47	11,480	1,734	6.62	29,255	2,438	12.00	10,494	613	17.12
2000	3,157	705	4.48	25,294	2,851	8.87	59,064	3,699	15.97	17,614	783	22.50
2001	804	281	2.86	8,587	1,297	6.62	22,899	2,391	9.58	8,668	621	13.96
2002	341	182	1.87	3,976	878	4.53	12,126	1,581	7.67	5,734	565	10.15
2003	365	217	1.68	3,617	803	4.50	9,802	1,352	7.25	5,908	655	9.02
2004	967	236	4.10	4,041	903	4.47	9,054	1,203	7.53	9,197	887	10.37
2005	996	264	3.77	4,079	856	4.76	8,576	1,115	7.69	9,937	1,062	9.36
2006	1,288	397	3.24	4,774	1,003	4.76	11,140	1,381	8.07	10,353	1,105	9.37
2007	1,835	526	3.49	6,084	1,134	5.36	11,077	1,274	8.69	12,955	1,290	10.04
2008	1,923	536	3.59	5,927	1,150	5.15	10,698	1,241	8.62	11,422	1,251	9.13
2009	1,734	374	4.64	4,921	977	5.04	6,829	894	7.64	6,769	904	7.49
2010	$1,666	409	4.07	5,907	1,283	4.60	8,666	1,074	8.07	7,071	874	8.09
2011	$1,080	446	2.42	8,908	1,594	5.59	9,762	1,021	9.56	9,896	930	10.64

Table 2 continued

Year	Information technology			Business/consumer/retail			Healthcare			Industrial/energy		
	Amount ($M)	# of deals	Average ($M)	Amount ($M)	# of deals	Average ($M)	Amount ($M)	# of deals	Average ($M)	Amount ($M)	# of deals	Average ($M)
C: US venture capital investments (1995–2011) by industries[c]												
1995	3,202	879	3.64	1,750	338	5.18	1,959	428	4.58	527	128	4.12
1996	5,539	1,318	4.20	2,071	425	4.87	2,545	587	4.34	495	155	3.19
1997	7,627	1,623	4.70	2,230	518	4.30	3,333	667	5.00	704	212	3.32
1998	11,283	1,952	5.78	3,705	613	6.04	3,773	726	5.20	1,257	185	6.79
1999	30,108	2,929	10.28	13,727	1,312	10.46	5,179	711	7.28	1,459	203	7.19
2000	67,722	4,573	14.81	20,143	1,820	11.07	8,073	819	9.86	2,637	254	10.38
2001	27,434	2,729	10.05	4,560	714	6.39	6,128	706	8.68	1,248	202	6.18
2002	13,444	1,909	7.04	1,891	378	5.00	5,593	634	8.82	826	131	6.31
2003	11,146	1,784	6.25	1,768	314	5.63	5,605	679	8.25	771	141	5.47
2004	12,346	1,845	6.69	2,660	327	8.13	6,695	750	8.93	846	158	5.36
2005	12,405	1,830	6.78	2,410	396	6.09	6,497	756	8.59	1,138	154	7.39
2006	13,289	2,038	6.52	3,065	530	5.78	8,033	895	8.98	1,945	223	8.72
2007	14,320	2,076	6.90	3,727	630	5.92	9,839	986	9.98	3,064	306	10.01
2008	12,486	1,998	6.25	2,930	620	4.73	8,934	992	9.01	4,574	358	12.78
2009	7,817	1,466	5.33	2,337	433	5.40	6,613	842	7.85	2,568	259	9.91
2010	9,852	1,730	5.69	2,500	509	4.91	6,543	894	7.32	3,380	297	11.38
2011	12,960	1,971	6.58	3,435	631	5.44	8,000	882	9.07	3,637	307	11.85

[a] We collect quarterly data about US venture capital investments from Q1 1995 to Q4 2011 based on the *MoneyTree Report from PriceWaterhouseCoopers/National Venture Capital Association* where the data was provided by Thomson Reuters. The historical venture data include the total amount of venture capital investments and the total number of deals. We define the average amount of venture capital investments per deal as the total amount of venture capital investments divided by the total number of deals

[b] *MoneyTree Report* classifies the venture capital financing into four stages: Seed/Start-Up Stage, Early Stage, Expansion Stage, and Later Stage. The Seed/Start-Up Stage is the initial stage when the company has a concept or product under development, but probably not yet fully operational. In the Early Stage, the company has a product or service in testing or pilot production. At the Expansion Stage, the product or service of a venture-backed company is in production and commercially available. At the Later Stage, the product or service of a venture-backed firm is widely available, and the company is generating on-going revenue, probably with positive cash flow

[c] The original data source from Thomson Reuters classifies all venture capital investments into 17 industries. In this study, we simplify these industries into several major business segments: Information Technology (Computers and Peripherals, IT Service, Software, etc.), Business/consumer/retail (Business Products and Services, Consumer Products and Services, Retailing/Distribution, etc.), Healthcare (Biotechnology, Healthcare Services, Medical Devices and Equipment, etc.), Industrial/Energy, and Others

the worldwide venture industry with 65 % of the global deals and 67 % of the amount investing inside the US during the first quarter of 2010. However, the leading position does not mean US venture investments have always been moving up. There is significant variation over time as shown in Panel A of Table 2.

In 1995, there were a total of $8.0 billion investments on 1,895 deals. The investments exploded during the years 1995 to 2000 accompanying the booming of information technology and internet business. As the *NASDAQ Composite* index peaked at an intra-day high of 5,132.52 points and closed at an all-time high of 5,048.62 points in March 2000, the total amount of VC investments in 2000 also reached a historical high at $105.2 billion in 2000, which was approximately 13.2 times the overall investing dollars in 1995. A total of 8,026 deals occurred in 2000, and that also set a record high. The average investments per deal also tripled during the period, increasing from $4.22 million per deal in 1995 to $13.11 million per deal in 2000.

However, the collapse of the *NASDAQ* stock market crashed the dot-com bubble and dragged down VC investments in the United States over 80 % in the subsequent 3 years from the peak. In 2003, the overall investing dollars dropped to just $19.68 billion and the number of deals also declined to only 3,005. A similar trend is observed for the average investments per deal, which was down from $13.11 million in 2000 to $6.55 million per deal in 2003.

During the years from 2003 to 2007, venture industry rebounded slowly. In 2007, there were a total of 4,140 deals valued at $31.85 billion, averaged at $7.69 million per deal. But this trend was reversed by the 2008 global financial crisis and economic recession. The $20.1 billion investments on 3,080 deals with an average $6.53 million per deal in 2009 return to the situation of the industry in 2003. Since then, the venture industry has been recovering steadily, and there were $29.1 billion investments in 3,762 deals in 2011. The average investing dollars also increased to $7.76 million for a deal.

Fig. 1 displays the trend of the three measures of the VC investments at an aggregate level over the sample period. We have observed that the time-series trend of the overall investing dollars, the number of deals, and the average investments per deal are highly correlated. All three measures peaked in 2000, declined sharply from 2000 to 2003, then rebounded slowly through

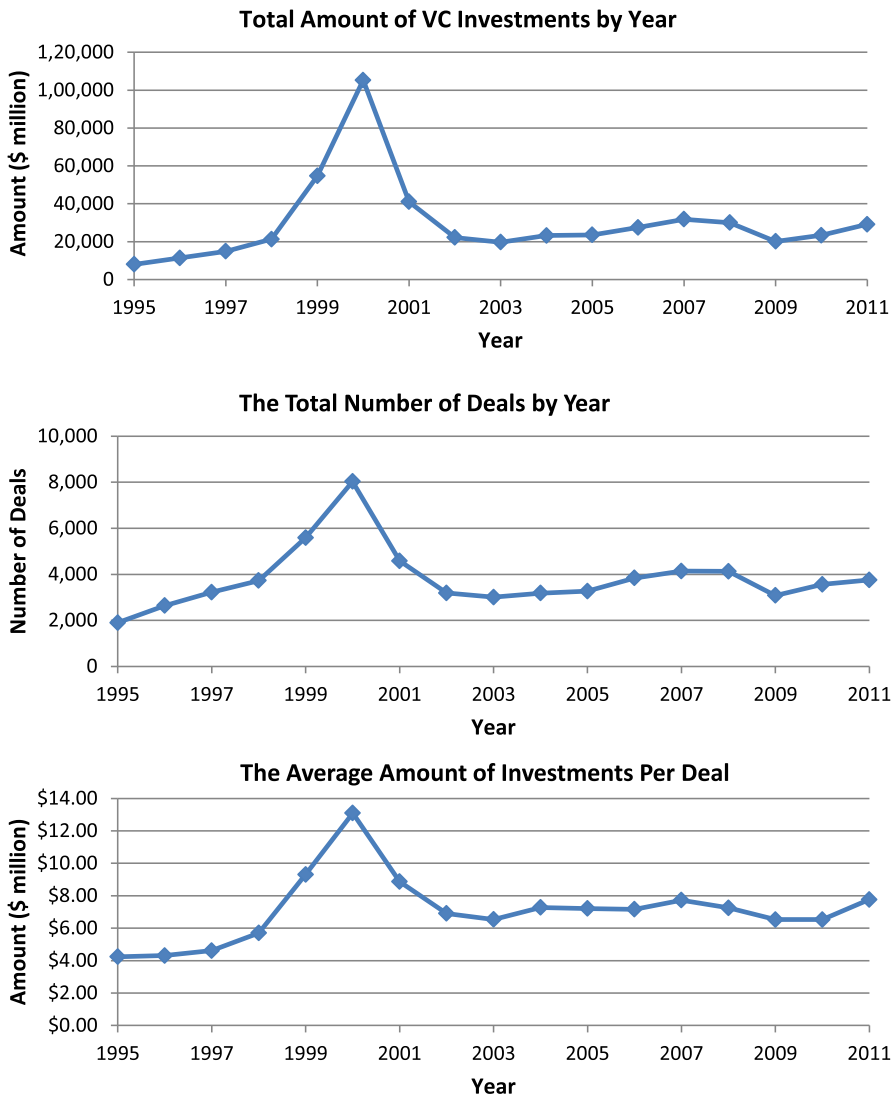

Fig. 1 The US venture capital investments from 1995 to 2011

2007, dropped again in 2008, and recovered steadily since 2009. These results indicate that venture capitalists and entrepreneurs quickly made adjustments in response to stock market crash, financial crisis, and economic recession. When the macroeconomic situation is good, venture capitalists are more likely to invest their money by securing more deals and investing more dollars in a single deal, on average.

4.2 Venture capital investments by the stages of development

We further examine the trend of VC investments by four stages of development: *Seed/Start-Up Stage, Early Stage, Expansion Stage*, and *Later Stage*. Generally, the earlier the stage, the higher the risk is, and also the higher the potential return is. Panel B in Table 2, as well as Fig. 2, shows the VC investments by stage from 1995 to 2011. At an aggregate level, the largest amount of venture financing went to the companies at the *Expansion Stage*. These relatively mature companies generally have products or services in production and available commercially characterized by significant revenue growth. This is also the stage when the companies mostly need financing to expand their products and services to increase their market shares aggressively. In contrast, the least amount of total capital is invested at the *Start-up/*

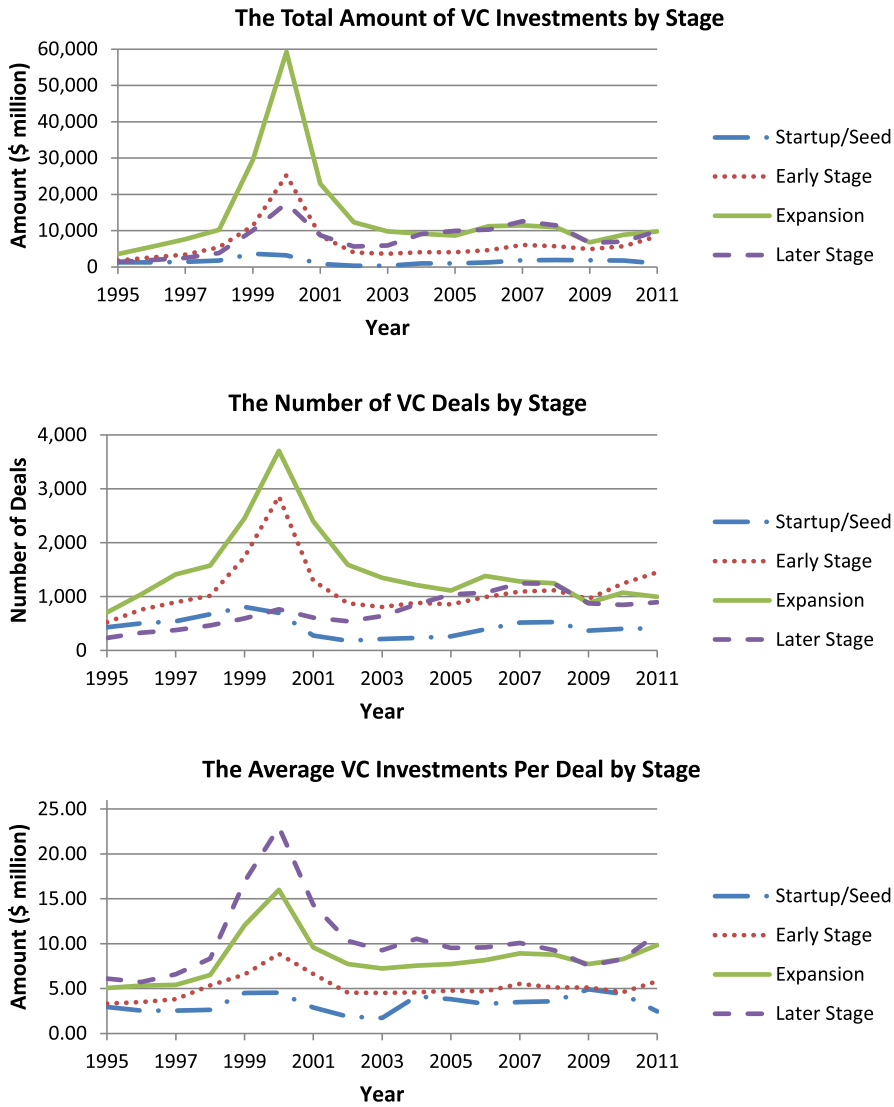

Fig. 2 US venture capital investments (1995–2011) by stage

Seed stage, which is the initial stage only with a concept or product under development. This stage is most risky, but has the highest potential return. Also, start-ups have a smaller firm valuation and does not need a large amount of investments.

Another interesting finding from Panel B is that, from 1995 to 2001, more venture funds were invested in the *Early-Stage* companies than that in the *Later-Stage* firms whose products or services are widely available. This might reveal that, before 2000, venture capitalists were more willing to take high-risk investments for potentially high returns. However, the high-tech crash in 2000 has reversed this trend and made venture investors more cautious than ever. Accordingly, they took appropriate steps to adjust risk and investment strategies. Since 2001, the total amount of investments at the *Later Stage*, which is usually referred to as PE financing in the industry, has exceeded *Early-Stage* financing, and in some years it even passed the total amount of investments at the *Expansion Stage*. This provides evidence supporting the boom of the PE industry in recent years, when venture investors actively seek deals with companies that are ready for IPOs or for sale.

Panel B also reports the total number of deals by four stages during the sample period. The trend is similar to the pattern identified for the investing amounts observed. We find that most deals occur at the *Expansion Stage* and the fewest deals occurred on the *Start-up/Seed Stage*. The number of deals that occur at the *Later Stage* has increased steadily since the high-tech stock market crash in 2000, outnumbered the deals at the *Early Stage* in 2004, and was close to the number of deals at the *Expansion Stage*.

However, the average amount of VC investments per deal shows a different trend. Venture firms invest the largest average amount of their funds in the *Later-Stage* companies, followed by the companies at the *Expansion Stage* and *Early Stage*. *Start-up* companies receive the smallest amount of financing on average. The results indicate that even venture firms invest most of the venture funds in the companies at the *Expansion Stage,* they tend to invest heavily in the *Later-Stage* firms with low risk and high possibility to go for IPO or for sale. Another fact is the later-stage firms are generally much larger in firm size and value, and they do need a relatively larger amount of equity financing to expand their business.

4.3 Venture capital investments by segments

There are "hot" investment segments over time in the venture industry. For example, while information technology was very "hot" in the 1990s, clean energy has more recently been gaining more attention from venture capitalists thanks to the high oil price, global warning, and other environmental concerns. Social media start-ups have been also attractive investments for venture investors in the past several years with the success of Facebook, Twitter, and LinkedIn. So a research issue is the variations of venture investments by business segments over time.

The original data source from *Thomson Reuters* classifies 17 industries. For research purposes, we simplify these industries into five major business segments: *Information Technology* (Computers and Peripherals, IT Service, Software, etc.), *Business/Consumer/Retail* (Business Products and Services, Consumer Products and Services, Retailing/Distribution, etc.), *Healthcare* (Biotechnology, Healthcare Services, Medical Devices and Equipment, etc.), *Industrial/Energy*, and *Others*.

Panel C in Table 2 (as well as Fig. 3) show VC activities and the patterns of VC investing by segments. First, VC investments in most industries were negatively affected by the high-tech crash in 2000 and the global financial crisis and economic recession in 2008. Very few industries could be immune from the impact of these major economic and financial storms. Second, information technology obtained the largest amount of VC with the most number of deals in the 1990s, but the discrepancy with other segments has narrowed significantly since the dot-com bubble burst. Third, life sciences and clean energy industries have been becoming more favored by venture capitalists and the investments in these "hot" sectors have increased steadily. Information technology has also rebounded significantly since 2009 thanks to the "hotness" of the social media start-ups. Finally, the average investing amount per deal is closely related to the "hotness" of an industry. For example, the information technology industry had the highest average of venture financing per deal in 2000, but the energy (i.e. clean technologies) and healthcare sectors (i.e. life sciences) have been leading other sectors to obtain more venture funds in a single deal on average in the past years. All these findings support the notion that venture capitalists are usually pioneers in providing financing for "hot" sectors.

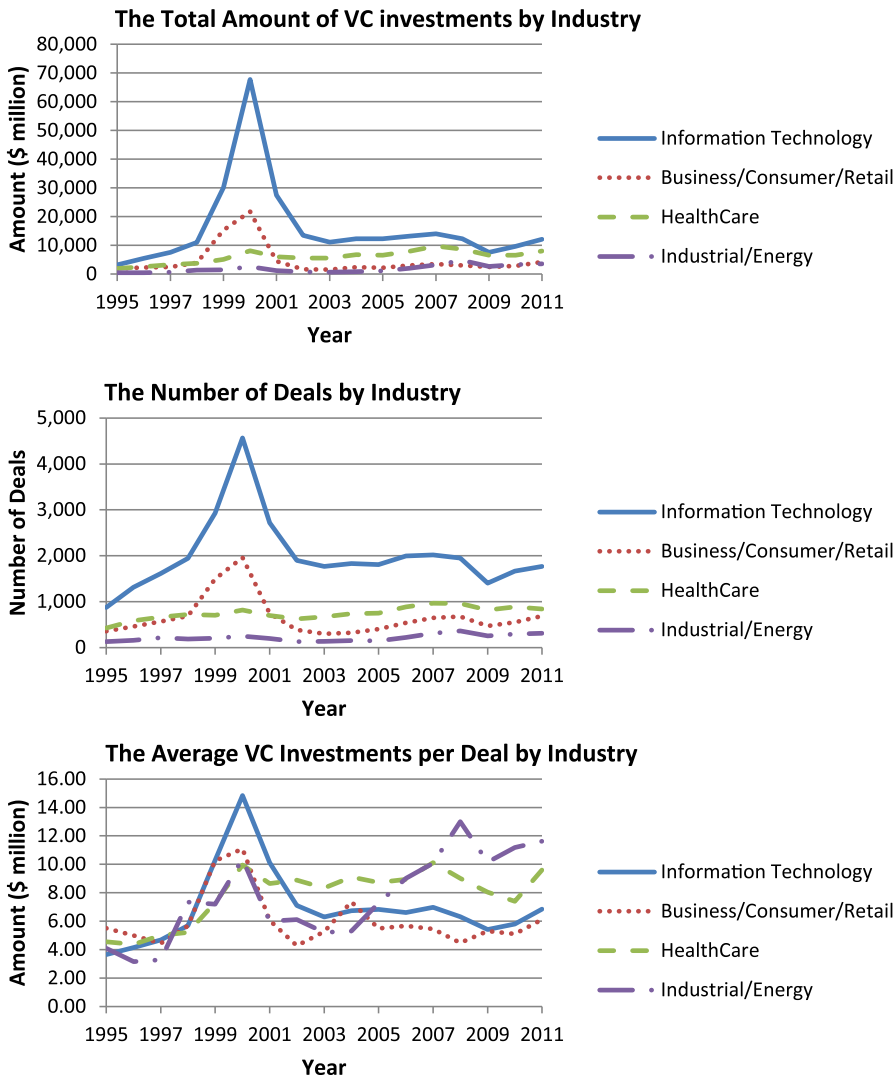

Fig. 3 US venture capital investments (1995–2011) by industry

In summary, the trend analysis of venture investments in total, as well as the average amount at different stages of development and across business segments suggests that fundamental changes in macroeconomic conditions are driving forces of venture industry development. We continue to explore the driving factors using univariate tests and multivariate analysis in the following sections.

5 The driving forces of venture capital investments

In this section, we use multiple regression models to examine the determinants of VC investing to test the Macroeconomic Situation hypothesis (H1) as well as the Public Market Hypothesis (H2). We then use univariate and multivariate models to analyze the aggregate venture investments, Stage Funds and Deals Ratios, and Financing Sequences Ratios during 5-/7-year time windows around the 2000 high-tech bubble and the 2008 financial crisis, respectively.

5.1 Test of the macroeconomic situation hypothesis

To test H1, we first use the lagged-variable models in which the total amount of VC investments, the total number of deals, and the average amount per deal in Year t are dependent variables. The independent

variables are the log value of Real GDP, IPI, UR, and annual CPI at $t-1$. As we have discussed in the data and methodology section, we control the log value of total number of IPOs at $t-1$ in all the models. Table 3 has the regression results.

Panel A in Table 3 shows that the regression results when the total amount of VC investments is the dependent variable. We find that, in Model 1, the log value of real GDP at $t-1$ has a significantly positive impact on the VC investments ($t = 4.18$, $p < 0.01$) at t. The control variable, the number of IPOs at $t-1$, is also found to positively affect the venture activities ($t = 2.54$, $p < 0.05$), which is consistent with the findings by Jeng and Wells (2000) and Gompers et al. (2008). Models 2 and 3 results indicate that a greater industry production index ($t = 6.20$, $p < 0.01$) and a lower UR ($t = -2.31$, $p < 0.05$) at $t-1$ can lead to more venture investments in Year t. We also find a

Table 3 The determinants of VC investments from the macroeconomic perspective

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5
A: The log of total quarterly VC investments at t as the dependent variable					
Constant	−51.988	18.119	23.310	20.524	−55.16
	(−2.92)***	(24.67)***	(54.01)***	(23.02)***	(−3.28)***
LN(Num of IPOs) ($t-1$)	0.176	0.153	−0.039	0.114	0.125
	(2.54)**	(2.74)***	(−0.60)	(1.50)	(1.86)*
LN (Real GDP) ($t-1$)	2.457				2.592
	(4.18)***				(4.66)***
Industry Production Index ($t-1$)		0.044			
		(6.20)***			
Unemployment Rate ($t-1$)			−0.110		−0.125
			(−2.31)**		(−3.02)***
Annual CPI ($t-1$)				0.009	
				(2.30)**	
# of Obs.	68	68	68	68	68
Adjusted R^2	18.8 %	35.3 %	4.8 %	4.7 %	27.8 %
F Statistic	8.78***	19.25***	2.68*	2.66*	9.61***
Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5
B: The log of total number VC deals at t as the dependent variable					
Constant	−28.363	4.549	7.058	5.688	−29.958
	(−2.87)***	(10.86)***	(30.25)***	(11.76)***	(−3.17)***
Number of IPOs ($t-1$)	0.119	0.110	0.016	0.092	0.094
	(3.10)***	(3.44)***	(0.45)	(2.22)**	(2.47)**
LN (Real GDP) ($t-1$)	1.155				1.223
	(3.54)***				(3.92)***
Industry Production Index ($t-1$)		0.021			
		(5.20)***			
Unemployment rate ($t-1$)			−0.056		−0.063
			(−2.17)**		(−2.71)***
Annual CPI ($t-1$)				0.004	
				(2.06)**	
# of Obs.	68	68	68	68	68
Adjusted R^2	15.6 %	28.9 %	6.1 %	5.4 %	23.0 %
F statistic	7.17***	14.61***	3.16**	2.92*	7.68 %

Table 3 continued

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5
C: The log of average VC investments per deal at t as the dependent variable					
Constant	−23.625	13.570	16.25	14.836	−25.198
	(−2.75)**	(38.95)***	(76.48)***	(33.92)***	(−3.12)***
Number of IPOs ($t-1$)	0.057	0.043	−0.055	0.022	0.032
	(1.70)*	(1.63)	(−0.71)	(0.60)	(0.98)
LN (Real GDP) ($t-1$)	1.302				1.369
	(4.60)***				(5.14)***
Industry Production Index ($t-1$)		0.023			
		(6.81)***			
Unemployment rate ($t-1$)			−0.054		−0.062
			(−2.31)**		(−3.12)***
Annual CPI ($t-1$)				0.004	
				(2.41)**	
# of Obs.	68	68	68	68	68
Adjusted R^2	23.3 %	40.2 %	6.0 %	6.7 %	32.4 %
F statistic	11.17***	23.94***	3.12*	3.39**	11.70

The sample consists of a total of 68 quarters (observations) from Q1 1995 to Q4 2011. The dependent variables are the log values of total amount of quarterly venture capital investments, the number of quarterly VC deals, and the average amount of VC investments per deal at t. The number of IPOs is the control variable which is the number of companies which filed IPO in a given quarter. The Real GDP is an inflation-adjusted value of total goods and services produced by residents and non-residents in the United States in a given period. The Industrial Production Index is used to assess the country's industrial output and the changes in output from the manufacturing, mining, electric and gas industries. The Unemployment Rate is the average number of unemployed citizens over 18 years of age relative to the total labor force. Consumer Price Index (CPI) shows the annual change of value of the consumer basket of goods and services

***, **, * Significance at the 1, 5, and 10 % levels, respectively

positive relation between annual CPI and venture investments ($t = 2.30, p < 0.05$) in Model 4, supporting our discussion of the variable in the hypothesis section. In Model 5, we add all the macroeconomic variables that are not highly correlated into the regression model[3] and obtain quantitatively similar results in Model 5. When we use the log value of total number of deals as the dependent variable in Panel B and the log value of the average amount of VC investments per deal as the dependent variable in Panel C, we obtain similar findings for most of the macroeconomic variables.

To further explore the impact of the macroeconomic situation on the VC industry, we use the changes in three VC variables relative to the previous year as the dependent variables. The independent variables consist of real GDP growth rate, and changes in industry production index, UR, and annual CPI. We also add the changes in the total number of IPOs as a control variable. The regression results are given in Table 4.

Panel A in Table 4 reports the regression results with the changes in overall investing dollars as the dependent variable. We find that changes in total VC investments are driven up by a higher real GDP growth rate ($t = 2.90$, $p < 0.01$), an increase in the industry production index ($t = 3.11, p < 0.01$), and a decrease in the UR ($t = -2.11$, $p < 0.05$). The change in the number of IPOs is also found to positively influence the changes in VC activities in all of the models in Table 3. However, we only find weak evidence ($t = 0.98$, insignificant) that the changes in annual CPI are related to the changes in VC investments. When we add other explanatory variables in Model 5,

[3] We do not add the two variables, industry production and annual CPI, in Model 5 because these two variables are highly correlated to the log value of real GDP, so the additions of the two variables into the model simultaneously would cause the multicollinearity problem.

Table 4 The impact of the changes of macroeconomic variables on VC investments

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
A: The Δ (total amount of quarterly VC investments) as the dependent variable					
Constant	−526.51	−115.249	173.304	−159.475	−475.299
	(−1.63)	(−0.46)	(0.69)	(−0.44)	(−1.10)
Δ (Num of IPO)	16.024	17.162	17.790	18.114	16.294
	(2.28)**	(2.47)**	(2.47)**	(2.44)**	(2.27)**
Real GDP Growth Rate	1,032.076				904.999
	(2.90)***				(1.90)*
Δ (Industry Production Index)		578.570			
		(3.11)***			
Δ (Unemployment Rate)			−1,661.817		−363.814
			(−2.11)**		(−0.35)
Δ (Annual CPI)				223.377	37.516
				(0.98)	(0.16)
# of Obs.	68	68	68	68	68
Adjusted R^2	16.3 %	17.8 %	11.5 %	6.7 %	19.1 %
F Statistic	7.42***	8.12***	5.28***	3.37**	3.65***
Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
B: The Δ (total number VC deals) as the dependent variable					
Constant	−38.647	−8.158	12.627	16.860	−41.531
	(−1.87)*	(−0.51)	(0.78)	(1.05)	(−1.39)
Δ (Num of IPO)	1.325	1.410	1.455	1.243	1.355
	(2.94)***	(3.16)***	(3.12)***	(2.70)***	(2.96)***
Real GDP growth rate	75.699				65.421
	(3.32)***				(2.15)**
Δ (Industry Production Index)		41.539			
		(3.48)***			
Δ (Unemployment rate)			−120.744		−20.431
			(−2.38)**		(−0.31)
Δ (Annual CPI)				125.640	8.848
				(3.00)***	(0.60)
# of Obs.	68	68	68	68	68
Adjusted R^2	22.8 %	24.0 %	16.9 %	20.7 %	21.0 %
F statistic	10.76***	11.39***	7.69***	9.60***	5.39***
Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5
C: The Δ (the average VC investments per deal) as the dependent variable					
Constant	−0.096	0.013	0.102	−0.021	−0.040
	(−0.72)	(0.12)	(0.99)	(−0.14)	(−0.21)
Δ (Num of IPO)	0.005	0.006	0.006	0.006	0.006
	(1.80)*	(1.92)*	(1.97)*	(1.96)*	(1.85)*
Real GDP growth rate	0.282				0.167
	(1.89)*				(0.84)
Δ (Industry Production Index)		0.165			
		(2.12)**			

Table 4 continued

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5
Δ (Unemployment rate)			−0.601		−0.342
			(−1.88)*		(−0.80)
Δ (Annual CPI)				0.083	0.026
				(0.90)	(0.26)
# of Obs.	68	68	68	68	68
Adjusted R^2	7.6 %	8.9 %	7.6 %	3.7 %	5.9 %
F statistic	3.73**	4.21***	3.70**	2.26	2.03

The sample consists of a total of 68 quarters (observations) from Q1 1995 to Q4 2011. The dependent variables are Δ (total amount of quarterly venture capital investments), Δ (the number of quarterly VC deals), and Δ (The average amount of VC investments per deal), which are the quarterly changes of the three VC variables from Quarter $t-1$ to t. The number of IPOs is the control variable which is the number of companies which filed IPO in a given quarter. The Real GDP Growth Rate measures the quarterly growth rate on the inflation adjusted value of all goods and services produced by residents and non-residents in the US. The Industrial Production Index is used to assess the country's industrial output and the changes in output from the manufacturing, mining, electric and gas industries. The Unemployment Rate is the average number of unemployed citizens over 18 years of age relative to the total labor force. Consumer Price Index (CPI) shows the annual change of value of the consumer basket of goods and services

***, **, * Significance at the 1, 5, and 10 % levels, respectively

we only find that the real GDP growth rate and the changes in the number of IPOs still keep significant, other variables become insignificant.

When we use the changes in the total number of VC deals as the dependent variable in Panel B of Table 4, we find similar results for all of the explanatory variables, even the change in annual CPI is significantly related to the changes of the number of deals ($t = 3.00, p < 0.01$). The regression results in Panel C of Table 4 show the average investing amount per deal is affected by the changes in the macroeconomic variables in the same way as before, but with overall lower significance levels, mostly ranging from 0.05 to 0.10 confidence levels.

In summary, the regression results in Table 3 and Table 4 provide evidence supporting the Macroeconomic Situation Hypothesis (H1) that an expanding economic situation, characterized with a higher GDP growth rate, a greater industry production index, and a lower UR, has a significantly positive impact on the supply of and demand from VC. This, in turns, leads to a greater amount of VC investments, a larger number of deals, and a greater amount of investments in a single deal on average.

5.2 Test of the public market hypothesis

To test the Public Market Hypothesis (H2), we use the signals of public stock and bond markets, including the log value of the total number of IPOs, Russell 2000 Index, NASDAQ Composite, and 10-year T-bond yield at $t-1$ as the independent variables.[4] The regression results are given in Table 5.

Panel A reports the regression results with the total amount of VC investments as the dependent variable. We find in Model 1 and Model 2 that both Russell 2000 index ($t = 3.25, p < 0.01$) and NASDAQ Composite index ($t = 8.55, p < 0.01$) have a positive impact on the aggregate venture investments as expected. The impact of NASDAQ stock market on venture activities is especially strong when the t value is as high as 8.55. We also find that 10-year T-bond yield at $t-1$ is inversely related to total venture investments ($t = -3.29, p < 0.01$), which is consistent with the argument that bonds are alternative investments to VC, so a lower rate can increase the attractiveness of investing in venture funds and increase the willingness of investors to supply capital to venture firms (Gompers and Lerner 1998). The estimated coefficient for the number of IPOs keeps positively significant ($t = 2.48, p < 0.05$) when

[4] We added both the macroeconomic variables and market indicators in the same regressions for H1 and H2, but we found VIFs for some variables are as high as 40–80 due to the multicollinearity problem. Panel B of Table 1 shows the significant correlations among some macroeconomic variables and market indicators.

Table 5 The determinants of VC investments from the public market perspective

Independent variables	Model 1	Model 2	Model 3	Model 4
A: The log of total quarterly VC investments at Year t as the dependent variable				
Constant	21.633	21.491	23.030	21.698
	(−2.92)***	(101.55)***	(79.92)***	(77.78)***
LN(Num of IPOs) ($t-1$)	0.051	−0.010	0.209	0.045
	(0.84)	(−0.24)	(2.48)**	(0.69)
Russell 2000 Index ($t-1$)	0.001			
	(3.25)***			
NASDAQ composite ($t-1$)		0.001		0.001
		(8.55)***		(7.40)***
10-Year T-bond yield ($t-1$)			−0.257	−0.071
			(−3.29)***	(−1.35)
# of Obs.	68	68	68	68
Adjusted R^2	11.3 %	51.5 %	11.7 %	51.7 %
F Statistic	5.29***	36.56***	5.45***	24.91***
Independent variables	Model 1	Model 2	Model 3	Model 4
B: The log of total number VC deals at t as the dependent variable				
Constant	6.237	6.153	6.918	6.273
	(31.93)***	(49.41)***	(44.23)***	(38.20)***
LN(Num of IPOs) ($t-1$)	0.061	0.031	0.142	0.063
	(1.82)*	(1.19)	(3.12)***	(1.63)
Russell 2000 Index ($t-1$)	0.001			
	(2.80)***			
NASDAQ composite ($t-1$)		0.0003		0.0003
		(7.10)***		(6.08)***
10-Year T-bond yield ($t-1$)			−0.131	−0.041
			(−3.10)***	(−1.12)
# of Obs.	68	68	68	68
Adjusted R^2	10.1 %	43.3 %	12.2 %	43.5 %
F statistic	4.75**	26.57***	5.66***	18.20***
Independent Variables	Model 1	Model 2	Model 3	Model 4
Panel C. The log of average VC investments per deal at t as the dependent variable				
Constant	15.396	15.338	16.113	15.425
	(88.83)***	(153.99)***	(113.46)***	(117.23)***
LN(Num of IPOs) ($t-1$)	− 0.009	−0.042	0.066	−0.018
	(−0.32)	(−0.99)	(1.59)**	(−0.58)
Russell 2000 Index ($t-1$)	0.001			
	(3.52)***			
NASDAQ composite ($t-1$)		0.0003		0.0003
		(9.28)***		(8.11)***
10-Year T-bond yield ($t-1$)			−0.126	−0.030
			(−3.27)***	(−1.01)
# of Obs.	68	68	68	68
Adjusted R^2	14.6 %	56.2 %	12.7 %	56.2 %

Table 5 continued

Independent Variables	Model 1	Model 2	Model 3	Model 4
F statistic	6.72***	44.03***	5.86***	29.70***

The sample consists of a total of 68 quarters (observations) from Q1 1995 to Q4 2011. The dependent variables are the log values of total amount of quarterly venture capital investments, the number of quarterly deals, and the average amount of investments per deal at *t*. The number of IPOs is the control variable which is the number of firms which filed IPO in a given quarter. The NASDAQ Composite and Russell 2000 Index are equity indices which follow technology/growth stocks and 2,000 small-cap stocks, respectively. The 10-year T-bond yield is the yield on 10-year US Treasury bonds

***, **, * Significance at the 1, 5, and 10 % levels, respectively

10-year T-bond yield is included as the explanatory variable, but its significance levels disappear when the stock indices are included. One possible explanation is that IPOs are more likely to be successful in a boom stock market than that in a down stock market because higher equity returns can boost venture investors' positive sentiments.

When we use the log value of total number of deals as the dependent variable in Panel B and the log value of the average amount per deal as the dependent variable in Panel C, we obtain similar findings for all the public market indicators. These findings support the Public Market Hypothesis that the superior performance in the equity and bond markets can drive up the supply of and demand from VCs, leading to more deals with more dollars per deal on average.

We further examine the impact of the variation in the public markets on venture industry using the changes in three VC variables relative to the previous year as the dependent variables, and present the regression results in Table 6.

Table 6 reports the regression results with the change in the total amount of VC investments (in Panel A), the total number of deals (in Panel B), and the average amount of investments per deal (in Panel C) as the dependent variables. We find that an increase in the total amount of venture investments is driven by a higher Russell 2000 quarterly return and a superior NASDAQ stock market performance. However, we find a positive relationship between the change in 10-year T-bond yield and the change in the aggregate amount of venture investments, which are different from the results in Table 4, in which the 10-year T-bond yield at $t-1$ is negatively related to total VC investments at *t*. We argue that while the level of low long-term interest rate can boost VC investments (Table 5), the changes in long-term bond yields, which are largely determined by the anticipated inflation rate and the interest rate policies implemented by the Federal Reserve Bank, are more likely to be associated with an expanding economic situation with a potentially higher inflation rate. Central banks usually increase the target interest rates to curb potential high inflation rate in a fast-expanding economy, but cut the target interest rate to stimulate economic growth when the economy is in recession, as the Federal Reserve Bank's near-zero target interest rate policy since the 2008 global financial crisis and economic recession. So a positive relation between the changes in long-term bond yields and the changes in the aggregate venture investments is possible.

The overall regression results in Tables 5 and 6 provide evidence supporting the Public Market Hypothesis that superior performance in the stock and bond markets can positively affect the venture industry by driving up more VC deals with a larger average amount of dollars for each deal. Among these public market indicators, NASDAQ Composite, which is widely followed and closely-watched as an indicator of technology and growth stock performance, is found to be the best predictor of venture activities. Its predicting power is even better than the RUSSELL 2000 index, a small-cap stock market index. We originally expect that venture-backed firms are mostly new and small companies pursuing an IPO, so the RUSSELL 2000 index should have a greater influence on venture activities than other stock indices.

5.3 Test of the Crisis Hypothesis

5.3.1 The impact of the 2000 high-tech bubble

To test H3, we compare the total amount of VC investments, the total number of deals, Stage Funds

Table 6 The changes of public market indicators on venture capital investments

Independent variables	Model 1	Model 2	Model 3	Model 4
A: The Δ (total amount of quarterly VC investments) as the dependent variable				
Constant	−43.438 (−0.17)	−157.50 (−0.73)	248.192 (1.01)	−34.632 (−0.16)
Δ (Num of IPO)	11.521 (1.54)	6.424 (1.00)	14.533 (2.06)**	5.423 (0.87)
Russell 2000 quarterly return	60.109 (2.59)**			
NASDAQ composite quarterly return		88.116 (5.63)***		79.668 (5.08)***
Δ (10-year T-bond Yield)			1,938.133 (3.02)***	1,240.945 (2.21)**
# of Obs.	68	68	68	68
Adjusted R^2	14.3 %	36.6 %	17.1 %	40.2 %
F statistic	6.49***	20.08***	7.80***	15.82***
Independent variables	Model 1	Model 2	Model 3	Model 4
B: The Δ (total number VC deals) as the dependent variable				
Constant	−43.438 (−0.17)	−5.230 (−0.34)	16.860 (1.05)	4.094 (0.26)
Δ (Num of IPO)	1.101 (2.22)**	0.908 (1.96)*	1.243 (2.70)***	0.832 (1.85)*
Russell 2000 Quarterly Return	3.388 (2.21)**			
NASDAQ Composite Quarterly Return		4.237 (3.75)***		3.596 (3.19)***
Δ (10-year T-bond Yield)			125.640 (3.00)***	94.171 (2.33)**
# of Obs.	68	68	68	68
Adjusted R^2	15.9 %	25.8 %	20.7 %	30.6 %
F statistic	7.25***	12.48***	9.60***	10.71***
Independent variables	Model 1	Model 2	Model 3	Model 5
C: The Δ (the average VC investments per deal) as the dependent variable				
Constant	0.015 (0.15)	−0.014 (−0.15)	0.117 (1.14)	0.016 (0.17)
Δ (Num of IPO)	0.003 (1.04)	0.002 (0.67)	0.005 (1.64)	0.002 (0.58)
Russell 2000 Quarterly Return	0.025 (2.69)***			
NASDAQ Composite Quarterly Return		0.030 (4.50)***		0.028 (4.08)***
Δ (10-year T-bond Yield)			0.549 (2.04)**	0.302 (1.22)
# of Obs.	68	68	68	68
Adjusted R^2	12.4 %	25.9 %	8.4 %	26.5 %
F statistic	5.67***	12.54***	4.04**	8.92***

The sample consists of a total of 68 quarters (observations) from Q1 1995 to Q4 2011. The dependent variables are Δ (total amount of quarterly venture capital investments), Δ (the number of quarterly deals), and Δ (The average amount of investments per deal), which are the quarterly changes. The number of IPOs is the control variable which is the number of firms which filed IPO in a given quarter. NASDAQ Composite and Russell 2000 quarterly returns are the rates of return, expressed as a percentage, earned on an investment during a 3-month period. The 10-year T-bond yield is the yield on 10-year US Treasury bonds

***, **, * Significance at the 1, 5, and 10 % levels, respectively

Ratios, Stage Deals Ratios, and Financing Sequences Ratios before and after the 2000 high-tech bubble. For the purpose of robustness tests, we use both a 5-year window (Year −2 to +2) and a 7-year Window (Year −3 to 3) for the analysis. Year 2000 is defined as Year 0. Table 7 reports the analysis results regarding the impact of the 2000 high-tech bubble on the venture industry.

The left column of the first section in Table 7 shows the impact of the high-tech crash on the total amount of VC investments. We find that the mean quarterly venture investments decreased from $9,496.8 million before the dot-com bubble to $7,900.7 million after the high-tech crash during a 5-year time window. The quarterly change in VC investments, which is the difference of two consecutive quarters, is positive ($2,363.4 M) before the high-tech bubble and became a negative number (–$2,199.0 M) after 2000. The *t*-test results show that the mean quarterly VC investments are significantly different ($t = 2.88$, $p < 0.05$). Furthermore, the quarterly growth in venture investments, which is defined as the quarterly change of the venture investments divided by the number in the previous quarter, is 25.99 %

Table 7 Impact of the 2000 high-tech bubble on venture capital investments

Variable	Years (−2, −1) versus Years (1, 2)			Years (−3, −1) versus Years (1, 3)		
	Before	After	*t* statistic	Before	After	*t* statistic
1. Total investments:						
Amount ($M)	9,496.8	7,900.7	0.63	7,574.6	6,907.3	0.35
Quarterly change ($M)	2,363.4	−2,199.0	2.88**	1,680.0	−1,373.5	2.69**
Quarterly growth	25.99 %	−16.89 %	3.66***	20.37 %	−9.17 %	3.25***
2. The number of deals						
Number of deals	1,065	971	1.30	1,045	898	1.29
Quarterly change	121	−129	2.79**	92	−81	2.69**
Quarterly growth	10.57 %	−9.65 %	2.77**	8.60 %	−5.73 %	2.63**
3. Stage funds ratios						
Stages ①/④	1.226	0.840	2.35**	1.279	0.767	4.34***
Stages (① + ②)/④	1.637	0.916	4.04***	1.743	0.839	6.56***
Stages (① + ②)/(③ + ④)	0.447	0.266	3.87***	0.460	0.263	5.76***
4. Stage Deals Ratios						
Stages ①/④	2.557	1.868	1.90*	2.494	1.673	3.21***
Stages (① + ②)/④	3.959	2.262	4.39***	3.904	2.049	6.83***
Stages (① + ②)/(③ + ④)	0.831	0.507	9.07***	0.823	0.509	11.57***
5. Financing sequence ratios						
Sequences ①/others	0.462	0.229	9.45***	0.472	0.230	12.88***
Sequences (① + ②)/others	1.242	0.731	6.46***	1.266	0.293	8.58***
Sequences (① + ②+③)/others	2.760	1.874	5.73***	2.771	1.701	6.85***

The sample consists of a total of 28 quarters (observations) from Q1 1997 to Q4 2003. This table compares the mean values of the total amount of venture capital investments, the total number of VC deals, and the average amount of VC investments per deal in a quarterly basis during a 5-year window (Year −2 to +2) and a 7-year window (Year −3 to +3), respectively, where Year 2000 is defined as Year 0. Quarterly Change is defined as the difference from Quarter $t - 1$ to t. Quarterly growth is defined as the quarterly change divided by the value in Quarter $t - 1$. Four stages of venture capital investment are as follows: Stage ① = Seed/Start-up Stage; Stage ② = Early Stage; Stage ③ = Expansion Stage; Stage ④ = Later Stage. Stage Funds Ratios are defined as the amount of venture funds invested in the earlier stages to the investments in the later stages. Stage Deals Ratios are defined as the number of deals invested in the earlier stages to the number of deals in the later stages. According to *MoneyTree* report, financing sequences record VC investments as the cash is actually received by the company as opposed to when a VC financing is committed. Financing Sequence Ratios are defined as the relative amount of cash that is actually received in the earlier sequences to the cash received in the later sequences. The *t* statistic is used to assess the significance of quarterly mean comparisons

***, **, * Significance at the 1, 5, and 10 % levels, respectively

before 2000 and −16.89 % after the bubble, which are significantly different ($t = 3.66$, $p < 0.01$). These results suggest that venture investors significantly cut their overall investing dollars after the 2000 high-tech crash. As robustness tests, we repeat t tests using a 7-year window from Year −3 to +3 in the right column of Panel A and obtain similar results.

The second section compares the total number of venture deals around the 2000 high-tech crash. We find that there were fewer deals secured after 2000 compared to the number before the crash. The quarterly changes and quarterly growth rate in the total number of deals also drop from positive before 2000 to negative thereafter, and the mean differences are significant ($t = 2.79$ and 2.77 respectively, $p < 0.05$).

The third section of Table 7 presents the comparison results for the VC Stage Funds Ratios, which are defined as the relative amount of venture funds invested in the earlier-stages projects to the dollars for the later-stages firms. We test three Stage funds ratios ①/④, (① + ②)/④, *and* (① + ②)/(③ + ④) for the purpose of robustness tests, and assume venture capitalists, in a response to the high-tech crash, would make adjustments to their risk preferences and investment strategies quickly by investing a greater proportion of their funds in the later-stage projects carrying a lower level of uncertainty and allowing them to exit sooner. As we have assumed, all three Stage Funds Ratios become significantly lower after 2000. For example, the *Stage Funds Ratio* ①/④, which is the total dollars invested in the Seed/Start-up Stage firms over the dollars for the Later-Stage companies, was 1.226 before the bubble. This means that the aggregate amount of venture funds allocated in the Seed/Start-up Stage is 122.6 % of the total amount invested in the later stage. This percentage drop to only 84.0 % after 2000 and the t test for the difference is significant ($t = 2.35, p < 0.05$). It seems that venture firms indeed adjust their risk and investment strategies by shifting more dollars to the later-stage projects with a much lower risk. This conclusion consistently holds when we use both the 5- and 7-year windows.

The next section in Table 7 has the t test results for Stage Deals Ratios, which are the number of deals for the earlier-stages projects relative to the number of deals sealed at later stages. There are three Stage Deals Ratios ①/④, (① + ②)/④, *and* (① + ②)/(③ + ④). We expect that more venture deals went to later-stages projects after the high-tech bubble. As expected, all three Stage Deals Ratios become significantly lower after 2000. For example, the *Stage Deals Ratio* ①/④, which is the number of deals secured at the Seed/Start-up Stage over the number of deals for the Later-Stage projects, is 2.56 before the crash. This means that the total number of deals occurred at the Seed/Start-up Stage is approximately 2.56 times the number secured in the later stage. However, this number drops to 1.87 after 2000, and the differences are significant ($t = 1.90$, $p < 0.10$). Similar conclusions are drawn from the other two Stage Deals Ratios *(*① + ②*)/*④ and *(*① + ②*)/(*③ + ④*)* and from the robustness tests using the 7-year time window.

In the last section of Table 7, we examine the aggregate amount of the cash that was actually received by the entrepreneurs in different financing sequences. VC Financing Sequence Ratios are defined as the relative amount of cash that is actually received in the earlier sequences to the cash received in the later sequences of VC financing. We calculate three *Financing Sequence Ratios, ①/Others, (*① + ②*)/Others,* and (① + ②+③*)/Others*, and expect a lower percentage of cash is injected into the company in the first several financing sequences due to the negative impact of the high-tech bubble in 2000. The t-test results do support this argument. All of the three Financing Sequence Ratios are significantly lower after the bubble. For example, *Financing Sequence Ratio ①/Others*, the total cash received in the first sequence over the cash received in all later sequences, is 0.462 before the bubble, suggesting the cash received in the first sequence was 46.2 % of the cash received in all later financing sequences. This ratio is down to only 22.9 % after the high-tech stock crash and the difference is strongly significant ($t = 9.45$, $p < 0.01$). The sudden collapse of the dot-com bubble and the venture industry, which brought down many high-tech companies, made venture firms more cautious and risk averse on their investments, so they choose to inject a lower proportion of their committed capital into the invested companies in the first financing sequence. They would like to "wait and see" how the new projects develop, and then decide whether or not to continue their supports for the invested firms in the later financing sequences. These findings consistently hold in the 5-year-window tests and the 7-year-window tests.

To further examine the impact of the cash of 2000 high-tech bubble on venture firms' risk aversion and investment strategies, we employ multiple regressions by adding the 2000 high-tech bubble dummy variable as a key explanatory variable. The dependent variables are Stage Funds Ratios, Stage Deals Ratios, and Financing Sequence Ratios. We define the 2000 high-tech bubble dummy as 1 for each quarter before the high-tech stock market crash in Q1 2000, and assign it as 0 after that. To avoid the multicollinearity problem, we only include the IPI, NASDAQ quarterly return, and the number of IPOs change as the control variables and use the data from Q1 1997 to Q4 2003 to estimate the models. The regression results are reported in Table 8.

The regression results in Table 8 are consistent with the findings from the univariate analysis in Table 7. When we use the three Stage Funds Ratios as the dependent variables in the three models respectively, the estimated coefficients for the high-tech bubble dummy variable are all positive and highly significant at 1 % or higher confidence levels ($t = 6.36$ for Stage Funds Ratio ①/④; $t = 4.18$ for Stage Funds Ratio (① + ②)/④; and $t = 3.98$ for Stage Funds Ratio (① + ②)/(③ + ④)) even after we control some macroeconomic and market factors. This

Table 8 Impact of the 2000 high-tech bubble on venture firms' risk and investment strategies

Dependent Variables	Constant	Bubble dummy	IPI ($t-1$)	NASDAQ ($t-1$)	Δ (# of IPO)	# of Obs.	Adjusted R^2(%)	F statistic
Stage funds ratios (t)								
Stages ①/④	1.948	0.247	−0.018	−0.002	−0.017	28	87.6	48.9***
	(5.46)***	(6.36)***	(−4.21)***	(−2.15)**	(−1.10)			
Stages (① + ②)/④	1.421	0.848	0.004	−0.006	−0.164	28	54.7	9.16***
	(0.76)	(4.18)***	(0.18)	(−1.62)	(−1.98)*			
Stages (① + ②)/(③ + ④)	0.756	0.175	−0.003	−0.002	−0.035	28	59.7	11.02***
	(1.87)**	(3.98)***	(−0.70)	(−1.98)*	(−1.95)*			
Stage Deals Ratios (t)								
Stages ①/④	1.284	0.931	0.001	−0.003	−0.066	28	82.1	32.02***
	(1.17)	(7.78)***	(0.09)	(−1.18)	(−1.34)			
Stages (① + ②)/④	−8.622	2.445	0.150	−0.006	−0.280	28	42.2	5.94***
	(−1.72)*	(4.49)***	(2.51)**	(−0.59)	(−1.26)			
Stages (① + ②)/(③ + ④)	−0.02	0.330	0.010	−0.001	−0.039	28	62.8	12.41***
	(−0.04)	(5.64)***	(1.57)	(−0.57)	(−1.61)			
Financing sequence ratios (t)								
Sequences ①/others	0.744	0.197	−0.003	−0.000	−0.014	28	75.7	22.06***
	(2.34)**	(5.69)***	(−0.84)	(−0.34)	(−0.96)			
Sequences (① + ②)/others	1.223	0.540	0.001	−0.003	−0.064	28	54.1	8.97***
	(1.03)	(4.17)***	(0.08)	(−1.17)	(−1.21)			
Sequences (① + ②+③)/others	1.132	1.085	0.021	−0.008	−0.207	28	37.4	5.04***
	(0.38)	(3.38)***	(0.61)	(−1.37)	(−1.58)			

The sample consists of a total of 28 quarters (observations) from Q1 1997 to Q4 2003. Four stages of venture capital investment are denoted as follows: Stage ① = Seed/Start-up Stage; Stage ② = Early Stage; Stage ③ = Expansion Stage; Stage ④ = Later Stage. Stage Funds Ratios are defined as the amount of venture funds invested in the earlier stages to the investments in the later stages. Stage Deals Ratios are defined as the number of deals invested in the earlier stages to the number of deals in the later stages. Financing Sequence Ratios are defined as the relative amount of cash that is actually received in the earlier sequences to the cash received in the later sequences. The bubble dummy is defined as 1 before the high-tech stock market crash at the end of Q1 2000, and is assigned as 0 thereafter. IPI ($t-1$) is the Industry Production Index at $t-1$, NASDAQ ($t-1$) is the quarterly return of NASDAQ Composite at $t-1$, and Δ (# of IPO) is defined as the quarterly change of log value of the number of IPOs. The t statistic is used to assess the significance of independent variables

***, **, * Significance at the 1, 5, and 10 % levels, respectively

indicates that venture capitalists become more cautious in risk taking after the 2000 high-tech bubble. They shift more dollars to later-stages investments which have a much lower risk. Similarly, when we use the three Stage Deals Ratios as the dependent variables, the estimated coefficients for the bubble dummy are all positive and strongly significant ($t = 7.78$ for Stage Deals Ratio ①/④; $t = 4.49$ for Stage Deals Ratio (① + ②)/④; and $t = 5.64$ for Stage Deals Ratio (① + ②)/(③ + ④); $p < 0.01$). This provides further evidence that more later-stages deals succeeded after the dot-com bubble. When we use the three Financing Sequence Ratios as the dependent variables, the estimated coefficients for the bubble dummy variable are also all significantly positive ($t = 5.69$ for Financing Sequence Ratio ①/Others; $t = 4.17$ for Financing Sequence Ratio (① + ②)/Others; and $t = 3.38$ for Financing Sequence Ratio (① + ②+③)/Others; $p < 0.01$). This indicates that venture firms are risk averse on their investments due to the market collapse, so in a response, they inject a lower proportion of the committed capital into the invested companies in the first several financing sequences.

The overall results in Tables 7 and 8 suggest that venture capitalists, also entrepreneurs, become more conservative due to the large number of failed dot-com start-ups and the crash of the high-tech stock market in 2000. The fundamental changes in the macroeconomic situations have forced venture firms to adjust their risk and investment strategies through investing less funds and securing fewer deals. Even when venture capitalists decide to invest, they shift a significant percentage of funds and seek more deals in the projects at the expansion stages and later stages rather than the start-ups and early-stage firms. They also reduce the percent of cash to the invested companies in the first several sequences of financing as opposed to committed capital after the bubble.

5.3.2 *The impact of the 2008 financial crisis*

We use *t* tests to examine the same set of variables for the 2008 financial crisis and report the univariate comparison results in Table 9.

The results in Table 9 show mixed results for the 2008 financial crisis compared to the findings in Table 7 for the 2000 high-tech bubble. Due to the worldwide financial crisis and economic recession, US venture firms reduce the risk exposure of their investment portfolios through investing less amount overall, securing fewer deals, and injecting less cash in the first several sequences of financing as opposed to their committed capital. However, we do find some striking differences of the impact of the 2008 financial crisis on the VC industry. First, the impact of the financial crisis on the VC industry is less dramatic than that of the 2000 high-tech crash. Although there are lower value and fewer deals secured in the venture industry after the 2008 financial crisis, the two measures of the changes in total investments and the number of deals, quarterly changes and growth rates, are not significantly different before and after 2008. It seems that, just before the financial crisis, venture firms were still on the way to recover from the collapse of the high-tech bubble when the total venture investments peaked at $105.2 billion and the number of deals was over 8,000 in 2000.

Second, we find that Stage Funds Ratios and Stage Deals Ratios show a totally different pattern. While a lower percentage of VC dollars and deals go to start-ups and early-stage companies after the 2000 high-tech bubble, in a contrast, a higher proportion of venture dollars and deals were allocated to the earlier-stages projects after the 2008 crisis. For example, the *Stage Funds Ratio* ①/④ was 0.473 before the crisis, indicating that the total amount of venture funds allocated to the Seed/Start-up Stage firms is 47.3 % of the total amount invested in the later stage. This number increases to 78.3 % after the 2008 financial crisis and economic recession and the *t* test for the difference is significant ($t = -3.71$, $p < 0.01$). The *Stage Deals Ratio* ①/④ is 0.91 before the crisis and the ratio increases to 1.29 after the crisis and the difference is also significant ($t = -3.07$, $p < 0.01$). These findings indicate that venture capitalists still invest more funds and secure more deals for earlier-stages projects and start-ups despite the global financial crisis and economic recession since 2008. We argue that this phenomenon happens due to two reasons. First, there is only a 7-year time span between the 2000 high-tech bubble and the 2008 financial crisis. The dramatic collapse of the venture industry in 2000 caused venture capitalists to make adjustments to their investment strategy, and this process is still on the way to the financial crisis. For example, the *Stage Deals Ratio* ①/④ was 0.473 just before 2008, which is

Table 9 Impact of the 2008 financial crisis on venture capital investments

Variable	Years (−2, −1) versus Years (1, 2)			Years (−3, −1) versus Years (1, 3)		
	Before	After	*t* statistic	Before	After	*t* statistic
1. Total investments						
Total amount ($M)	7,415.0	5,434.6	4.91***	6,909.5	6,049.6	1.94*
Quarterly change ($M)	319.2	−76.8	0.74	163.6	72.1	0.22
Quarterly growth	4.81 %	1.78 %	0.32	2.78 %	3.47 %	−0.10
2. The number of deals						
Total number of deals	997	831	3.39***	937	866	1.55
Quarterly change	34	−9	0.63	21	−5	0.52
Quarterly growth	3.98 %	0.69 %	0.42	2.66 %	0.80 %	0.32
3. Stage funds ratios						
Stages ①/④	0.473	0.783	−3.71***	0.453	0.811	−5.70***
Stages (① + ②)/④	0.608	1.046	−4.51***	0.577	1.020	−6.23***
Stages (① + ②)/(③ + ④)	0.305	0.480	−4.99***	0.294	0.480	−7.39***
4. Stage Deals Ratios						
Stages ①/④	0.910	1.290	−3.07***	0.883	1.414	−4.77***
Stages (① + ②)/④	1.302	1.739	−2.88**	1.228	1.869	−4.82***
Stages (① + ②)/(③ + ④)	0.601	0.803	−4.24***	0.574	0.865	−6.38***
5. Financing sequence ratios						
Sequences ①/others	0.313	0.225	4.91***	0.322	0.220	6.91***
Sequences (① + ②)/others	0.722	0.504	7.76***	0.744	0.493	10.05***
Sequences (① + ②+③)/others	1.337	0.976	6.95***	1.416	0.951	8.49***

The sample consists of a total of 28 quarters (observations) from Q1 2005 to Q4 2011. This table compares the mean values of VC investments, the number of VC deals, and the average amount of VC investments per deal in the quarterly basis during a 5-year window (Year −2 to +2) and a 7-year window (Year −3 to +3), respectively, where Year 2008 is defined as Year 0. Quarterly Change is defined as the difference from Quarter $t - 1$ to t. Quarterly growth is defined as the quarterly change divided by the value in Quarter $t - 1$. Four stages of venture capital investment are as follows: Stage ① = Seed/Start-up Stage; Stage ② = Early Stage; Stage ③ = Expansion Stage; Stage ④ = Later Stage. Stage Funds Ratios are defined as the amount of venture funds invested in the earlier stages to the investments in the later stages. Stage Deals Ratios are defined as the number of deals invested in the earlier stages to the number of deals in the later stages. According to *MoneyTree* report, financing sequences record VC investments as the cash is actually received by the company as opposed to when a VC financing is committed. Financing Sequence Ratios are defined as the relative amount of cash that is actually received in the earlier sequences to the cash received in the later sequences. The *t* statistic is used to assess the significance of quarterly mean comparisons

***, **, * Significance at the 1, 5, and 10 % levels, respectively

much lower than the ratio 1.226 before 2000. Therefore, the impact of the 2008 financial crisis on the venture industry, which mainly affects the mortgage and banking sectors, is less severe than that of the 2000 high-tech bubble. Second, the sudden rise and dramatic success of many social media start-ups in the past years, like Facebook, Twitter, and LinkedIn, have attracted venture capitalists and also entrepreneurs to invest heavily in the social media start-ups.

To further examine the effect of 2008 global financial crisis on venture firms' risk aversion changes, we employ multiple regressions by using the 2008 financial crisis bubble dummy variable as one of the explanatory variables, and Stage Funds Ratios, Stage Deals Ratios, and Financing Sequence Ratios as the dependent variables. We define the 2008 financial crisis dummy as 1 before the stock market hit record high in Q1 2008, and assign it as 0 after that. We include IPI, NASDAQ quarterly return, and the number of IPOs change as control variables, and use the data from Q1 2005 to Q4 2011 to estimate the models. The regression results are in Table 10.

The regression results in Table 10 confirm the findings in Table 9. When we use three Stage Funds

Table 10 The impact of 2008 financial crisis on venture firms' risk and investment strategies

Dependent variables	Constant	Crisis Dummy	IPI ($t-1$)	NASDAQ ($t-1$)	Δ (# of IPO)	# of Obs.	Adjusted R^2	F statistic
Stage funds ratios (t)								
Stages ①/④	0.566	−0.046	− 0.005	−0.000	0.025	28	28.4 %	3.68**
	(1.41)	(−1.33)	(−1.11)	(−0.35)	(1.25)			
Stages (① + ②)/④	1.096	−0.364	−0.006	0.004	0.101	28	59.9 %	11.07***
	(1.04)	(−4.01)***	(−0.51)	(1.10)	(1.92)*			
Stages (① + ②)/(③ + ④)	0.519	−0.155	−0.002	0.001	0.046	28	65.5 %	13.80***
	(1.28)	(−4.47)***	(−0.559)	(0.44)	(2.27)**			
Stage Deals Ratios (t)								
Stages ①/④	−0.340	−0.156	0.007	0.003	0.016	28	30.6 %	3.97**
	(−0.67)	(−3.56)**	(1.33)	(1.50)	(0.62)			
Stages (① + ②)/④	1.061	−0.584	0.001	0.008	0.054	28	29.1 %	3.77**
	(0.43)	(−2.75)**	(0.05)	(0.92)	(0.43)			
Stages (① + ②)/(③ + ④)	0.167	−0.296	0.004	0.003	0.039	28	41.5 %	5.79***
	(0.18)	(−3.67)***	(0.43)	(0.97)	(0.82)			
Financing sequence ratios (t)								
Sequences ①/Others	0.104	0.068	0.002	−0.001	−0.003	28	53.1 %	8.63***
	(0.45)	(3.39)***	(0.94)	(−0.69)	(−0.22)			
Sequences (① + ②)/Others	−0.114	0.154	0.009	−0.001	−0.0001	28	61.5 %	11.78***
	(−0.22)	(3.46)***	(1.68)	(−0.45)	(−0.004)			
Sequences (① + ②+③)/others	0.286	0.319	0.012	−0.001	−0.025	28	54.5 %	9.08***
	(0.26)	(3.39)***	(1.05)	(−0.18)	(−0.47)			

The sample consists of a total of 28 quarters (observations) from Q1 2005 to Q4 2011. Four stages of venture capital investment are denoted as follows: Stage ① = Seed/Start-up Stage; Stage ② = Early Stage; Stage ③ = Expansion Stage; Stage ④ = Later Stage. Stage Funds Ratios are defined as the amount of venture funds invested in the earlier stages to the investments in the later stages. Stage Deals Ratios are defined as the number of deals invested in the earlier stages to the number of deals in the later stages. Financing Sequence Ratios are defined as the relative amount of cash that is actually received in the earlier sequences to the cash received in the later sequences. The Crisis Dummy is defined as 1 before the financial crisis in Q1 2008, and is assigned as 0 thereafter. IPI ($t-1$) is the Industry Production Index at $t-1$, NASDAQ ($t-1$) is the quarterly return of NASDAQ Composite at $t-1$, and Δ (# of IPO) is defined as the quarterly change of log value of the number of IPOs. The t statistic is used to assess the significance of independent variables

***, **, * Significance at the 1, 5, and 10 % levels, respectively

Ratios and Stage Deals Ratios as the dependent variables respectively, the estimated coefficients for the financial crisis dummy variable are mostly negative and statistically significant. This indicates that venture firms, even under a tough economic environment caused by the global financial crisis and economic recession, still invest more funds in more early-stages deals, partly due to the dramatic success of social media start-ups during that period. However, we find that the impact of financial crisis on the Financing Sequence Ratios are similar to that of the 2000 high-tech bubble. The estimated coefficients for the crisis dummy variables are all positive and significant ($t = 3.39$ for Financing Sequence Ratio ①/Others; $t = 3.46$ for Financing Sequence Ratio (① + ②)/Others; and $t = 3.39$ for Financing Sequence Ratio(① + ②+③)/Others, $p < 0.01$), suggesting venture firms inject a lower proportion of committed capital into the invested projects in the first several financing sequences after 2008.

6 Robustness tests

This study employs multiple regression models to examine the impact of macroeconomic and public

market indicators on the venture industry. One potential concern is whether the long-term equilibrium exists in the data series. To address this concern, we conduct the Engle–Granger (EG) test for cointegration, which is a two-step residual-based test. First, VC variables are regressed on a constant and the explanatory variables (i.e. macroeconomic variables, public market indicators) and the residuals are calculated. Then, the first difference of the residuals is regressed on the lagged level of the residuals without a constant. The test statistic is the OLS t-statistic on the lagged residual. Rejection of the null hypothesis indicates the residual is stationary, which means the series are cointegrated. For example, in Model 5 (Panel A of Table 3), the dependent variable is the quarterly investments and the independent variables consist of the number of IPOs, Real GDP, and UR. We conduct the EG test and find that the estimated coefficient ($t = 14.39$) for the lagged level of residuals is highly significant at 0.1 % confidence level, so we reject the null hypothesis and conclude that the residual is stationary, so the cointegration does exist in the data series. The unit-root tests also confirms the first order of integration $I(1)$. Therefore, we revise the model by adding the lagged residual term at $t - 1$ and test the following first-order error correction model.

$$\Delta VC_t = \beta_1 \Delta IPO_t + \beta_2 \Delta GDP_t + \beta_3 \Delta UR_t - \lambda RES_{t-1} + \mu_t$$

In the above model, ΔVC_t, ΔIPO_t, ΔGDP_t, and ΔUR_t are the quarterly changes of VC investments, the number of IPOs, the real GDP, and UR from Quarter $t - 1$ to t. The residual term is defined as follows.

$$RES_{t-1} = VC_{t-1} - \partial_0 - \partial_1 IPO_{t-1} - \partial_2 GDP_{t-1} - \partial_3 UR_{t-1}.$$

We estimate the above first-order error correction model and obtain mostly similar results as that in the original Model 5 (Panel A in Table 3). The estimated coefficients for ΔIPO_t and ΔGDP_t are positive and significant ($t = 2.10$ and 2.09 respectively, both with $p < 0.05$). But ΔUR_t has a negative coefficient which is insignificant statistically ($t = -0.31$). Consistent with the cointegration test, the lagged residue term RES_{t-1} has a significant effect ($t = -2.33$, $p < 0.05$). We conclude that the regression results from the revised error correction model continue to support H1.

We further explore the potential endogenous relation between venture variables and macroeconomic variables, which might be jointly and endogenously determined. As mentioned in the introduction in this study, US venture-backed companies generated nearly $2.9 trillion in revenue, representing the equivalent of 21 % of the US GDP in 2008. So we perform the causality tests with first order of integration to check the long run causality between VC investments and real GDP. We find that while there is a significant effect of real GDP on VC activities ($t = 2.09$, $p < 0.05$), VC investments are also found to influence economic growth measured by real GDP significantly ($t = 2.30$, $p < 0.01$). This indicates a bi-directional relationship between VC activities and economic growth does exist.

We use similar methods to test the models for the Public Market Hypothesis. For example, we choose Model 4 in Table 5 to conduct conintegration tests between venture variables and market indicators. The estimated coefficient ($t = 2.32$) for the lagged level of residuals is not very strong as that for the macroeconomic variables, but is still significant at 5 % confidence level. Further unit-root tests also reveal the first order of integration $I(1)$. So we construct the following first-order error correction model.

$$\Delta VC_t = \beta_1 \Delta IPO_t + \beta_2 \Delta NASDAQ_t + \beta_3 \Delta TB_t - \lambda RES_{t-1} + \mu_t$$

In the above model, ΔVC_t, ΔIPO_t, $\Delta NASDAQ_t$, and ΔTB_t are the quarterly changes of VC investments, the number of IPOs, NASDAQ Composite, and 10-year T-bond yield from Quarter $t - 1$ to t. The residual term is defined as follows.

$$RES_{t-1} = VC_{t-1} - \partial_0 - \partial_1 IPO_{t-1} - \partial_2 NASDAQ_{t-1} - \partial_3 TB_{t-1}.$$

We estimate the improved model and obtain the results that are consistent with our proposed H2. Similar to the findings in Model 4 of Panel A (Table 5), the estimated coefficients for $\Delta NASDAQ_t$ is strongly significant and positive ($t = 5.19$, $p < 0.001$). However, both ΔIPO_t and ΔTB_t are insignificant statistically. The estimated coefficient for the lagged residual term RES_{t-1} is significant ($t = -6.71$, $p < 0.001$) as predicted. Therefore, the ECM estimation results support the Public Market Hypothesis.

We also explore the potential endogenous relation between VC variables and public market indicators. Since the NASDAQ Composite has been found to strongly impact venture activities, we perform causality tests with first order of cointegration to check whether there is long run causality between VC activities and high-tech stock market performance. We find evidence indicating a strong endogenous relationship between the two variables ($t = 5.19$ and 2.96 respectively, $p < 0.01$). So we conclude that there is bi-directional causality between VC investments and the public market indicators.

In summary, the robustness tests for cointegration, the estimation of the error correction model, and the causality tests reveal that although VC variables and macroeconomic variables as well as public market indicators have cointegeration, all of the empirical results from these models continue to support our proposed hypotheses.

7 Conclusions and discussions

Relatively few studies have examined the macroeconomic drivers of VC investments. This study helps fill the void using a sample of venture investment data in the United States over a 17-year period from 1995 to 2011 to examine the impact of macroeconomic and market factors on the venture industry.

We find evidence supporting the Macroeconomic Situation Hypothesis that an expanding economy with a higher GDP growth rate, a greater industry production index, and a lower UR has a positive impact on the VC industry by increasing the number of deals and the average investments for a single deal in general. The Public Market Hypothesis that the superior performance in the stock and bond markets can positively affect VC industry and drive up VC investments is also validated. The NASDAQ Composite, the most widely-followed index for technology and growth stocks, is the best predictor of VC activities, better than the small-cap stock market index, the RUSSELL 2000 index.

The analysis of total amount VC investments, total number of deals, Stage Funds Ratios, Stage Deals Ratios, as well as Financing Sequence Ratios which are used to gauge how venture firms make adjustments to their investment strategy in response to the 2000 high-tech bubble and the 2008 financial crisis, present consistent findings supporting the Crisis Hypothesis. We find that venture firms became more cautious and risk averse due to a large number of failed dot-com start-ups and the severe crash occurred in 2000. The fundamental change in the macroeconomic and industry conditions have forced venture firms to make adjustments to their investment strategies accordingly by investing less dollars and securing fewer deals, shifting a significant percentage of their deals and dollars to the later-stages companies, and injecting a lower proportion of cash in the first several sequences of financing as opposed to their overall committed amount of venture funds. We also find some differences regarding the impact of the 2008 financial crisis compared to the 2000 high-tech bubble. The impact of the 2008 financial crisis on the VC industry is less dramatic than that of the 2000 high-tech crash because venture firms were still on the way to recover from its 2000 peak just before the 2008 financial crisis. The empirical analysis results regarding Stage Funds Ratios and Stage Deals Ratios indicate that venture capitalists even increase their investments in the earlier-stages projects and start-ups despite the global financial crisis and economic recession in 2008 due to the success of the social media industry, which has largely captured the attention of venture investors.

Our study contributes to the literature by exploring the macroeconomic and public market driving factors of US VC investments. Our major findings have useful implications for both venture capitalists and start-up companies seeking venture financing. Venture capitalists can take appropriate steps to adjust their risk and investment strategies in response to the changes in the identified macroeconomic and public market indicators. For those newly-formed companies seeking venture financing, the best time to secure a deal with a large amount of financing is the time when the public market is moving upward and the key economic indicators are in the expanding mode.

Limitations do exist in this study. First, the impact of the 2008 financial crisis on VC investments is somewhat different from that of the 2000 high-tech crash. One explanation is the dramatic rise and success of social media start-ups during the period. But we have no venture data specifically for the social media industry to further isolate the impact of social media start-ups in the test of Crisis Hypothesis (H3). The research on this issue in the future can provide us more insights on the phenomena. Second, we only have the aggregate quarterly VC data in the US, so we cannot test our proposed hypotheses for other countries and regions,

and the findings in this study should be generalized to other countries/regions cautiously. Another limitation is that we only have a total of 68 quarters (observations) from Q1 1995 to Q4 2011, and the limited number of observation prevent us from including more control variables (i.e. labor market conditions, financial reporting standards, government programs, private pension funds, etc.) in our regression models. Finally, we do not examine how the changes in macroeconomic situations and public market and the economic storms affect VC deals, venture capitalists, and entrepreneurs in the microeconomic level. Further study in these areas can produce more interesting and insightful findings.

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References

Acs, Z., & Audretsch, D. (1991). *Innovation and technological change, an international comparison*. England: Harvester Wheatsheaf.

Alhorr, H., Moore, C., & Payne, G. (2008). The impact of economic integration on cross-border venture capital investments: evidence from the European Union. *Working Paper*, Baylor University.

Croce, A., D'Adda, D., & Ughetto, E. (2014). Venture capital financing and the financial distress risk of portfolio firms: How independent and bank-affiliated investors differ. *Small Business Economics*. doi:10.1007/s11187-014-9582-4

Cumming, D. (2008). Contracts and exits in venture capital finance. *Review of Financial Studies, 21*, 1948–1982.

Gilson, R., & Black, B. (1997). Venture capital and the structure of capital markets. *Journal of Financial Economics, 47*, 243–277.

Giot, P., & Schwienbacher, A. (2007). IPOs, trade sales and liquidations: Modeling venture capital using survival analysis. *Journal of Banking & Finance, 31*, 679–702.

Gompers, P., Kovner, A., Lerner, J., & Scharfstein, D. (2008). Venture capital investment cycle: The impact of public markets. *Journal of Financial Economics, 87*, 1–23.

Gompers, P., & Lerner, J. (1998). What drives venture capital fundraising? *Brrokings Papers ob Economic Activity: Microeconomics*, 149–204.

Gompers, P., & Lerner, J. (2001). The venture capital revolution. *Journal of Economic Perspectives, 15*, 145–168.

Haro-de-Rosario, A., Caba-Pérez, M., & Cazorla-Papis, L. (2014). Efficiency of venture capital firms: Evidence from Spain. *Small Business Economics, 43*(1), 229–243.

Hellman, T., & Puri, M. (2000). The interaction between product and financing strategy: The role of venture capital. *Review of Financial Studies, 13*, 959–984.

IHS Global Insight. (2009). *Venture impact: the economic importance of venture capital-backed companies to the US economy*. USA: The National Venture Capital Association.

Jeng, L., & Wells, P. (2000). The determinants of venture capital funding: Evidence across countries. *Journal of Corporate Finance, 6*, 241–289.

Kaplan, S., & Scholar, A. (2005). Private equity performance: Returns, persistence, and cash flows. *Journal of Finance, 60*(4), 1791–1823.

Kaplan, S., & Stromberg, P. (2003). Financial contracting theory meets the real world: An empirical analysis of venture capital contracts. *Review of Economic Studies, 70*, 281–315.

Kaplan, S., & Stromberg, P. (2004). Characteristics, contracts, and actions: Evidence from venture capital analyses. *Journal of Finance, 59*, 2177–2210.

Kortum, S., & Lerner, J. (2000). Assessing the contribution of venture capital to innovation. *RAND Journal of Economic, 21*, 674–692.

Lerner, J. (1995). Venture capitalists and the oversight of private firms. *Journal of Finance, 50*, 301–318.

Megginson, W., & Weiss, K. (1991). Venture capitalist certification in initial public offering. *Journal of Finance, 46*, 879–903.

Nahata, R. (2008). Venture capital reputation and investment performance. *Journal of Financial Economics, 90*, 127–151.

Poterba, J. (1989). Venture capital and capital gains taxation, tax policy and the economy. In H. Lawrence (Ed.), *Summers*. Cambridge: MIT Press.

Rin, M., Nikodano, G., & Sembenelli, A. (2005). *Public policy and the creation of active venture capital markets*. European Central Bank Working paper.

Sahlman, W. (1990). The structure and governance of venture capital organizations. *Journal of Financial Economics, 27*, 473–521.

Sorensen, M. (2007). How smart is smart money? A two-sided matching model of venture capital. *Journal of Finance, 62*, 2725–2762.