Economic and capital market antecedents of venture capital commitments (1960–2010)

Steven A. Carvell
Cornell University

Jin-Young Kim
Cornell University

Qingzhong Ma
Cornell University

Audrey D. Ukhov
Cornell University

Using vector autoregression technique, we examine the interrelation between venture capital flows, economic development, capital market fund-raising activities, and capital market valuation, based on annual data of the United States over the past half-century. We find that venture capital commitments appear to be correlated with GDP and capital market valuation. While capital market fund-raising activities (Initial Public Offerings and Seasoned Equity Offerings) are also correlated with venture capital flows, these effects are subsumed by GDP, indicating that the overall economy drives both venture capital flows and capital market financing activities. Analyses from impulse response functions suggest that shocks to GDP have a permanent effect on venture capital flows, while the impact of capital market valuation (Standard & Poor 500 returns) on venture capital flows is rather short lived. Overall, both economy-wide development and financial market fluctuations seem to impact venture capital flows.

Introduction

Venture Capital plays a critical role in the creation of wealth in the real economy. From the standpoint of providing seed financing it allows entrepreneurs to engage in the creation of business plans and begin the formation of their businesses. Later through start-up financing venture capital provides these start-up companies with resources to fund R&D and market testing of products. As a company matures venture capital will also provide funds through staged financing to begin production and distribution of new products or services. A reasonable description of this process is provided by Hudson (1995) and Gompers and Lerner (2001). In all its forms, at the formative stages of a company's life, this financial conduit aids in the creation of jobs as well as the acquisition of physical and intellectual

capital. Holmes and Schmitz (1990) summarize the importance of matching entrepreneurs with appropriate projects. Venture capital allows these entrepreneurs to bring their ideas into physical reality.

Venture capital also plays an important role within the capital markets. Sahlman (1990) and Jensen (1993) show that venture capitalists, by providing extensive due diligence on start-up companies, solve governance and monitoring problems that would hinder future financial contracting. Venture capitalists also play an important role in syndication and the staging of investments (Admati and Pfleiderer 1994; Bergemann and Hege 1998), thus creating an environment whereby firms can successfully mature. Finally, venture capital plays a crucial role as a precursor to the initial public offering (IPO) process (Barry et al. 1990), in the certification role (Megginson and Weiss 1991) and in the optimal IPO timing decision (Lerner 1994). Without this infusion of risk capital and the subsequent mitigation of agency issues, as well as the value accretive monitoring, management and guidance provided by venture capitalists the IPO market would no doubt be much less robust.

The importance of a vibrant market for venture capital is apparent given the pivotal role that venture capital plays in wealth creation, through the real economy, and as a supplier to the equity capital markets through the IPO's. While venture capital activities have invited substantial academic interest, the body of research into the antecedents of venture capital commitments has produced results that vary considerably. Furthering the understanding of what factors play a role in motivating venture capital commitments on a macro level will provide additional insight for entrepreneurs into the economic and financial environmental conditions that will promote the growth of this important value driver.

Another question that we seek to address in this study is whether there is a higher likelihood of venture capital commitments as other types of equity capital commitments increase in the market. Market timing of initial public offerings in so-called "hot markets" (Helwege and Liang 2004; Ibbotson and Jaffe 1975; Ritter 1984) is well documented and provides indications that these types of issuances have a tendency to move together. Similar evidence on seasoned equity offerings (SEO) can be found in Goebel (2007) and Howe and Zhang (2010). There is also some evidence that IPO's and SEO's follow waves that are connected (Barnes and Linehan 2006; Brau and Heywood 2008). In this study we will consider the notion that IPO and SEO offerings over time drive interest in the total commitments of venture capital.

This paper, then, is motivated to determine what connections can be shown to exist between venture capital commitments and real and capital market factors. In contrast to other studies looking at

this issue we will explore these relationships within a vector auto-regressive model. Using this modeling approach we will seek to determine if venture capital commitments are related to lagged structures of the level of economic activity, the level and returns in equity capital markets and the levels of other risk capital raising activities such as IPOs and SEOs.

Literature Review

Some studies have focused on a particular factor and its impact on venture capital activities. For instance, Poterba (1989) examined the impact of capital gains taxation on venture capital growth. His findings indicated that the growth in venture capital from the late 1970s to the end of the 1980s could be connected to the lower capital gains taxes primarily through the demand for venture capital. Black and Gilson (1998) emphasized the importance of a well-functioning stock market on venture capital funds flows.

Macroeconomic expansions have been discussed extensively as a central driver of venture capital activities. Economic growth is accompanied with more attractive opportunities for entrepreneurs, which in turn leads to an increase in the number of startups (Audretsch and Acs 1994). Thus, the demand for venture capital is likely to increase in a growing economy.

There have been a few studies at the aggregate level considering the connection of venture capital commitments and macro variables. Gompers and Lerner (1999) examine the macro factors that affect venture capital activities in the U.S. from 1972 through 1994. Jeng and Wells (2000) consider this relationship in an international setting analyzing the period from the mid-1980s to the mid-1990s. Using an equilibrium supply and demand framework these studies measure the relationship between macroeconomic conditions, regulatory changes, and the institutional environment on commitments in the venture capital market over time. The empirical results have not been uniform across these different studies, which may reflect the complexity involved in venture capital activities as well as the variant time horizons studied and model specifications employed.

Gompers and Lerner (1999) reported a significant positive impact of the previous year's real GDP growth on the overall fundraising in the U.S. venture capital market. One particular concern raised by the authors in this article was that their results may have been affected by serial correlation in the error terms. The Durbin-Watson statistics and Cochrane-Orcutt regression technique were used to test the credibility of these results. Further, the authors test the robustness of their findings by using a fixed effects modeling procedure and disaggregated state level data. They continue to find a significant

connection between Gross State Product and venture capital activity across their panel data. However, the possibility of the higher order time dependence was not addressed in their study.

Jeng and Wells (2000) studied the determinants of venture capital activity using a panel data set composed of 21 countries. Their analysis considered the impact of factors such as IPO levels, GDP growth as well as a number of other structural variables within a linearly specified supply and demand equilibrium model. The results indicated that growth in GDP was not significant when controlling across and within country.

Another factor considered to contribute to the increased likelihood of venture capital activity is equity market returns over time. Stock returns are known to be positively related to future growth of GNP and return on capital Fama (1981). However, Gompers and Lerner (1999) found no significant connection in the previous year's equity market return, as measured by CRSP value-weighted stock market return, on the level of venture capital fundraising. Jeng and Wells (2000) have also reported that market capitalization growth is not significant in regard to venture capital investment. Additional studies by Gompers et al. (2008) have shown that the inherently high volatility in fundraising and investment is associated with shifting valuations and activity in public equity markets. In their study, which used IPO and Tobins Q as the signal for the stock market, this connection was greatest for specialized venture capital firms with industry specific experience.

IPOs have received great deal of attention in venture capital literature with their additional importance as an exit mechanism in the venture capital cycle. Venture capitalists can realize gains by liquidating shares on the open market after the IPO (Gompers 1998). IPOs are also shown to be the most profitable exit opportunity (Gompers and Lerner 2004; Jeng and Wells 2000). For the entrepreneur, IPOs work as a call option to regain control from the venture capitalist (Black and Gilson 1998). They have argued that a well-developed stock market provides implicit and explicit contractual arrangements between venture capitalist and entrepreneurs, which is critical to the existence of a vibrant venture capital market. Under this view, IPO activities are expected to facilitate both the supply and demand of venture capital funds (Jeng and Wells 2000).

The empirical results of a relationship between IPO activity and venture capital commitments are again mixed. Jeng and Wells (2000) have reported that IPOs (value of IPOs normalized by the GDP) are the strongest driver of venture capital investing, lending support to the notion that high level of IPOs in a country lead to more venture capital. In further detail, a separate regression analysis on different stages of investment indicated that IPOs are significant only for later stage venture capital investment. In contrast, Gompers and Lerner (1999) have found a non-significant impact of IPO activities, as

measured by the value of previous year's venture capital-backed IPO, on venture capital fundraising. They interpreted their findings to suggest that; while it is difficult to rule out the role for IPOs in creating liquidity in the venture capital industry, once other factors, such as real GDP growth, equity market return, and capital gains tax rate, are included, it was no longer significant. To add credibility to this point, commenting on the importance of the overall legal regime and regulatory framework, Megginson (2004) noted that even in the IPO-oriented stock markets in Europe and Asia, it is still difficult to develop an active venture capital sector.

As mentioned earlier, it is also well known that publically traded firms have a propensity to issue equity when their market values are high. For IPOs, evidence is provided in studies by Ibbotson and Jaffe (1975), Ritter (1984), and Helwege and Liang (2004). For SEOs, this relationship was recently documented by Barnes and Linehan (2006), Goebel (2007) and Howe and Zhang (2010). As the connection between SEO and venture capital activities has not been widely studied in the literature this study will examine to what extent the relationship between the SEO activities and venture capital investments exists after controlling for other factors.

Data

Various private and public data sources are used to obtain the time series data for our analysis. The data for U.S. venture capital investment is obtained from VentureXpert of SDC Platinum. VentureXpert is the database maintained by Thomson Financial and it provides information on venture capital investment firms and the companies in which they invest. We identify the amount of total annual venture capital investment, i.e. the aggregate annual amount disbursed by venture capitalists in the U.S., for the period from 1960 to 2010. According to PricewaterhouseCoopers (PwC) Money Tree report (available at http://www.nvca.org/), the top ten sectors that receive venture capital flows over the past 15 years (1996–2010) are software, telecommunications, biotechnology, networking and equipment, media and entertainment, medical device, IT service, industrial/energy, semiconductors, and business product and services. While venture capital investment is concentrated in the high-tech and IT-related sectors as expected, it is interesting to find the business product and services (e.g. advertising, consulting, engineering, import, and distribution services) among the top ten sectors. Although service businesses in general can be implemented with notably less capital than that required for most industries (Parellada et al. 2011), the success and vitality of the service sector has become essential for

the growth of the economy (Dobón and Soriano 2008; Nissan et al. 2011). The venture capital flow may be consistent with such a trend.

We collected IPO data from "IPO Statistics for 2010 and Earlier Years" at Jay Ritter's website at http://bear.warrington.ufl.edu/ritter/ipodata.htm. In particular, the number of offerings and the amount of gross proceeds are obtained from Table 8, which covers the same time span of the venture capital investment. In this dataset, Jay Ritter states that: i) the offerings from 1975 exclude penny stock IPOs (IPOs with an offer price of less than $5.00), ADRs, best efforts, units, and Regulation A offers (small issues, raising less than $1.5 million during the 1980s), real estate investment trusts (REITs), partnerships, and closed-end funds. Banks and non-CRSP-listed IPOs are included. ii) Gross proceeds exclude overallotment options but include the international tranche, if any. iii) Gross proceeds are nominal values. No adjustments for inflation have been made.

Jay Ritter's SEO data is not available throughout the period from 1960 to 2010. Thus, we collected the number and the proceeds (nominal value) of SEO from SDC Platinum. From the Equity Offering database, SEOs in the U.S. are identified by excluding all initial offerings. Applying the similar rules as in the IPO database, we excluded closedend funds, penny stocks, and ADRs. Separately, we also checked the firms involved in the IPOs and SEOs by the sector corresponding to the PwC's money tree report. The top ten sectors of the IPO and SEO events include industrial/energy, financial services, business products and services, IT services, telecommunications, media and entertainment, electronics, consumer product and services, semiconductors (for IPO only), biotechnology (for SEO only) and retail/distribution. As one can see, these sectors overlap substantially with the sectors that receive venture capital flows.

Finally, for the macroeconomic variables, the U.S. annual GDP is obtained from the Bureau of Economic Analysis website at http://www.bea.gov, and S&P 500 index is downloaded from the COMPUSTAT North America database.

Results

In this section we describe the results of our empirical tests. The objective is to study the connection between economic and capital market variables and venture capital flows. The nature of the research question calls for making use of a long time series of venture capital flow data. The time span of the analysis is important because it allows us to subsume a variety of economic events. As Shiller and Perron (1985) and Shiller (1989) show, increasing the number of observations by sampling more

frequently while leaving the total time span of the data unchanged may not substantially increase the power of tests. If the time series have relatively slow movements through time, which is a common feature of economic data, then a long time series that spans many years is needed before the true joint tendencies of the variables can be measure reliably. Shiller (1989) stresses the argument that obtaining many observations by sampling frequently (e.g., through weekly or even daily observations) does not appreciably increase the power to measure the joint relationship between the time series if the data span a total of only a few years. This observation has been recognized in the recent studies connecting economic and market variables (Goyenko and Ukhov 2009; Goyenko et al. 2011; Ma and Ukhov 2011). The nature of the problem that we are addressing here requires long economic time series. The long time series, in turn, call for a careful econometric approach. Thus, we conduct our tests considering time series properties of the data in all regressions. We must also conduct tests in a vector autoregression or VAR framework, which is well suited for this type of study.

Venture capital flows and economic conditions

In the first set of empirical tests we investigate the relation between venture capital flows and GDP. The tests recognize the time series properties of both the venture capital flow series and the GDP series, and the fact that long time series of data are needed to uncover economic relations. In the first test, we fit a linear regression of venture capital flows on GDP. Because both the dependent and the independent variable are autoregressive time series, lagged values of both variables are included in the regression. We estimate the regression,

$$VCFlow_t = \beta_0 + \beta_1 GDP_t + \sum_{i-1}^{L} \gamma_i VCFLow_{t-i} + \sum_{i-1}^{L} \delta_i GDP_{t-i} + \varepsilon$$

where L is the number of lags (two or four) included in the regression.

The results are presented in Table 1. We estimate the model both in levels (the first two columns of the table), and in logs (applied to both the dependent and the independent variables). We find a strong positive association between GDP and venture capital flows. This finding is robust to the regression

Table 1 VC flows and GDP

	Data in levels		Logs of data	
	$VCFlow_t$	$VCFlow_t$	$VCFlow_t$	$VCFlow_t$
GDP_t	56,131,753 (3.35)***	60,609,414 (3.14)***	9.691 (3.407)***	10.980 (3.574)***
$VCFlow_{t-1}$	0.843 (5.32)***	0.831 (4.76)***	0.906 (6.254)***	0.866 (5.421)***
$VCFlow_{t-2}$	−0.262 (−1.603)	−0.236 (−1.062)	−0.256 (−1.758)*	−0.132 (−0.633)
$VCFlow_{t-3}$		−0.044 (−0.196)		0.007 (0.036)
$VCFlow_{t-4}$		−0.039 (−0.199)		−0.260 (−1.659)*
GDP_{t-1}	−98,176,434 (−3.34)***	−106,000,000 (−2.683)***	−14.405 (−2.976)***	−18.307 (−3.522)***
GDP_{t-2}	44,651,426 (2.44)**	49,406,062 (0.773)	5.798 (2.046)**	10.678 (1.805)*
GDP_{t-3}		14,084,727 (0.211)		−4.595 (−0.794)
GDP_{t-4}		−15,630,031 (−0.389)		2.792 (0.847)
DW	2.01	1.97	1.90	2.05

The table presents results of regressions of venture capital flows on DGP, $VCFlow_t = \beta_0 + \beta_1 GDP_t + \sum_{i=1}^{L} \gamma_i VCFLow_{t\ i} + \sum_{i=1}^{L} \delta_i GDP_{t\ i} + \varepsilon$

Where L is the number of lags (two or four) included in the regression. t-statistic is presented in parenthesis below each regression coefficient. The coefficients are large because of the units. All regressions include intercept. Durbin-Watson statistic is reported specification (two or four lags) and whether the data was in levels or subject to logarithmic transformation.

As our goal is to explore the inter-temporal associations between venture capital flows, economic, and capital market variables, we use VAR analysis to study the joint dynamics of the variables. We use the following VAR specification:

$$VCFlow_t = \sum_{j-1}^{K} \gamma_{1j} VCFlow_{t-j} + \sum_{j-1}^{K} \delta_{1j} GDP_{t-j} + u_t$$
$$GDP_t = \sum_{j-1}^{K} \gamma_{2j} VCFlow_{t-j} + \sum_{j-1}^{K} \delta_{2j} GDP_{t-j} + v_t$$

In accordance with the Akaike information criterion (AIC) and Schwarz Bayesian information criterion (BIC), we estimate the VAR system with one lag.

We now examine impulse response functions (IRFs) for the VAR system. Figure 1 illustrates the response of venture capital flows to a unit standard deviation change in a particular variable, traced

forward over a period of 10 years. The 95% confidence bands are provided to gauge the statistical significance of the responses. The figure indicates that venture capital flows experience a strong long-lasting increase in response to GDP shocks. Venture capital flows increase in response to its own shock, with that response decaying over time. These results hold whether we estimate the VAR system using the data in levels, or the data in logs.

Venture capital flows, economic conditions, and financial markets performance

Our next set of tests concerns the relation between venture capital flows, the performance of the economy (GDP), and the performance of the equity capital

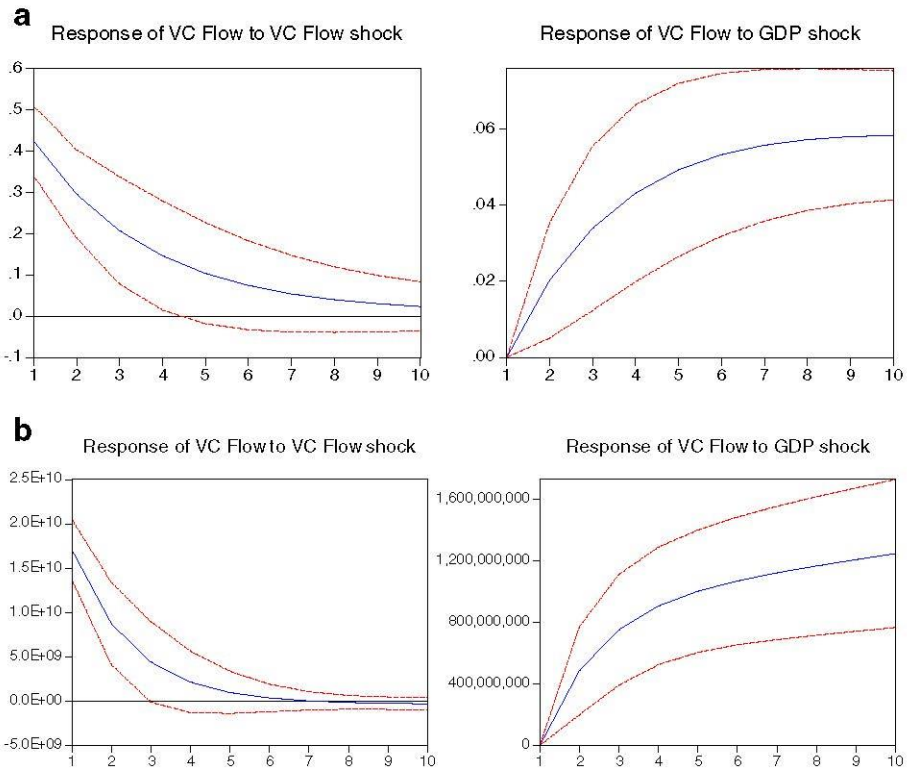

Fig. 1 VC flows and GDP. In Fig. 1 we plot impulse response functions for venture capital flows in the VAR system with venture capital flows and GDP. Response to Cholesky one standard deviation. Dashed lines represent 95% confidence bands. Panel a: variables are in logs. Panel b: variables are not modified (in levels). Panel a. Response of VC flows to endogenous variables. Panel b. Response of VC flows to endogenous variables

market, as measured by the returns on the S&P 500 index. The objective is to determine whether economic performance and financial performance have a separate impact on the decision to allocate capital to venture capital. The question of interest is whether GDP and stock market performance impact venture capital flows after the mutual impact of all the variable is taken into account. The tests recognize the time series properties of both the venture capital flow series, the GDP series, and the stock market index series. The tests are performed with long time series of data needed to uncover economic relations. In the first test, we fit a linear regression of venture capital flows on GDP and a measure of stock market performance. Because both the dependent and the independent variable are autoregressive time series, lagged values of both the dependent and the independent variables are included in the regression. We estimate the regression,

$$VCFlow_t = \beta_0 + \beta_1 GDP_t + \beta_2 SPPerformance_{t-1} + \sum_{i-1}^{L} \gamma_i VCFLow_{t-i} + \sum_{i-1}^{L} \delta_i GDP_{t-i} + \sum_{i-1}^{L} \varphi_i SPPerformance_{t-1-i} + \varepsilon$$

Where L is the number of lags (two or four) included in the regression. The stock market performance is measured by one of the three variables: S&P 500 index return, lagged level of S&P 500 index, and the change (first difference) in the S&P 500 index over the prior year.

The results are presented in Table 2. The *VCt* are venture capital flows in year *t* (natural logarithm); GDP_t is the natural logarithm of GDP in year *t*; SPR_{t-1} is the return on S&P 500 index over the year preceding the year t; ΔSP_{t-1} is the first difference in S&P 500 index levels over the year preceding the year *t*; SP_{t-1} is the level of S&P 500 index at the end of year *t*−1. The results are presented in three different panels. Panel A: S&P 500 returns; Panel B: S&P 500 index level at the end of the prior year. Panel C: S&P 500 first differences over the previous year.

The first point of interest is the coefficient on GDP. In all regression specifications, this coefficient is positive and strongly statistically significant. Therefore, even after controlling for the equity capital market performance, we find a strong positive association between GDP and venture capital flows.

The next point of interest is the coefficient on a measure of stock market performance. Panel A reports results when stock market performance is measured by the S&P 500 return over the previous year. We find that past stock market return has a positive and strongly significant impact on venture capital flows. Panel B reports results for regressions where equity captial market performance is measured by the level of S&P 500 index at the end of the previous year. We find similar results in this case to the results reported in Panel A. High levels of the stock market index in the previous year have a

positive and strongly significant impact on the venture capital flows. In Panel C we report results for regressions where financial market performance is measured by the first difference (level change) in the S&P 500 stock market index. In this case, too, we find that market performance has a positive and strongly significant impact on venture capital flows.

In sum, evidence from our time series regressions suggests that both economic performance, as measured by GDP and equity market performance, as measured by S&P 500 stock market index, are both important determinants of venture capital flows.

The study's primary goal is to explore the inter-temporal associations between venture capital flows, economic, and equity capital market variables when the mutual impact of these variables has been properly controlled for in the model estimation procedure. Due to the joint dynamics that are likely to be present in the data on economic and capital market performance, a VAR framework appears to be particularly well suited for the study. Therefore, we use VAR analysis to study the joint dynamics of the variables using the following specification:

$$VCFlow_t = \sum_{j-1}^{K} \gamma_{1j} VCFlow_{t-j} + \sum_{j-1}^{K} \delta_{1j} GDP_{t-j} + \sum_{j-1}^{K} \beta_{1j} SP500Ret_{t-j} + u_t$$

$$GDP_t = \sum_{j-1}^{K} \gamma_{2j} VCFlow_{t-j} + \sum_{j-1}^{K} \delta_{2j} GDP_{t-j} + \sum_{j-1}^{K} \beta_{1j} SP500Ret_{t-j} + v_t$$

$$SP500Ret_t = \sum_{j-1}^{K} \gamma_{3j} VCFlow_{t-j} + \sum_{j-1}^{K} \delta_{3j} GDP_{t-j} + \sum_{j-1}^{K} \beta_{1j} SP500Ret_{t-j} + z_t$$

Table 2 VC flows and GDP, and S&P 500 performance

	Panel A: S&P return			Panel B: S&P level			Panel C: S&P change		
	VC_t	VC_t	VC_t	VC_t	VC_t	VC_t	VC_t	VC_t	VC_t
GDP_t	6.43 (2.15)**	6.21 (1.95)*	5.93 (1.64)*	7.06 (2.22)**	6.89 (2.54)**	6.91 (2.32)**	6.84 (2.56)***	6.66 (2.40)**	6.36 (2.00)**
SPR_{t-1}	0.78 (2.25)**	0.76 (2.08)**	0.85 (2.14)**						
SP_{t-1}				0.0009 (2.37)**	0.0009 (2.61)***	0.0010 (2.74)***			
ΔSP_{t-1}							0.0008 (2.63)**	0.0008 (2.41)**	0.0009 (2.59)**
VC_{t-1}	0.965 (7.18)***	0.918 (5.15)***	0.872 (4.60)***	0.841 (5.32)***	0.956 (6.78)***	0.866 (4.71)***	0.955 (7.05)***	0.964 (5.51)***	0.902 (4.87)***
VC_{t-2}	−0.298 (−2.15)**	−0.14 (−0.62)	−0.107 (−0.40)	−0.132 (−0.86)	−0.201 (−1.12)	−0.099 (−0.43)	−0.295 (−2.17)**	−0.195 (−0.89)	−0.208 (−0.82)
VC_{t-3}		−0.17 (−1.07)	−0.047 (−0.20)		−0.147 (−1.10)	−0.068 (−0.34)		−0.146 (−0.96)	0.036 (0.16)
VC_{t-4}			−0.146 (−0.87)			−0.161 (−1.09)			−0.199 (−1.23)
GDP_{t-1}	−12.94 (−2.45)**	−12.37 (−2.07)**	−12.17 (−1.86)*	−11.99 (−2.24)**	−14.35 (−3.08)***	−13.99 (−2.79)***	−14.29 (−3.16)***	−14.36 (−2.95)***	−13.88 (−2.66)***
GDP_{t-2}	7.37 (2.43)**	6.91 (1.08)	6.38 (0.88)	5.744 (1.79)*	10.04 (2.05)**	8.51 (1.52)	8.312 (3.08)***	9.801 (1.82)*	9.525 (1.66)*
GDP_{t-3}		0.28 (0.08)	1.43 (0.20)		−1.58 (−0.54)	1.729 (0.32)		−1.102 (−0.34)	−0.459 (−0.08)
GDP_{t-4}			−0.43 (−0.11)			−1.981 (−0.62)			−0.270 (−0.08)
SPR_{t-2}	0.23 (0.69)	0.19 (0.48)	0.22 (0.53)						
SPR_{t-3}	0.43 (1.44)	0.27 (0.71)	0.20 (0.47)						
SPR_{t-4}		0.03 (0.08)	−0.15 (−0.38)						
SPR_{t-5}			−0.22 (−0.62)						
SP_{t-2}				−0.0006 (−1.04)	−0.0006 (−1.31)	−0.0006 (−1.29)			
SP_{t-3}				−0.0003 (−0.71)	−0.0002 (−0.28)	−0.0003 (−0.53)			
SP_{t-4}					0.0000 (0.14)	0.0000 (−0.03)			
SP_{t-5}						0.0002 (0.49)			

Table 2 (continued)

	Panel A: S&P return			Panel B: S&P level			Panel C: S&P change		
	VC_t	VC_t	VC_t	VC_t	VC_t	VC_t	VC_t	VC_t	VC_t
ΔSP_{t-2}							0.0003 (0.75)	0.0002 (0.46)	0.0003 (0.65)
ΔSP_{t-3}							0.0003 (0.68)	0.0000 (0.03)	0.0000 (−0.05)
ΔSP_{t-4}								0.0000 (0.18)	−0.0002 (−0.38)
ΔSP_{t-5}									0.0003 (0.68)
DW	2.09	2.07	2.03	1.53	2.15	2.16	1.98	2.09	1.99

The table presents results of regressions of venture capital flows on DGP, and stock market performance measure by performance of the S&P 500 stock market index, $VCFlow_t = \beta_0 + \beta_1 GDP_t + \beta_2 SPPerformance_{t-1} + \sum_{i=1}^{L} \gamma_i VCFLow_{t-i} + \sum_{i=1}^{L} \delta_i GDP_{t-i} + \sum_{i=1}^{L} \varphi_i SPPerformance_{t-1-i} + \varepsilon$

Where L is the number of lags (two or four) included in the regression. The stock market performance is measured by one of the three variables: S&P 500 index return, lagged level of S&P 500 index, and the change (first difference) in the S&P 500 index over the prior year. The VC_t are venture capital flows in year t (natural logarithm); GDP_t is the natural logarithm of GDP in year t; SPR_{t-1} is the return on S&P 500 index over the year preceding the year t; ΔSP_{t-1} is the first difference in S&P 500 index levels over the year preceding the year t; SP_{t-1} is the level of S&P 500 index at the end of year $t-1$. The results are presented in three different panels. Panel A: S&P 500 returns; Panel B: S&P 500 index level at the end of the prior year. Panel C: S&P 500 first differences over the previous year. t-statistic is presented in parenthesis below each regression coefficient. Durbin-Watson statistic is reported

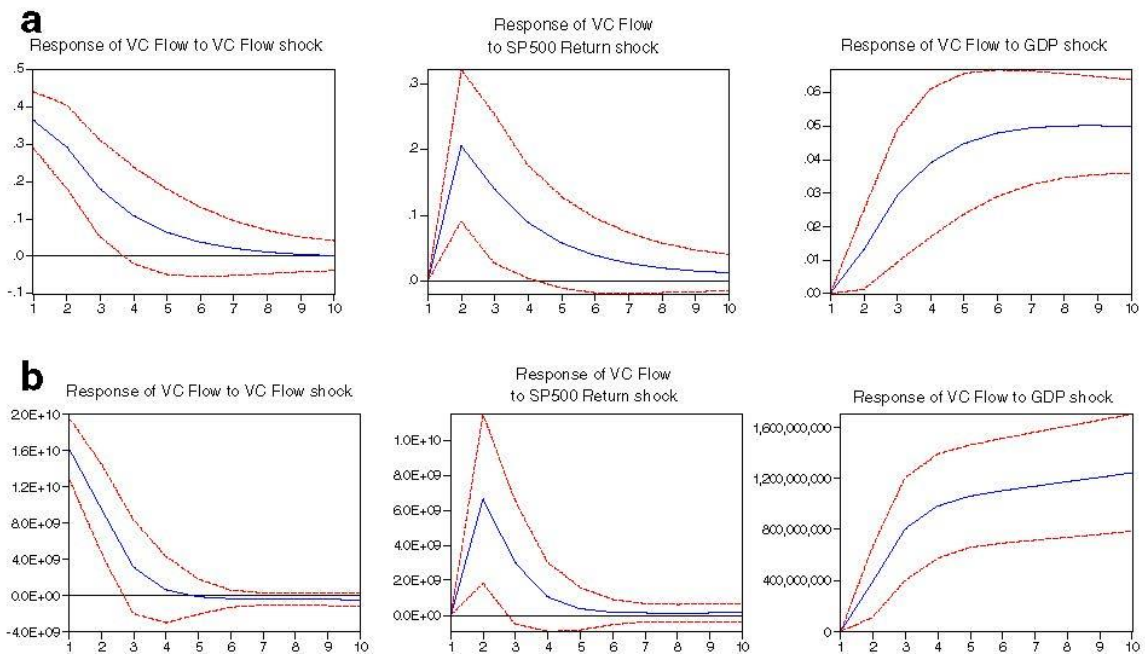

Fig. 2 VC flows, GDP and market returns. In Fig. 2 we plot impulse response functions for venture capital flows in the VAR system with venture capital flows, GDP, and S&P 500 returns. Response to Cholesky one standard deviation. Dashed lines represent 95% confidence bands. Panel a: variables are in logs. Panel b: variables are not modified (in levels). Panel a. response of VC flows to endogenous variables. Panel b. Response of VC flows to endogenous variables

In accordance with the Akaike information criterion (AIC) and Schwarz Bayesian information criterion (BIC), we estimate the VAR system with 1 lag.

We next examine impulse response functions (IRFs) for the VAR system.

Figure 2 illustrates the response of venture capital flows to a unit standard deviation change in a particular variable, traced forward over a period of 10 years. The 95% confidence bands are provided to gauge the statistical significance of the responses. The figure indicates that venture capital flows experience a strong, long-lasting increase in response to GDP shocks. Venture capital flows increase in response to its own shock, with response decaying over time over a period of approximately 3 years. The figure also indicates the importance of stock market performance for the venture capital flows. Venture capital flows increase following shock to S&P 500 returns. The effect of S&P 500 returns on venture capital flows is strong, but the effect decays after approximately 3 years. This is quite different from the effect of a GDP shock, which lasts for a longer time. Thus, it appears that a positive shock to financial market performance has a strong, but shorter-term effect on venture capital flows, while a shock to GDP has a longer lasting effect on VC flows.1

Venture capital flows, economic conditions and the new venture market activity

In the next set of tests we study whether venture capital flows respond to activity in the new issues market. To measure conditions in the market for new issues we use pricing of Initial Public Offerings (IPOs) and pricing of Seasoned Equity Offerings (SEOs). We use the following VAR specification:

$$VCFlow_t = \sum_{j-1}^{K} \gamma_{1j} VCFlow_{t-j} + \sum_{j-1}^{K} \delta_{1j} IPOPrc_{t-j} + \sum_{j-1}^{K} \beta_{1j} SEOPrc_{t-j} + u_t$$
$$IPOPrc_t = \sum_{j-1}^{K} \gamma_{2j} VCFlow_{t-j} + \sum_{j-1}^{K} \delta_{2j} IPOPrc_{t-j} + \sum_{j-1}^{K} \beta_{1j} SEOPrc_{t-j} + v_t$$
$$SEOPrc_t = \sum_{j-1}^{K} \gamma_{3j} VCFlow_{t-j} + \sum_{j-1}^{K} \delta_{3j} IPOPrc_{t-j} + \sum_{j-1}^{K} \beta_{1j} SEOPrc_{t-j} + z_t$$

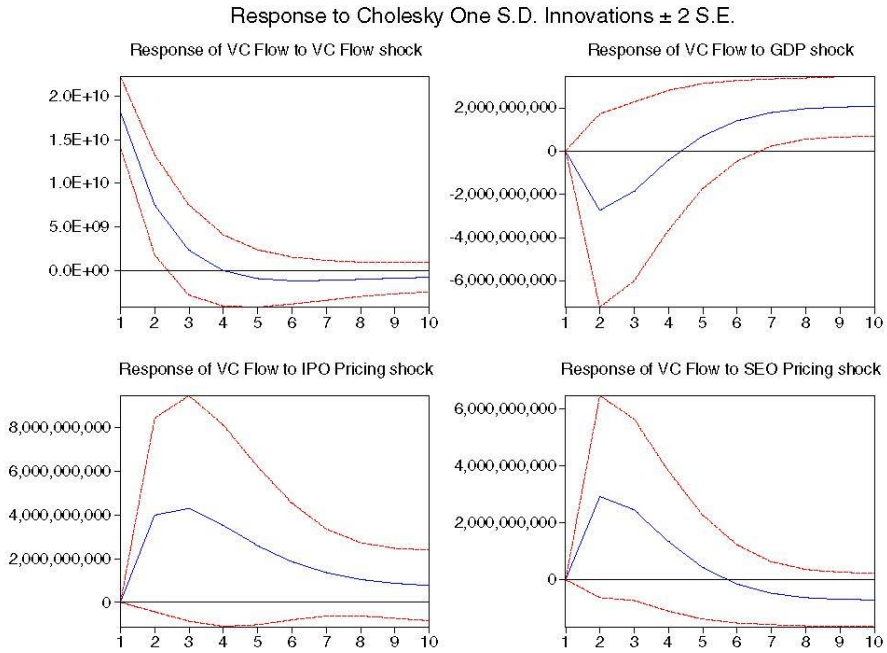

Fig. 4 VC flows, new venture market, and economic activity. In Fig. 4 we plot impulse response functions for venture capital flows in the VAR system with venture capital flows, GDP, IPO price index, and SEO price index. Response to Cholesky one standard deviation. *Dashed lines* represent 95% confidence bands. All data are in levels

In accordance with the Akaike information criterion (AIC) and Schwarz Bayesian information criterion (BIC), we estimate the VAR system with 1 lag.

We examine impulse response functions (IRFs) for the VAR system. Figure 3 illustrates the response of venture capital flows to a unit standard deviation change in a particular variable, traced forward over a period of 10 years. As before, the 95% confidence bands are provided to gauge the statistical significance of the responses.

The figure indicates that venture capital flows experience a strong increase in response to SEO Pricing shocks. Venture capital flows increase in response to its own shock, with response decaying over time over a period of approximately 3 years. Venture capital flows also increase following a shock to IPO Pricing. The figure indicates the importance of conditions in the market for new ventures for the venture capital flows.

In the previous section we established the importance of GDP for venture capital flows. It is important, therefore, to add GDP to the VAR system. We re-estimate the above VAR system after adding GDP series. Impulse response functions for this system are shown in Fig. 4 (and Fig. 5). The figure illustrates the response of venture capital flows to a unit standard deviation change in a particular variable, traced forward over a period of 10 years. We again provide the 95% confidence bands to gauge the statistical significance of the responses. The figure indicates that once effects of the GDP are taken into account, conditions in the market for the new ventures no longer impact VC flows. First, from the IRFs we observe that venture

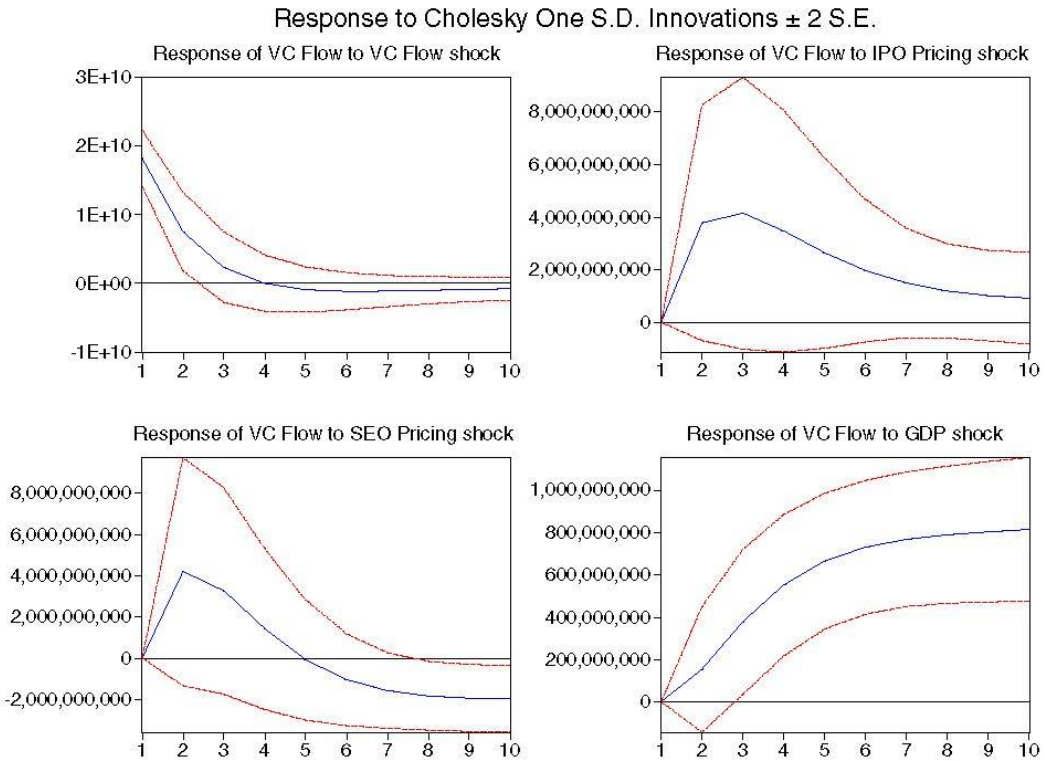

Fig. 5 VC flows, new venture market, and economic activity (different VAR ordering). In Fig. 5 we plot impulse response functions for venture capital flows in the VAR system with venture capital flows, IPO price index, SEO price index, and GDP. The VAR system has different ordering. Response to Cholesky one standard deviation. *Dashed lines* represent 95% confidence bands. All data are in levels

capital flows experience a long-lasting (albeit, delayed) increase in response to GDP shocks. However, venture capital flows now do not respond to SEO pricing or to IPO pricing shocks. The figure indicates that economic conditions, as measured by GDP overpower any impact that the market for new ventures may have on the VC flows. This result is consistent with our earlier findings of the importance of economic conditions on the venture captial flows.

Conclusion

Using vector autoregression technique, we examine the interrelation between venture capital flows, economic development, capital market fund-raising activities, and capital market valuation, based on annual data of the United States over the past half-century. We find that venture capital commitments appear to be correlated with GDP and capital market valuation. While capital market fund-raising activities (Initial Public Offerings and Seasoned Equity Offerings) are also correlated with venture capital flows, these effects are subsumed by GDP, indicating that the overall economy drives both venture capital flows and capital market financing activities. Analyses from impulse response functions suggest that shocks to GDP have a permanent effect on venture capital flows, while the impact of capital market valuation (Standard & Poor 500 returns) on venture capital flows is rather short lived. Overall, both economy-wide development and financial market fluctuations seem to impact venture capital flows.

References

Admati, A. R., & Pfleiderer, P. (1994). Robust financial contracting and the role of venture capitalists. *Journal of Finance*, 49(2), 371–402.

Audretsch, D. B., & Acs, Z. J. (1994). New-firm startups, technology, and macroeconomic fluctuations. *Small Business Economics*, 6(6), 439–449.

Barnes, E., & Linehan, S. (2006). The timing of seasoned equity offerings: evidence from UK markets 1990–2002. *Irish Accounting Review*, 13(1), 1–21.

Barry, C. B., Muscarella, C. J., Peavy, J. W., & Vetsuypens, M. R. (1990). The role of venture capital in the creation of public companies: Evidence from the going-public process. *Journal of Financial Economics*, 27(2), 447–471.

Bergemann, D., & Hege, U. (1998). Venture capital financing, moral hazard, and learning. *Journal of Banking & Finance*, 22(6–8), 703–735.

Black, B. S., & Gilson, R. J. (1998). Venture capital and the structure of capital markets: banks versus stock markets. *Journal of Financial Economics*, 47(3), 243–277.

Brau, J., & Heywood, D. (2008). IPO and SEO waves in health care real estate investment trusts. *Journal of Health Care Finance*, 35(1), 70–88.

Dobón, S. R., & Soriano, D. R. (2008). Exploring alternative approaches in service industries: the role of entrepreneurship. *The Service Industries Journal*, 28(7), 877–882.

Fama, E. F. (1981). Stock returns, real activity, inflation, and money. *American Economic Review*, 71(4), 545–565.

Goebel, J. M. (2007). Macro timing of seasoned equity offerings: how well does management perform? *Journal of Business and Economic Studies*, 13(1), 58–72.

Gompers, P. (1998). Venture capital growing pains: should the market diet? *Journal of Banking & Finance*, 22(6–8), 1089–1104.

Gompers, P., & Lerner, J. (1999). What drives venture capital fundraising? National Bureau of Economic Research Working Paper No. 6906.

Gompers, P., & Lerner, J. (2001). The venture capital revolution. *Journal of Economic Perspectives*, 15(2), 145–168.

Gompers, P., & Lerner, J. (2004). *The venture capital cycle* (2nd ed.). Cambridge: MIT Press.

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

Goyenko, R. Y., & Ukhov, A. D. (2009). Stock and bond market liquidity: a long-run empirical analysis. *Journal of Financial and Quantitative Analysis*, 44, 189–212.

Goyenko, R. Y., Subrahmanyam, A., & Ukhov, A. D. (2011). The term structure of bond market liquidity and its implications for expected bond returns. *Journal of Financial and Quantitative Analysis*, 46, 111–139.

Helwege, J., & Liang, N. (2004). Initial public offerings in hot and cold markets. *Journal of Financial and Quantitative Analysis*, 39(03), 541–569.

Holmes, T. J., & Schmitz, J. A., Jr. (1990). A theory of entrepreneurship and its application to the study of business transfers. *Journal of Political Economy*, 98(2), 265–294.

Howe, J. S., & Zhang, S. (2010). SEO cycles. *Financial Review*, 45(3), 729–741.

Hudson, B. T. (1995). Venture capital in the restaurant industry. *Cornell Hotel and Restaurant Administration Quarterly*, 36(3), 50–61.

Ibbotson, R. G., & Jaffe, J. F. (1975). “Hot issue” markets. *Journal of Finance*, 30(4), 1027–1042.

Jeng, L. A., & Wells, P. C. (2000). The determinants of venture capital funding: evidence across countries. *Journal of Corporate Finance*, 6(3), 241–289.

Jensen, M. C. (1993). The modern industrial revolution, exit, and the failure of internal control systems. Journal of Finance, 48(3), 831–880.

Lerner, J. (1994). Venture capitalists and the decision to go public. *Journal of Financial Economics*, 35(3), 293–316.

Ma, Q., & Ukhov, A. D. (2011). Valuation of takeover targets and the market for corporate control throughout the business cycle. *Insurance Markets and Companies: Analyses and Actuarial Computations*, 2, 5–15.

Megginson, W. L. (2004). Toward a global model of venture capital? *Journal of Applied Corporate Finance*, 16(1), 89–107.

Megginson, W. L., & Weiss, K. A. (1991). Venture capitalist certification in initial public offerings. *Journal of Finance,* 46(3), 879–903.

Nissan, E., Galindo, M.-A., & Méndez, M. T. (2011). The future of services in a globalized economy. *The Service Industries Journal,* 31(1), 59–78.

Parellada, F. S., Soriano, D. R., & Huarng, K.-H. (2011). An overview of the service industries' future (priorities: linking past and future). *The Service Industries Journal,* 31(1), 1–6.

Poterba, J. M. (1989). Venture capital and capital gains taxation. *Tax Policy and the Economy*, 3, 47–67.

Ritter, J. R. (1984). The "hot issue" market of 1980. *Journal of Business,* 57(2), 215–240.

Sahlman, W. A. (1990). The structure and governance of venture-capital organizations. *Journal of Financial Economics,* 27(2), 473–521.

Shiller, R. J. (1989). *Market volatility*. Cambridge: MIT Press.

Shiller, R. J., & Perron, P. (1985). Testing the random walk hypothesis: power vs. frequency of observation. *Economics Letters,* 18, 381–386.