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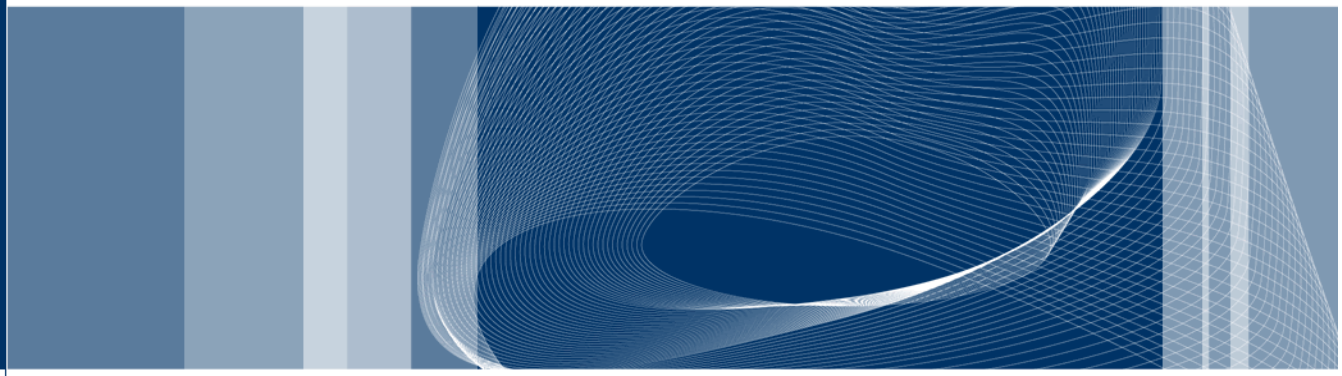

The effect of venture capital financing on firm's investment-cash flow sensitivity

Does the type of investor matter?

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Agenda

- Aim of the paper
- Related literature
- The sample
- Research methodology
- Results
- Conclusions

Aim of the paper

The aim of the paper is to study whether:

- New Technology Based Firms (NTBFs) suffer from inefficiencies of financial markets that constrain their investment policy
- Venture Capital (VC) is effective in reducing financial constraints in the short and long-run
- Different VC investors, namely Independent Venture Capital Funds (IVC) and Corporate Venture Capital (CVC) differ in their short and long-run effect on firm's financial constraints

Related literature

Theoretical underpinnings

- If capital markets were perfect (à la Modigliani and Miller, 1958) firms would always find means to finance profitable investments
- However capital markets imperfections (e.g. information asymmetry between investors and firms) result in suboptimal investment policy
  - Adverse selection (i.e. investors, at time of contracting, are unable to observe investment quality at no cost) might result in underinvestment (Fazzari et al., 1988)
  - Moral hazard (i.e. investors, after contracting, are unable to observe manager's effort at no cost) might result in overinvestment (Jensen, 1986)
- Both capital market imperfections (could) lead to a positive correlation between Cash Flows and Investment rate
  - In an adverse selection framework "outside capital" is more costly than internally generated capital, thus an increase in the latter results in an increase in the investment rate
  - In a moral hazard framework managers will use free cash flows to finance investments which grant them some private benefit
- This issue is however quite debated and we will address it more thoughtfully later in the presentation

Related literature

Investment-cash-flow sensitivity (1/2)

- There is a vast empirical literature (Hubbard, 1998) finding that the investment-cash-flow relationship is positive and highly significant
  - Fazzari et al. (1988) find that the investment-cash flow sensitivity is higher for firms with low dividend payouts, which allegedly have superior investment opportunities relative to current profits.
  - Whited (1992) further supports their findings showing that the investment-cash flow sensitivity is higher for highly leveraged firms.
  - Himmelberg and Petersen (1994) investigate the relationship between investments in fixed assets and R&D expenses and show that cash flows are the main determinant of investments for firms in their sample
  - Carpenter et al. (1998) prove that inventory investments are also significantly influenced by cash flows
- However it is hard to empirically disentangle underinvestment from overinvestment since most studies are based on a sample of public companies where both adverse selection and moral hazard are likely to be in place

Related literature

The investment-cash-flow sensitivity (2/2)

- NTBFs are an interesting research candidate:
  - Adverse selection is very high since NTBFs:
    - Have a short track record
    - Operate in industries which tend to be “obscure” to general investors
    - Have few collateralisable assets
  - Moral hazard tends to be rather low:
    - Ownership is often in the hands of the founders (especially for unlisted NTBFs)
    - Outside investors are VC investors (e.g. IVC and CVC companies) which have much higher monitoring skills and incentives than the average investor of a public company
- Manigart et al. (2002) analyse a sample of Belgian unlisted firms and study whether VC reduces the cash flow sensitivity of investments in fixed assets
  - Surprisingly they find that investments of VC-backed firms are more sensitive to cash-flows than those of non-VC-backed firms
  - However they show that VC seems to play a positive role in financing intangible assets

Related literature

IVC vs. CVC

- It has been suggested in the literature that the effect of external equity financing on invested firms crucially depends on the identity of the investor (Ernst et al., 2005)
- We focus attention on the distinction between two sources of VC financing:
  - Independent Venture Capital funds (IVC)
  - Venture Capital by non-financial firms (corporate venture capital, CVC)
- The investment objectives of these two categories of investors differ markedly:
  - The aim of IVCs is to realize the greatest possible capital gain in the shortest possible time
  - CVCs often pursue strategic objectives in addition to or even in substitution of financial objectives (Skyes, 1990; Gompers and Lerner, 1998; Chesbruogh, 2000; Dushnitsky and Lenox, 2004)
- The different characteristics of IVC and CVC are likely to result in different effects on investee firms and, in particular, on their investment policy

The sample

Sampling procedure

- We analyse the investment cash-flow sensitivity in a sample of Italian NTBFs extracted from the RITA database (developed at Politecnico di Milano which comprises 1,974 NTBFs and is the most comprehensive database on Italian NTBFs)
- NTBFs are defined as firms:
  - established in 1980 or later
  - independent since founding and until the end of 2003
  - operating in high-tech sectors, in both manufacturing and services
- The sample used in the present work consists of all RITA firms for which we were able to create a complete data set:
  - overall the sample comprises 379 Italian NTBFs observed from 1994 (or since their founding) to 2003, 52 of which (13.7%) obtained external VC funding
  - For each firm in the sample we have hand-collected data about:
    - detailed financial statement information
    - year and typology of outside equity financing
- Two $\chi 2$ tests show that there are no statistically significant differences between the distributions of the sample firms across industries and regions and the corresponding distribution of the population of 1,974 of RITA firms from which the sample was obtained

The sample

Descriptive statistics

Industry	*Total sample*		*VC-backed*		*IVC-backed*		*CVC-backed*	
	N.	*%*[a]	*N.*	*%*[b]	*N.*	*%*[b]	*N.*	*%*[b]
Internet and telecommunications services	130	34.3	23	17.7	14	10.8	12	9.2
Software	115	30.3	10	8.7	2	1.7	9	7.8
ICT manufacturing	79	20.8	13	16.5	2	2.5	7	8.9
Biotechnology and pharmaceutics	19	5.0	3	15.8	1	5.3	2	10.5
Automation and robotics	36	9.5	3	8.3	0	0.0	3	8.3
Total	379	100.0	52	13.7	19	5.0	33	8.7

Geographical area	*Total sample*		*VC-backed*		*IVC-backed*		*CVC-backed*	
	N.	*%*[a]	*N.*	*%*[c]	*N.*	*%*[c]	*N.*	*%*[c]
Northwest	181	47.8	24	13.3	14	7.7	14	7.7
Northeast	85	22.4	14	16.5	1	1.2	10	11.8
Centre	72	19.0	12	16.7	3	4.2	8	11.1
South	41	10.8	2	4.9	1	2.4	1	2.4
Total	379	100.0	52	13.7	19	5.0	33	8.7

Methodology

The econometric models (1/3)

- To analyse the investment cash-flow sensitivity in our sample we estimate a Euler equation (Bond, Meghir, 1994)

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \tau_t + \beta_1\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \beta_2\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right)^2 + \beta_3\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \beta_4\left(\frac{S_{i,t}}{K_{i,t-1}}\right) + \beta_5\left(\frac{D_{i,t}}{K_{i,t-1}}\right)^2 + \varepsilon_{i.t}$$

- Where:
  - $I_{i,t}$ are investments in fixed and intangible assets of firm *i* at time *t*,
  - $K_{i,t}$ is the end-of-period *t* net value of firm's *i* invested assets,
  - $CF_{i,t}$ is firm's *i* cash flow at time *t*,
  - $S_{i,t}$ are firm's *i* sales during year *t*
  - $D_{i,t}$ are firm's *i* total end-of-period *t* debts
- If financial markets were perfect and external capital a perfect substitute for internal capital, we would expect coefficient β_3 not to be significantly different from zero
- Following the observation by Manigart et al. (2002), we consider investments in both fixed and intangible assets

Methodology

The econometric models (2/3)

- To analyse how the presence of a VC investor (namely a IVC or CVC) affects the investment policy of the investee firm we estimate the following augmented Euler Equation:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \tau_t + \gamma_1\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \gamma_2\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right)^2 + \gamma_3\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + +\gamma_4\left(\frac{S_{i,t}}{K_{i,t-1}}\right) + \gamma_5\left(\frac{D_{i,t}}{K_{i,t-1}}\right)^2 +$$

$$+\gamma_6 VC_{i,t} + \gamma_7 VC_{i,t}\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \varepsilon_{i.t}$$

- Where $VC_{i,t}$ is a dummy variable that equals *1* if firm *i* received financing by a VC investor in year *t* or earlier
- Coefficients γ_7 is the interaction term between liquidity and the presence of VC and capture its marginal effect on the investment cash-flow sensitivity
- Coefficient γ_6 measures the increase in the investments rate after a VC investment

Methodology

The econometric models (3/3)

- To analyse how IVC and CVC affect the investment policy of the investee firm we estimate the following augmented Euler Equation:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \tau_t + \delta_1\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \delta_2\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right)^2 + \delta_3\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \delta_4\left(\frac{S_{i,t}}{K_{i,t-1}}\right) + \delta_5\left(\frac{D_{i,t}}{K_{i,t-1}}\right)^2 +$$

$$+ \delta_6 IVC_{i,t} + \delta_7 IVC_{i,t}\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \delta_8 CVC_{i,t} + \delta_9 CVC_{i,t}\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \varepsilon_{i.t}$$

- Where:
  - $IVC_{i,t}$ is a dummy variable that equals *1* if firm *i* received financing by a IVC investor in year *t* or earlier
  - $CVC_{i,t}$ is a dummy variable that equals *1* if firm *i* received financing by a CVC investor in year *t* or earlier
- The δ_7 and δ_9 coefficients are the interaction terms between liquidity and the presence of respectively IVC and CVC investors and capture their effect on the investment cash-flow sensitivity
- The δ_6 and δ_8 coefficients measure the increase in the investments rate after an investment by respectively an IVC or CVC investor

Methodology

Winsorising

• Most variables, being computed as ratios with a denominator which is sometimes close to zero, exhibit a strong non-normal distribution which would bias our estimates

• We thus winsorise the left and right tails at the 2% threshold in order to have well-behaved data with minimal information loss (see for a similar approach to treat outliers Cleary, 2006)

	Variable	N. obs.	Mean	Median	Std. Dev.			Skweness	Kurtosis
					Overall	Between	Within		
Not wisnorised	$I_{i,t}/K_{i,t-1}$	2,578	2.176	0.457	23.773	7.435	22.293	36.870	1,573.367
	$CF_{i,t}/K_{i,t-1}$	2,578	0.984	0.444	14.021	6.242	12.762	26.990	1,062.486
	$S_{i,t}/K_{i,t-1}$	2,578	57.650	9.942	1,417.079	430.908	1,325.315	46.171	2,221.537
	$D_{i,t}/K_{i,-1t}$	2,578	22.484	4.945	417.761	129.382	390.238	46.192	2,234.156
Winsorised 2% each tail	$I_{i,t}/K_{i,t-1}$	2,578	1.081	0.457	1.867	1.122	1.658	3.279	14.439
	$CF_{i,t}/K_{i,t-1}$	2,578	0.742	0.444	1.756	1.328	1.364	1.656	10.262
	$S_{i,t}/K_{i,t-1}$	2,578	19.181	9.942	25.574	20.640	16.878	2.604	10.375
	$D_{i,t}/K_{i,-1t}$	2,578	10.093	4.945	14.105	11.097	9.830	3.145	14.028

Methodology

Estimation of the models

- Models (1), (2) and (3) are autoregressive, distributed-lag models on a panel with a large number of cross-section units, each observed for a relatively short time period
- Within (i.e. Fixed) Effects estimation in these circumstances can lead to serious biases (Bond et al., 2001)
- We thus resort to a two-step system GMM estimation (Arellano and Bover, 1995; Blundell and Bond, 1998) with finite-sample correction (Windmeijer, 2005)
- The use of GMM estimation allows us to explicitly model endogeneity between covariates and investment rate
- In particular, endogeneity of VC, IVC and CVC are likely to be a problem in our model. We thus consider those variables (and the relative interaction terms) as endogenous or pre-determined
- Hansen-Sargan tests are performed to control for over-identification and resolve the structure of instruments

Methodology

hypotheses tests (1/2)

- To analyse the sensitivity of firm's investments (depending on the presence of VC investors) to the level of cash flows we estimate the following hypotheses:
  - Sensitivity to a short-run shock in current cash-flows
  - Sensitivity to a long-run parallel shift in cash-flows
- The former hypothesis is tested by looking at the following linear combination of coefficients (referred to equation 3):

$$H_0 : \begin{cases} \delta_3 = 0 \text{ For non - VC - backed firms} \\ \delta_3 + \delta_7 = 0 \text{ For IVC - backed firms} \\ \delta_3 + \delta_9 = 0 \text{ For CVC - backed firms} \end{cases}$$

Methodology

hypotheses tests (2/2)

- To test the second set of hypotheses we estimate the limit (i.e. $t \rightarrow \infty$) marginal elasticity of investment rate due to a permanent increase in cash flows from time *t=1* for a firm which would have null investments in equilibrium

$$H_0 : \begin{cases} \dfrac{\delta_3}{1-\delta_1} = 0 \text{ For non - VC - backed firms} \\ \dfrac{\delta_3 + \delta_7}{1-\delta_1} = 0 \text{ For IVC - backed firms} \\ \dfrac{\delta_3 + \delta_9}{1-\delta_1} = 0 \text{ For CVC - backed firms} \end{cases}$$

Results

Regression results (1/3)

	Variable	All sample	
β_1	I/K lag	0.0519 (0.399)	
β_2	$(I/K)^2$ lag	0.0001 (0.989)	
β_3	CF/K	0.1911 (0.000)	***
β_4	Sales/K	0.0372 (0.001)	***
β_5	$(Debt/K)^2$	-0.0004 (0.226)	
	N. observations	1.839	
	Sargan-Hansen	108.30 [103]	
	AR(1)	-5.007 ***	
	AR(2)	0.466	
	Sensitivity to CF shifts	0.2016 (0.001)	***

Results

Regression results (2/3)

	Variable	Equation (2)	
δ_1	I/K lag	0.0472 (0.510)	
δ_2	$(I/K)^2$ lag	0.0007 (0.911)	
δ_3	CF/K	0.2081 (0.002)	***
δ_4	Sales/K	0.0200 (0.000)	***
δ_5	$(Debt/K)^2$	0.0001 (0.735)	
δ_6	VC	0.8565 (0.014)	**
δ_{10}	VC*(CF/K)	0.1158 (0.468)	
	N. observations	1.839	
	Sargan-Hansen	120.191 [152]	
	AR(1)	-5.238 ***	
	AR(2)	0.360	
	Sensitivity to CF shocks		
	Non-VC-backed	0.2081 (0.002)	***
	VC-backed	0.3239 (0.051)	*
	Sensitivity to CF shifts		
	Non-VC-backed	0.2184 (0.002)	***
	VC-backed	0.3400 (0.049)	**

Results

Regression results (3/3)

	Variable	Equation (3)	
δ_1	I/K lag	0.1163	
		(0.229)	
δ_2	$(I/K)^2$ lag	-0.0065	
		(0.605)	
δ_3	CF/K	0.2169	***
		(0.001)	
δ_4	Sales/K	0.0184	***
		(0.002)	
δ_5	$(Debt/K)^2$	0.0002	
		(0.337)	
δ_{11}	IVC	0.5645	
		(0.112)	
δ_{12}	IVC*(CF/K)	-0.2562	
		(0.187)	
δ_{13}	CVC	0.4966	
		(0.209)	
δ_{14}	CVC*(CF/K)	0.3319	***
		(0.045)	
	N. observations	1.839	
	Sargan-Hansen	122.547 [203]	
	AR(1)	-5.281 ***	
	AR(2)	0.385	
	Sensitivity to CF shocks		
	Non-VC-backed	0.2169	***
		(0.001)	
	IVC-backed	-0.0393	
		(0.839)	
	CVC-backed	0.5488	**
		(0.002)	
	Sensitivity to CF shifts		
	Non-VC-backed	0.2455	***
		(0.001)	
	IVC-backed	-0.0444	
		(0.839)	
	CVC-backed	0.6211	***
		(0.004)	

Back to the literature

Investment-cash flow sensitivity and financial constraints (1/2)

- Up to now we have taken for granted that a high cash-flow sensitivity is a clue of the presence of financial constraints
- The literature on this issue is however not unanimous and surprisingly divided on the interpretation of this phenomenon
- Kaplan and Zingales (1997) develop a theoretical model showing that firms which exhibit the highest investment cash-flow sensitivity could actually be the ones which are less, rather than more, financially constrained; the reasons for this non-monotonic relationship could be the following:
  - cash flow may act as a proxy for investment opportunities not captured by Tobin's *Q*
  - differences in sensitivities might be driven by a few influential outliers
  - distressed firms might be forced to use cash flow to repay their debt
- Empirical evidence supporting this alternative view has been produced among others by Kaplan and Zingales (1997, 2000), Kadapakkam et al. (1998) and Cleary (1999)
- Furthermore a high cash-flow sensitivity could be the result of over- rather than under-investment

Back to the literature

Investment-cash flow sensitivity and financial constraints (2/2)

- We (at least partially) defend our interpretation of cash-flow sensitivity as a signal of firm's financial status against the issues raised by Kaplan and Zingales (1997) and Jensen (1986) both theoretically and empirically
- Theoretically we address the issues by:
  - Considering a sample of small closely-held private firms (i.e. managerial misbehaviour is minimal)
  - Estimating Euler equations rather than models based on Tobin's *Q*
  - Winsorising the variables to reduce the impact of outliers
- Empirically:
  - we split the sample of non-VC-backed firms in two subsamples based on the a-priori that smaller firms are more subject than larger ones to financial constraints
  - we estimate whether these two subsamples exhibit different cash flows sensitivity and, observe that the relationship is coherent with our interpretation

Cash flow sensitivity

large VS. small non-VC-backed firms

	Variable	All sample		Non VC-backed Large		Non VC-backed Small	
β_1	I/K lag	0.0519		0.0792		0.0512	
		(0.399)		(0.477)		(0.653)	
β_2	$(I/K)^2$ lag	0.0001		0.0008		-0.0019	
		(0.989)		(0.956)		(0.910)	
β_3	CF/K	0.1911	***	0.1331		0.3402	***
		(0.000)		(0.145)		(0.000)	
β_4	Sales/K	0.0372	***	0.0266	**	0.031	**
		(0.001)		(0.024)		(0.038)	
β_5	$(Debt/K)^2$	-0.0004		0.0000		-0.0004	
		(0.226)		(0.991)		(0.327)	
	N. observations	1.839		878		726	
	Sargan-Hansen	108.30 [103]		118.23 [102]		97.59 [102]	
	AR(1)	-5.007 ***		-3.737 ***		-2.680 ***	
	AR(2)	0.466		-0.748		1.312	
	Sensitivity to CF shifts	0.2016	***	0.1445		0.3585	***
		(0.001)		(0.147)		(0.000)	

Conclusions

- Our results show that:
  - NTBFs in Italy exhibit a strong and significant investment cash-flow sensitivity which we interpret as the consequence of capital market inefficiencies
  - The effect of IVC and CVC on firm's investment policy are substantially different
    - IVC-backed firms are unaffected by either short- and long-run cash-flow shocks
    - Neither short- nor long run shocks affect CVC-backed companies less than non-VC-backed ones
- These results confirm that VC, generally speaking, can significantly contribute to reducing the dependence of firm's investment policy on current cash flows
- However significant differences characterise different players and, in particular, IVC and CVC