The effect of venture capital financing on the sensitivity to cash flow of firm's investments

Fabio Bertoni

Department of Management, Economics, and Industrial Engineering, Politecnico di Milano ,

E-mail: fabio.bertoni@polimi.it

Massimo G. Colombo

Department of Management, Economics, and Industrial Engineering, Politecnico di Milano ,

E-mail: massimo.colombo@polimi.it

Annalisa Croce

Department of Management, Economics, and Industrial Engineering, Politecnico di Milano ,

E-mail: annalisa.croce@polimi.it

Abstract

This work studies the effect of venture capital (VC) financing on firms' investments in a longitudinal sample of 379 Italian unlisted new-technology-based firms (NTBFs) observed over the 10-year period from 1994 to 2003. We distinguish the effects of VC financing according to the type of investor: independent VC (IVC) funds and corporate VC (CVC) investors. Previous studies argue that NTBFs are the firms most likely to be financially constrained. The technology–intensive nature of their activity and their lack of a track record increase adverse selection and moral hazard problems. Moreover, most of their assets are firm-specific or intangible and hence cannot be pledged as collateral. In accordance with this view, we show that the investment rate of NTBFs is strongly positively correlated with their current cash flows. We also find that after receiving VC financing, NTBFs increase their investment rate independently of the type of VC investor. However, the investments of CVC-backed firms remain sensitive to shocks in cash flows, whereas IVC-backed firms exhibit a low and statistically not significant investment–cash flow sensitivity that we interpret as a signal of the removal of financial constraints.

Keywords: Investments, new-technology-based firms, financial constraints, venture capital, corporate venture capital.

JEL codes: G32, D92, G23

Support from the Venture Fun project promoted by the PRIME Network of Excellence is gratefully acknowledged. The authors are grateful to an anonymous referee, Gil Avnimelech, Marina Balboa, Terttu Luukkonen, Pascal Petit, Michel Querè, Alessandro Rosiello, Morris Teubal and participants in the 2006 EFMA Conference, 2006 EARIE Conference and XX RENT Conference for helpful comments. The usual disclaimer applies.

1. Introduction

A growing body of literature in corporate finance has focused attention on the effects of capital market imperfections deriving from information asymmetries on firms' ability to raise external financing for investments (e.g. Stein, 2003). Young firms operating in high-tech sectors are the ones most likely to be financially constrained because of these capital market imperfections (Carpenter and Petersen, 2002a). This is particularly worrying because such firms contribute fundamentally to the static and dynamic efficiency of national economies (Audretsch, 1995).

Several authors point out that venture capital (VC) is the most natural candidate to relax the financial constraints of new-technology-based firms (NTBFs) (e.g. Denis, 2004). Accordingly, we expect VC financing to have a beneficial effect on the investments of portfolio NTBFs. Unfortunately, the empirical evidence on this issue is almost non-existent (for an exception see Manigart et al., 2003). In particular, despite the fact that VC investors have different characteristics in terms of their level and mix of support activity, their organisation and incentive schemes, and the objectives they pursue (Bottazzi et al., 2008; Tykvova, 2006), the effects of these differences on the investments of VC-backed companies have so far remained unexplored.

In this work we analyse the investments in fixed and intangible assets in a longitudinal hand-collected dataset consisting of 379 Italian privately held NTBFs observed between 1994 and 2003. We are especially interested in assessing whether VC financing influences the investment–cash flow sensitivity of these sample firms and whether this effect depends on the type of investor. For this purpose, we consider two types of VC investor: independent venture capital (IVC) funds and corporate venture capital (CVC) investors.

In accordance with the view proposed by previous studies that NTBFs are financially constrained, we find evidence that non-VC-backed NTBFs, especially smaller ones, rely significantly on internal capital to finance their investments. After firms obtain VC financing from

IVC investors, this positive investment–cash flow sensitivity largely disappears, while the level of investment increases. We interpret these findings as suggesting that IVC-backed firms have a rather elastic external capital supply curve. In other words, if NTBFs are financially constrained, IVC investors manage to remove these constraints on firms' investment activity. Conversely, CVC-backed firms still exhibit positive investment–cash flow sensitivity, to an even greater degree than non-VC-backed firms.

This article is structured as follows. Section 2 discusses the theoretical background of the study. Section 3 describes the sample and reports some descriptive statistics. Section 4 presents the econometric models. Section 5 reports the results, and Section 6 concludes.

2. Theoretical background

2.1. The sensitivity to cash flow of firm's investments

Modigliani and Miller (1958) showed that under the hypothesis of frictionless financial markets, every investment with positive net present value is financed in equilibrium and the source of financing is irrelevant. Under the same hypothesis, Jorgenson (1963) and Hall and Jorgenson (1967) developed a theory of firms' intertemporal optimal investments. In these models the availability of internal capital (i.e. current cash flows) plays no role. Internal and external capital are perfect substitutes and their (opportunity) cost is set by market equilibrium.

However, when market imperfections deriving from information asymmetries are taken into account, inefficient equilibria arise. In particular, when investors are less informed than entrepreneurs, external capital in the form of both debt (Stiglitz and Weiss, 1981) and equity (Myers and Majluf, 1984) is rationed and some profitable investments are not financed. As a consequence, firms adhere to a 'pecking order' in financing their investments (Myers and Majluf, 1984): they first rely on internal capital, which is the source of financing with the lowest opportunity cost; then, when internal capital is exhausted, they turn to the external capital source with the lowest cost, which is usually debt (at least for firms with low leverage). In addition, Fazzari et al. (1988) argued that whereas the marginal opportunity cost of internal capital is constant, the marginal cost of debt follows an upward slope: the greater the capital market imperfections, the steeper the slope. Under these circumstances, one would expect the investments of firms that face a steep debt supply curve and are thus 'financially constrained', to be more sensitive to internal cash flows than those of their unconstrained counterparts. Fazzari et al.'s (1988) empirical analysis of investments in fixed assets in a sample of US listed manufacturing firms supports this prediction. They showed that firms' investments are significantly and positively correlated with cash flows. Moreover the investment–cash flow sensitivity is higher for firms with low dividend payouts, which are assumed to have more binding financial constraints.

A rich body of literature stemmed from this seminal work. Several studies replicated the analysis by grouping firms according to different proxies of the extent of information costs, such as firm's age, size, ownership structure and membership in *keiretsu* or business groups (see Hubbard, 1998, for a comprehensive survey). Moreover, the analysis was extended to other types of investment, such as R&D expenses (Himmelberg and Petersen, 1994), inventory investments (Carpenter et al., 1998), cash savings (Almeida et al., 2004; Ferreira and Vilela, 2004) and total assets (Carpenter and Petersen 2002b).

However, recent work has argued that the approach proposed by Fazzari et al. (1988) has some weaknesses. First, Kaplan and Zingales (1997, 2000) developed a simple theoretical model showing that firms' investment–cash flow sensitivity does not necessarily decrease monotonically with the level of available internal capital or increase monotonically with the wedge between the cost of external and internal capital. They used the detailed qualitative and quantitative information contained in firms' annual reports and financial statements to rank the extent to which the 49 low-dividend firms included in the Fazzari et al. (1988) study were financially constrained each year. They found that firms that were classified as more financially constrained exhibited lower investment–cash flow sensitivity than those classified as less financially constrained.

Cleary (1999) refined Kaplan and Zingales's classification using a 'financial status' indicator. He again found that firms with poorer financial status have lower investment–cash flow sensitivity. Almeida and Campello (2007) showed that because firms are able to pledge their assets as collateral, investments and borrowing become endogenous. Specifically, the investment–cash flow sensitivity of financially constrained firms increases as the tangibility of their assets increases, whereas when firms are unconstrained, the investment–cash flow sensitivity is unaffected by asset tangibility. Kadapakkam et al. (1998) and Cleary (2006) extended the analysis to an international sample and found results that again contradict Fazzari et al.'s (1988) hypothesis.

Second, positive investment–cash flow sensitivity may simply result from a lack of proper control for unobserved investment opportunities (see again Hubbard, 1998). In empirical works these unobserved investment opportunities are generally captured by average Tobin's Q as a proxy for marginal Tobin's q. However, the relationship between the investment rate and Tobin's Q may be non-linear if adjustment costs are not well described by a quadratic functional form. Moreover, Tobin's Q ceases to be a sufficient statistic for the influence of investment opportunities when the perfect competition and constant returns to scale assumptions are not met. Finally, Tobin's Q can suffer from measurement errors (Erickson and Whited, 2000). Gomes (2001), Alti (2003) and Moyen (2004) showed that measurement errors and identification problems lead to significant investment–cash flow sensitivity even in the absence of financing frictions. An alternative approach that partially solves the problems mentioned above is to estimate directly the Euler equation (Abel, 1980). In this way one can relax the assumption of linear homogeneity of the net revenue function and avoid the use of share price data (Bond and Van Reenen, 2007).

Finally, Jensen (1986) pointed out that opportunistic behaviour by managers who misuse firms' free cash flows could cause overinvestment and lead to a positive relation between the investment rate and the level of cash flows. Even though the sources of overinvestment and underinvestment problems are clearly different, they generate similar empirical effects and are thus difficult to disentangle, especially because most of the empirical evidence refers to listed companies where overinvestment may play a significant role. Vogt (1994) reported evidence that both effects are at work and that overinvestment (underinvestment) dominates for larger (smaller) firms. Morgado and Pintado (2003) also analyse the overinvestment and underinvestment hypotheses and found, using panel data methodology, that the relationship is quadratic, thus indicating that an optimal level of investment exists. Pawlina and Renneboog (2005) also found that the agency costs of ownership influence the investment–cash flow sensitivity.

2.2. The effect of VC financing on the investments of NTBFs

In this article we focus on NTBFs. This alleviates some of the problems mentioned in the previous section. First, most NTBFs are privately held, and ownership and control are not separated. For these firms free cash flow abuses on the part of owner–managers are far less likely than for large public companies, so Jensen's (1986) free cash flow argument is less pertinent. Second, the investment opportunities for NTBFs, especially in their early years, depend on the quality of their business ideas and the innovative content of the technologies they are developing, but they are unlikely to be correlated with current cash flows.

In addition, previous studies have argued that these are the firms most likely to be financially constrained. On the one hand, because of the technology-intensive nature of their activity and their lack of a track record, they face severe adverse selection and moral hazard problems. On the other hand, most of their assets are firm-specific or intangible and hence cannot be pledged as collateral (Berger and Udell, 1998; Carpenter and Petersen, 2002a; Denis, 2004).

To the extent that NTBFs are financially constrained, we expect them to exhibit great investment–cash flow sensitivity. We also expect this sensitivity largely to disappear if they manage to obtain equity financing from external sources and the external equity supply curve is sufficiently elastic. In accordance with this view, Carpenter and Petersen (2002b) showed that in a panel of more than 1,600 small US listed manufacturing firms, a sizeable proportion of which operated in high-tech industries, an additional dollar of internal finance generated slightly more than a dollar of growth in assets. Moreover, the small number of these firms that resorted extensively to new equity issues exhibited a much weaker relation between growth and internal finance.

We argue that VC financing should have a similar effect. In fact, the financial literature contends that because of their superior scouting and monitoring capabilities, VC investors are able to deal effectively with the adverse selection and moral hazards problems that NTBFs face (e.g. Amit et al., 1998; Bottazzi and Da Rin, 2002; Chan, 1983; Gompers, 1995; Kaplan and Strömberg, 2001). In addition, the objective of VC investors is to obtain the largest possible capital gain in the shortest possible time. Once they have identified promising investment opportunities, they have incentives to provide portfolio firms with the financial resources they need to fully exploit their (supposedly great) investment opportunities. So the VC supply curve is likely to be very elastic. Finally, VC investments have a signalling effect, certifying firms' quality to uninformed third parties (Stuart et al., 1999). Therefore, endorsement by a VC investor makes it easier for portfolio firms to obtain access to other external financial resources and to tangible and intangible assets (e.g. distribution channels, manufacturing facilities, sales force) possessed by other firms through the establishment of alliances (Colombo et al., 2006; Hsu, 2006). This latter effect further relaxes the financial constraints these firms would otherwise experience, as these resources do not need to be built internally.

It is quite surprising that the empirical evidence on the effects of VC financing on the investments of NTBFs is fairly limited. Manigart et al. (2003) analysed whether VC financing reduces the cash flow sensitivity of investments in fixed assets using a modified accelerator model (Mairesse et al., 1999). They considered a sample of 859 Belgian unlisted firms which received VC between 1987 and 1997 and a matched sample of non-VC-backed firms. Contrary to their predictions, they found that the fixed investments of VC-backed firms were more sensitive to cash flows than those of non-VC-backed firms. Yet they also provided some indication that VC investors play a more positive role in financing investments in intangible assets.

One drawback of Manigart et al.'s (2003) study is that it does not account for the heterogeneity of VC investors. In fact, it has been argued in the VC literature that, especially in Europe, this heterogeneity is considerable (Bottazzi et al., 2008; Tykvova, 2006). The effects of VC financing on portfolio firms are likely to differ according to the identity of the investor (Engel and Heger, 2006; Tykvova and Walz, 2007).[1] In this work, we contrast VC financing provided by IVC funds and by CVC investors. This is an important distinction, as differences between these two types of investor are likely to affect their ability and incentives to remove the financial constraints of portfolio firms.

First, it has been shown by previous studies that the objectives of CVC investors generally differ from those of IVC funds. In addition to, or even in place of, financial objectives, CVC investors often pursue strategic objectives connected with the desire to open a 'technology window' on the novel technologies portfolio NTBFs are developing (Chesbrough, 2002; Dushnitsky and Lenox, 2005a,b; Ernst et al., 2005; Gompers, 2002; Siegel et al., 1988). Hence, we expect them to be less inclined than IVC investors to support the investments of portfolio firms beyond the amount that is needed to develop these technologies.

Second, previous studies argue that CVC investors may suffer from organisational deficiencies in comparison with IVC funds. Early-stage financing of high-tech firms is generally a non-core activity for the parent companies of CVC investors; hence, CVC investors are likely to be involved in a smaller number of deals and to be less experienced than IVC investors. It is also rather difficult for CVC parent companies to design incentive schemes for the managerial personnel of their CVC units suitable to attract and retain highly qualified individuals because of the interdependency between the CVC unit and the units which operate in other businesses (Block and Ornati, 1987). Moreover, VC financing engenders appropriability hazards, as VC investors may try

---

[1] Hsu (2004) showed that financing offers from VC firms with a high reputation are more than three times more likely to be accepted by recipient firms than other offers; in addition, these investors obtain a discount on the purchase price of the participation of between 10% and 14%. The reason may be the greater benefits that firms expect to reap from these reputable investors.

to expropriate technologies from portfolio companies (Ueda, 2004). These appropriability hazards are greater with a CVC investor than with an IVC fund. A CVC investor, especially if it is operating in the same industry as the portfolio NTBF, is likely to possess the specialised complementary assets that are required for commercial exploitation of the NTBF's technology. Hence, NTBFs will be cautious about revealing sensitive information to CVC investors (Block and MacMillan, 1993; Dushnitsky, 2007). It follows that because of the supposedly lower scouting and monitoring capabilities possessed by CVC investors and the more secretive attitude that is likely to be adopted by the NTBFs they target for investment, these investors will find it more difficult than IVC investors to deal effectively with the ex ante and ex post information asymmetry problems that prevent NTBFs from obtaining efficient financing.

In summary, CVC investors often pursue non-financial objectives and are likely to possess lower scouting and monitoring capabilities than their IVC counterparts, to adopt less efficient incentive schemes for their personnel and to elicit less cooperative attitudes from would-be portfolio companies. As a corollary, the CVC supply curve is likely to be less elastic than the IVC supply curve. With all else equal, we expect the investment–cash flow sensitivity of CVC-backed firms to exceed that of their IVC-backed counterparts.

3. Sample and descriptive statistics

This work is based on a sample of 379 Italian privately held NTBFs observed from 1994 (or since their founding) to 2003. Sample firms were established in 1980 or later, were independent at the time of their founding and remained so up to 1 January 2004 (i.e. although other organisations may have held minority shareholdings, the sample firms were not controlled by another business organisation). They operate in the following high-tech manufacturing and services sectors: computers; electronic components; telecommunications equipment; optical, medical and electronic instruments; biotechnology; pharmaceuticals; advanced materials; aerospace; robotics and process automation equipment; multimedia content; software; Internet services (e-commerce, Internet service provision, web-related services) and telecommunications services.

The sample was extracted from the RITA 2004 (Research on Entrepreneurship in Advanced Technologies) database, developed at the Politecnico di Milano. This database is the most complete source of data on young high-tech startups presently available in Italy. It includes 1,974 firms.

The procedure followed to build the sample is described in Appendix A. Two χ^2 tests show that there are no statistically significant differences between the distributions of the 379 sample firms across industries and geographical areas and the corresponding distributions of the population of 1,974 RITA firms from which the sample was obtained [respectively, $\chi^2(4) = 2.17$ and $\chi^2(3) = 3.19$]. However, sample firms are somewhat younger [$\chi^2(5) = 7.16$, *p*-value 6.7%]. Moreover, almost all of them are limited liability companies (S.r.l. and S.p.a.).

The sample is quite large and exhibits considerable heterogeneity in terms of firm characteristics. Note, however, that there is no presumption here of a random sample. First, in this domain representativeness is a slippery notion, as new ventures may be defined in different ways (e.g. Aldrich et al., 1989; Birley, 1984; Gimeno et al., 1997). Second, in the absence of reliable official statistics (see Appendix A) it is impossible to identify unambiguously the population of Italian NTBFs. Therefore, one cannot check ex post whether the sample used in this work is representative of the population. Third, only firms that survived up to the final survey date could be included in the sample. In principle, attrition may generate a sample selection bias that distorts the estimates. In fact, VC-backed firms' likelihood of going bankrupt may exceed that of their non-VC-backed counterparts, as VC investors are less risk averse than other investors. The results of previous studies appear to support this argument. For instance, Manigart et al. (2002) compared the likelihood of survival of 565 Belgian VC-backed companies up to nine years after the first round of financing with that of 565 comparable non-VC-backed companies. VC-backed firms exhibited a significantly higher probability of not surviving owing to either bankruptcy or closure.

In fact, it is almost impossible to control for this selection bias. The best we can do is to check its extent. For this purpose, we focused attention on the RITA 2000 sample. This sample is composed of 401 NTBFs that were selected through a procedure similar to the one through which the RITA 2004 sample was obtained (Colombo et al., 2004). Of these firms, 31 were VC-backed at the start of 2000. We examined the exit rate of these firms during 2000–2003 as a result of bankruptcy or closure. Four VC-backed firms (12.9%) ceased activity in this period. The corresponding percentage for non-VC-backed firms is fairly close (12.2%). A χ^2 test shows that the difference between the two values is not statistically significant at a conventional confidence level [$\chi^2(1) = 0.02$]. Therefore, although we acknowledge that our sample suffers from a survivorship bias, we are quite confident that this does not greatly influence the results of our estimates.

Of the 379 sample firms, 52 (13.7%) obtained VC financing.[2] This figure clearly overestimates the diffusion of VC financing among Italian high-tech startups. First, the sample used in this study includes few non-limited liability companies, among which VC financing is non-existent. Second, the RITA population, owing to the procedure used to build it (see again Appendix A), is likely to include the universe of IVC-backed NTBFs and most CVC-backed NTBFs but only a sample of non-VC-backed ones.

Among VC-backed firms, 46 obtained financing from IVC and/or CVC investors. More precisely, 19 were financed by IVC funds, some of which are foreign owned; 33 obtained VC from CVC investors. Six sample firms received VC financing from both IVC and CVC investors and are included in both categories. These investments were not syndicated; that is, IVC funds and CVC investors did not invest jointly in the company. This fact suggests that joint investments by different categories of VC investor are relatively rare in Italy. The reason may be the limited diffusion of syndication; it may also be the different objectives that are pursued by different types of investor.

---

[2] Three sample firms obtained equity capital directly from financial institutions as part of the restructuring of their capital structure. They are included in the non-VC-backed category. Their allocation to the VC-backed category would not alter the results presented in next section.

The CVC category includes both investments made directly by corporations and those made indirectly through affiliated financial subsidiaries or investment funds. The number of CVC-backed firms as a proportion of the total number of VC-backed firms is substantially larger than the figure that typically appears in statistics published by national VC associations. The reason is that our data also include direct investments, which are excluded from these statistics. Thus, we are able to offer more complete coverage of CVC financing.

Finally, three sample NTBFs were financed by bank-controlled VC funds and three by VC funds controlled or participated in by local government institutions (e.g. regional governments). The extent to which local government investors pursue financial objectives rather than broader social objectives is open to debate. Nonetheless, among these social objectives, supporting the investment activity of portfolio firms is likely to figure quite prominently. Bank-controlled VC funds are, like IVC investors, likely to pursue financial objectives. Both bank-controlled and governmental VC funds, because of their captive nature, are likely to have the same organisational deficiencies as CVC investors. Unfortunately, the number of sample firms backed by these investors is too small to analyse the effects of these types of VC financing.

[Table 1 about here]

Table 1 reports the distribution of sample firms across industries and geographical areas. It also shows the industry and geographical distribution of firms according to the type of VC financing they obtained. IVC and CVC investors focus on more or less the same industries, with the notable exception of software, where CVC investors seem to be much more active than IVC funds (nine versus two investments). Both IVC and CVC investors invest little in the south of the country, with only one investment each. IVC investments are more concentrated in the northwestern regions (14 out of 19 investments), while the distribution of CVC investments is more balanced across the country.

Finally, a comment on the separation of ownership and control in sample firms is in order. Unfortunately, we do not have detailed information about the evolution of the ownership structure of the sample firms. Nevertheless, we do know the number of shareholders at foundation for 344 (90.8%) of them. The average number of shareholders at foundation is 2.72. In 259 firms (75.3%), all founders were actively involved in the management of the company; for the remaining 85 firms, the average number of shareholders not actively involved in the management of the company is 1.92. Therefore, one can assume that the separation of ownership and control in our sample is fairly limited.

4. The econometric models

4.1 Specification

Several econometric models have been used in the literature to analyse investment–cash flow sensitivity (Bond and Van Reenen, 2007; Hubbard, 1998). The main problem is that current cash flows are used as a measure of the availability of internal capital but, at the same time, are possibly related to firms' investment opportunities. As mentioned above, this problem is likely to be less severe for NTBFs. Nevertheless, it is important to include in the model some control for firms' unobserved investment opportunities. In theory, this could be accomplished by the inclusion in the model of firms' marginal Tobin's *q*. This is, however, difficult to estimate empirically. Under some hypotheses average Tobin's Q can be used, but, as pointed out by Hubbard (1998), these hypotheses are likely not to be met. Some alternative approaches have been proposed in the literature. For instance, Abel and Blanchard (1988) used a sales accelerator model. However, this model is unlikely to control correctly for firms' investment opportunities (Fazzari et al., 1988). An alternative approach, which we follow in our work, is to estimate a Euler equation (Bond and Meghir, 1994):

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

where $I_{i,t}$ measures the level of investments of firm i in period t, $K_{i,t}$ is the end-of-period-t net value of firm i's invested assets, $CF_{i,t}$ is firm i's cash flow in period t, $S_{i,t}$ is firm i's sales during period t and $D_{i,t}$ is firm i's end-of-period-t total debts. If there are capital market imperfections and the external capital supply curve of NTBFs is upward sloping, we expect β_3 to be positive and statistically significant.

To understand whether investment–cash flow sensitivity is affected by VC financing we estimate an augmented version of equation (1):

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \tau_t + \gamma_1\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \gamma_2\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right)^2 + \gamma_3\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \gamma_4\left(\frac{S_{i,t}}{K_{i,t-1}}\right) + \gamma_5\left(\frac{D_{i,t}}{K_{i,t-1}}\right)^2 + \\ + \gamma_6 VC_{i,t} + \gamma_7 VC_{i,t}\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \varepsilon_{i,t}, \qquad (2)$$

where $VC_{i,t}$ is a time-variant dummy variable that equals 1 if firm i received VC before or during period t. In other words, $VC_{i,t}$ differentiates between firms that by time t have never been VC-backed ($VC_{i,t}$ = 0) and the remaining firms ($VC_{i,t}$ = 1). It switches from 0 to 1 in the year in which firms obtain their first round of VC financing.[3] The coefficient γ_6 captures whether the level of investments increases after receiving VC. The coefficient γ_7 measures the effect of VC financing on investment–cash flow sensitivity. It is worth noting that coefficients γ_6 and γ_7 relate to two different and complementary aspects: γ_7 deals with changes in the sensitivity of firms' investments to current cash flows, but it does not reveal anything about investment levels, whereas γ_6 measures changes in investment levels independently of their relation to available internal capital.

Finally, we extend equation (2) to analyse whether different types of VC investor (namely, IVC funds and CVC investors) have different effects on firms' investments:

---

[3] Note that $VC_{i,t}$ does not switch back to 0 when VC investors exit. The reason is that firms that obtained VC financing are inherently different from firms that never did so. For instance, VC financing is assumed to signal the good quality of a firm to uninformed third parties, making it easier for the firm to obtain access to external resources. This effect is likely to persist even after the exit of the VC investor.

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \tau_t + \delta_1\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \delta_2\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right)^2 + \delta_3\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \delta_4\left(\frac{S_{i,t}}{K_{i,t-1}}\right) + \delta_5\left(\frac{D_{i,t}}{K_{i,t-1}}\right)^2 + \\ + \delta_6 IVC_{i,t} + \delta_7 IVC_{i,t}\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \delta_8 CVC_{i,t} + \delta_9 CVC_{i,t}\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \varepsilon_{i,t}. \qquad (3)$$

$IVC_{i,t}$ and $CVC_{i,t}$ are time-varying dummy variables that equal 1 if firm i received financing from IVC and CVC investors, respectively, before or during period t. Again, δ_6 and δ_8 measure the effects on firms' investment levels, and δ_7 and δ_9 capture changes in firms' investment–cash flow sensitivity as a result of IVC and CVC financing, respectively.

Equations (1), (2) and (3) are autoregressive models that are estimated on a panel dataset with a large number of cross-section units, each observed for a relatively short period. Both pooled ordinary least squares (OLS) and fixed-effects within-groups (WG) estimates in these circumstances can lead to serious biases (Bond et al., 2001).[4] We thus resort to two-step system generalised method of moments (GMM) estimation (Arellano and Bover, 1995; Blundell and Bond, 1998) with finite-sample correction (Windmeijer, 2005). The use of GMM estimation allows us explicitly to model endogeneity between covariates and the investment rate. As we are particularly concerned with direct causality between VC financing and firm's investment rate we have to deal with the potentially endogenous nature of VC financing [i.e. $VC_{i,t}$ in equation (2) and $IVC_{i,t}$ and $CVC_{i,t}$ in equation (3)]. In other words, a firm which increases its investment level could be more likely to look for external financing, thus leading to a correlation between the two variables caused by reverse causation (i.e. investments causing VC financing). We consider all VC financing variables and relative interaction terms to be predetermined.

[4] Pooled OLS estimates are likely to be biased because of lack of proper control for unobserved heterogeneity and endogeneity bias. Through first differencing, WG estimates correct for time-invariant unobserved factors. Nevertheless, they do not take into account positive or negative shocks that may affect both the endogenous variable and (some of) the covariates. Results of pooled OLS and WG estimates are available from the authors upon request.

4.2 Variables

Previous studies have analysed the sensitivity of several types of firms' investments (e.g. fixed assets, intangible assets, R&D, inventories) to the availability of internal capital. In this work we focus on investments in fixed and intangible assets. Hence, the dependent variable $I_{i,t}$ is calculated as the increase in a firm's book value of tangible and intangible assets net of depreciation. The investment rate $I_{i,t}/K_{i,t-1}$ is the ratio between total investments in year t and the beginning-of-period-t total book value of fixed and intangible assets. Firms' cash flows, $CF_{i,t}$, are calculated after taxes but before dividends. Other authors have used ex-dividend cash flows (e.g. Manigart et al., 2003). We opted for cash flows before dividends because our sample is composed of unlisted firms, in which dividends have no signalling role. Whereas a reduction in the amount of dividends paid to shareholders is perceived as a negative signal by investors in listed firms, shareholders of privately held firms are far more informed about firm performance and the signalling power of dividends is much reduced. This implies that privately held firms are less constrained than listed ones in their dividend policy and, theoretically, that all cash flows can be reinvested if some profitable investment opportunity arises. The variable $S_{i,t}$ is calculated as total sales of firm i in period t. The variable $D_{i,t}$ accounts for short- and long-term debt at the end of period t.

[Table 2 about here]

Table 2 reports some descriptive statistics for the variables in equations (1)–(3). All these variables are normalised to the beginning-of-period-t stock of fixed and intangible assets. As firms in our sample are relatively young and small, this value is sometimes close to zero, producing extremely skewed and leptokurtic distributions of the variables. The presence of these outliers would severely bias our results. We thus winsorised all the variables (e.g. Dixon, 1960) with a 2% cut-off for each tail. In other words, for each variable we calculated the values corresponding to the 2nd and 98th percentiles of its distribution and assigned these values to all observations falling beyond them. This approach is attractive because it reduces the impact of outliers and allows the use of a larger number of observations than would be possible if outliers were deleted. Furthermore, it has already been used in the investment literature (e.g. Baker et al., 2003), notably to assess investment–cash flow sensitivity (e.g. Cleary, 1999, 2006). Other cut-offs for winsorising were computed, namely 1% and 5%, but a 2% cut-off offers the best compromise between smoothing extreme values and maintaining sufficient variance. Estimates using these different cut-offs are reported in Appendix A (see Table A1). They are very close to those described in next section. Descriptive statistics for winsorised variables are also reported in Table 2.

5. The econometric results

Since equations (1)–(3) have an intrinsically dynamic structure, it is useful to analyze the effects of two, complementary, types of cash flow perturbation, namely short-run shocks (i.e. an instantaneous increase ΔCF of cash flows in a given year) and long-run parallel shifts (i.e. a permanent increase ΔCF of cash flows). We pay specific attention to the effects of these perturbations according to (a) whether NTBFs are VC-backed and (b) the type of VC investor.

The effects of short-run shocks can be gauged through a simple linear test on the parameters of the models. If an instantaneous change ΔCF in $CF_{i,t}$ produces a change in the investment rate, the coefficient of $CF_{i,t}/K_{i,t-1}$ should be positive and significant. Hence, we performed the following Wald tests of the null hypothesis that an instantaneous change of cash flows does not affect the investment rate:

In equation (1):	$\beta_3 = 0$.	
In equation (2):	$\gamma_3 = 0$	for non-VC-backed firms,
	$\gamma_3 + \gamma_7 = 0$	for VC-backed firms.
In equation (3):	$\delta_3 = 0$	for non-VC-backed firms,
	$\delta_3 + \delta_7 = 0$	for IVC-backed firms,
	$\delta_3 + \delta_9 = 0$	for CVC-backed firms.

To measure the dependence of firms' investments on long-run variations in cash flows, we calculated the marginal increase in the equilibrium investment rate (i.e. $I_{i,t}/K_{i,t-1}$ with t → ∞) following a *permanent* marginal increase ΔCF in cash flows starting from an equilibrium in which firms' investments are nil. The dynamic structure of models (1)–(3) requires the following non-linear pseudo-Wald tests on the parameters (for the derivation of the test see Appendix B):

In equation (1): $\beta_3 / (1-\beta_1) = 0$

In equation (2): $\gamma_3 / (1-\gamma_1) = 0$ for non-VC-backed firms,

$(\gamma_3 + \gamma_7) / (1-\gamma_1) = 0$ for VC-backed firms.

In equation (3): $\delta_3 / (1-\delta_1) = 0$ for non-VC-backed firms,

$(\delta_3 + \delta_7) / (1-\delta_1) = 0$ for IVC-backed firms,

$(\delta_3 + \delta_9) / (1-\delta_1) = 0$ for CVC-backed firms.

The tests are performed using the 'delta' method. We predict that investment–cash flow sensitivity depends on whether a firm is VC-backed and on the type of VC investor. In particular, we expect the investment cash–flow sensitivity of VC-backed firms to be negligible, especially when they obtain financing from an IVC investor.

As a preliminary step, we provide in Table 3 the estimates of model (1) after eliminating VC-backed companies from the sample. We also split the sample into two sub-samples, composed of 'larger' and 'smaller' firms. An observation falls in the 'large firms' ('small firms') sub-sample if in that particular year the firm has total assets above (below) the overall median (i.e. firms might move between the two sub-samples as their size changes over time). As highlighted earlier in this article, non-VC-backed NTBFs are likely to be financially constrained. In accordance with previous work (e.g. Gilchrist and Himmelberg, 1995), this is most likely to be the case for smaller NTBFs. Conversely, VC-backed NTBFs benefit from the support of their VC investor, and so they should be able to remove the financial constraints that would otherwise inhibit investments. Quite unsurprisingly, in column (2) the coefficient of the cash flow variable is positive and significant (at 1%), highlighting a positive investment–cash flow sensitivity of a magnitude similar to those found by previous studies. Similarly, a permanent shift in current cash flows results in a positive statistically significant (at 1%) increase of the equilibrium investment rate, as is apparent from the value of the pseudo-Wald test reported at the bottom of Table 3. When we group firms according to size [see columns (3) and (4)], the coefficient of the cash flow variable is again positive and significant in the 'small firms' model, whereas it is positive but not significant in the 'large firms' model. Results relating to the effect of a permanent cash flow shift are similar. It should be recognised that these findings may be driven by factors other than imperfections in capital markets, such as misuse of free cash flows by firms' owner–managers or lack of proper control in the model specification for unobserved factors that are correlated with both cash flows and investment opportunities. In fact, the presence of binding financial constraints is not a necessary condition for positive investment–cash flow sensitivity. Nevertheless, these situations are less likely to apply here for the reasons given in Section 2.2. In summary, our findings are in line with those of previous studies in showing that the investments of firms which are presumed to face severe information asymmetries in capital markets, resulting in a steep external capital supply curve (i.e. non-VC-backed NTBFs, especially those of smaller size), are sensitive to the level of cash flows, with all else equal. In other words, if these firms find it difficult to obtain external capital at fair terms, and so are financially constrained, they are forced to rely mainly on internal capital to finance their investments. In turn, this results in high investment–cash flow sensitivity.

[Table 3 about here]

Let us now consider the effect of VC financing on the investment–cash flow sensitivity of sample firms. For this purpose, we report in panel (a) of Table 4 the results of the estimates of equations (2) and (3) for the whole sample [see columns (3) and (4), respectively]; we also present in column (2) the estimates of equation (1) for comparison purposes. Panel (b) analyses how firms' investments are affected by short-run shocks and long-run parallel shifts in cash flows, depending on their access to VC financing and the type of VC investor.

[Table 4 about here]

Let us first compare VC-backed and non-VC-backed firms, regardless of the type of investor. The estimates of equation (2) confirm that non-VC-backed firms rely largely on internal cash flows to finance their investments. In fact, the investment rate of these firms is significantly and positively affected by both a short-run cash flow shock and a long-run parallel shift in cash flows, as documented by the results of the Wald and pseudo-Wald tests reported in panel (b). We are especially interested in assessing whether, after NTBFs obtain VC financing, their investment rates are both higher and less sensitive to cash flows, which would possibly indicate the removal of financial constraints. The coefficient of $VC_{i,t}$ is positive as expected and statistically significant; that is, after receiving VC financing firms invest more. It is quite surprising that the coefficient of the interaction term with current cash flows ($VC_{i,t} \cdot CF_{i,t}/K_{i,t-1}$) is also positive, though not significantly different from 0. The Wald and pseudo-Wald tests indicate that the null hypothesis that for VC-backed firms investments do not depend on short-run shocks or parallel shifts in cash flows can be rejected at conventional confidence levels. The magnitude of these effects is even larger than those relating to non-VC-backed firms. Note, however, that the standard deviation of the estimated coefficient of the interaction term $VC_{i,t} \cdot CF_{i,t}/K_{i,t-1}$ is quite high. This possibly points to the existence of great heterogeneity in the investment–cash flow sensitivity of firms included in the VC-backed category.

To shed light on this issue, we turn to the analysis of the differences between IVC- and CVC-backed firms in equation (3). In the estimate of this equation, six firms that received financing from bank-controlled and governmental VC funds were excluded from the sample. Results relating to non-VC-backed firms are in line with those above and do not warrant further comment. The coefficients of both the $IVC_{i,t}$ and $CVC_{i,t}$ variables are positive, though insignificant, possibly owing to the small number of firms that fall in each category. The coefficient of the interaction term

$IVC_{i,t} \cdot CF_{i,t}/K_{i,t-1}$ is negative, whereas that of $CVC_{i,t} \cdot CF_{i,t}/K_{i,t-1}$ is positive and significant. The results of the tests reported in panel (b) of Table 4 clearly indicate that there are substantial differences between IVC-backed and CVC-backed firms. The investments of IVC-backed firms are found not to be sensitive to internal cash flows; in fact, the null hypothesis that the investment rate is not affected by either a short-run shock or a parallel shift in cash flows cannot be rejected at conventional confidence levels. Conversely, CVC-backed firms exhibit great sensitivity of investments to cash flows, with their investment rate being significantly affected by both types of perturbation, as is evident from the magnitude of the values illustrated in panel (b).

Let us summarise the key findings from the econometric estimates. Investments by non-VC-backed Italian privately held NTBFs are significantly affected by shocks in cash flows, possibly as a consequence of the presence of binding financial constraints. VC investors may be able to remove these constraints. Our results strongly support the view that this depends crucially on the type of investor. On average, both IVC- and CVC-backed firms increase their investments after they obtain VC financing. However, the dependence of investments on cash flows becomes negligible only when the investor is an IVC fund. Both short-run and long-run cash flow perturbances significantly affect the investment rate of CVC-backed firms.

6. Concluding remarks

In this work we have studied the relationship between investments and internal cash flows in a sample of 379 Italian privately held NTBFs, 52 of which are VC-backed. Non-VC-backed firms exhibit high investment–cash flow sensitivity, especially if they are of smaller size. VC financing results in an increase of the investment rate independently of the type of investor, but *on average* it appears not to affect the sensitivity of investments to internal capital. On this latter issue, we have found that there is substantial heterogeneity according to the *type* of VC investor. CVC-backed firms exhibit positive investment–cash flow sensitivity of an even larger magnitude than non-VC-backed firms. Conversely, when firms receive VC financing from an IVC investor, the sensitivity of investments to cash flows disappears.

Previous studies have claimed that NTBFs are the firms most likely to be financially constrained; this claim seems to be pertinent to Italian NTBFs (Colombo and Grilli, 2007). Therefore, the positive investment–cash flow sensitivity of Italian non-VC-backed NTBFs, and especially of smaller ones, comes as no surprise. Of course, this relation may be driven by other factors. However, cash flow misuses are quite unlikely among Italian privately held non-VC-backed NTBFs, as the separation of ownership and control is generally fairly limited. In addition, we estimated a Euler equation that allows us to control better for unobserved investment opportunities which may be correlated with cash flows. More important, if imperfect control for unobserved investment opportunities leads to a spurious correlation between investments and cash flows, there is no reason for this correlation to vanish when firms obtain IVC financing.

If one assumes that Italian NTBFs are financially constrained, our results clearly indicate that IVC investors manage to remove these constraints and that IVC-backed firms have a rather elastic external equity capital supply curve. It is interesting that we failed to detect a similar effect for CVC financing.

Our work contributes to the empirical literature that has documented the fact that VC financing is extremely important in supporting NTBFs. Its findings are also in line with those of the few previous studies indicating that the identity of the investor matters (Bottazzi et al., 2008; Engel and Heger, 2006; Tykvova, 2006; Tykvova and Walz, 2007). In particular, in a companion paper, Bertoni et al. (2007) have documented that VC financing has a dramatic positive impact on the rate of growth of NTBFs, measured by both sales and employees, and that these effects are considerably greater when firms obtain VC from financial intermediaries, most of which are IVC funds, rather than from CVC investors (see Audretsch and Lehmann, 2004, and Engel, 2002, for similar evidence). This article offers a possible explanation: IVC investors manage to relax the financial constraints from which NTBFs are assumed to suffer, whereas CVC investors fail to do so.

Despite our findings, much remains to be done in this field. Two directions for future research seem to us most promising. First, we found that the type of investor matters, but the empirical analysis offered no indication as to the why. Previous studies indicate that there is substantial heterogeneity across VC investors according to factors such as their investing experience, the human capital of managing partners and the size and industry composition of their portfolio of firms (see again Bottazzi et al., 2008). These differences are likely to influence the effects of VC financing on firms' investment policy. Moreover, these effects are likely to depend on specific characteristics of the firms invested in, such as the life-cycle stage in which the first round of VC financing is obtained, the technological knowledge firms possess, the business and technological environment in which they operate and the associated extent of the adverse selection and moral hazard problems and appropriability hazards that make it difficult for them to obtain external financing. It would be extremely interesting to assess whether the differences we detected between IVC and CVC financing persist after controlling for these investor- and invested-firm-specific variables. This exercise was not possible here owing to the limitations of our dataset.

Second, one may wonder whether results relating to Italy can be generalised to other countries (a discussion about the complexity of cross-country comparison in VC investments can be found for instance in Manigart et al., 2000). In fact, the creation of a long longitudinal dataset relating to NTBFs located in different countries and including both non-VC-backed companies and firms that obtained VC financing from different types of investors is essential to extending our knowledge of the effects of VC financing on portfolio firms.

References

Abel, A.B., 'Empirical investment equations: An integrative framework', Carnegie-Rochester Conference on Public Policy, a supplement series to the *Journal of Monetary Economics*, Vol. 12, 1980, pp. 39–91.

Abel, A. and Blanchard, O., 'Investment and sales: Some empirical evidence', in Barnett, W.A., Berndt, E.R. and White, H., eds. *Dynamic econometric modelling*, (Cambridge, UK: Cambridge University Press, 1988, pp. 269–296).

Aldrich, H.E., Kalleberg, A., Marsden, P. and Cassel, J., 'In pursuit of evidence: Sampling procedures for locating new businesses', *Journal of Business Venturing*, Vol. 4, 1989, pp. 367–386.

Almeida, H. and Campello, M., 'Financial constraints, asset tangibility, and corporate investment', *Review of Financial Studies*, Vol. 20, 2007, pp. 1429–1460.

Almeida, H., Campello, M. and Weisbach, M.S., 'The cash flow sensitivity of cash', *Journal of Finance*, Vol. 59, 2004, pp. 1777–1804.

Alti, A., 'How sensitive is investment to cash flow when financing is frictionless?', *Journal of Finance*, Vol. 58, 2003, pp. 707–722.

Amit, R., Brander, J. and Zott, C., 'Why do venture capital firms exist? Theory and Canadian evidence', *Journal of Business Venturing*, Vol. 13, 1998, pp. 441–466.

Arellano, M. and Bover, O., 'Another look at the instrumental variables estimation of error-components models', *Journal of Econometrics*, Vol. 68, 1995, pp. 29–51.

Audretsch, D.B., *Innovation and industry evolution*, (Cambridge, MA: MIT Press, 1995).

Audretsch, D.B. and Lehmann, E., 'Financing high-tech growth: The role of banks and venture capitalists', *Schmalenbach Business Review*, Vol. 56, 2004, pp. 340–357.

Baker, M., Stein, J.C. and Wurgler, J., 'When does the market matter? Stock prices and the investment of equity-dependent firms', *Quarterly Journal of Economics*, Vol. 118, 2003, pp. 969–1005.

Berger, A.N. and Udell, G.F., ‘The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle’, *Journal of Banking and Finance*, Vol. 22, 1998, pp. 613–673.

Bertoni, F., Colombo, M.G. and Grilli, L., ‘Venture capital financing and the growth of new technology-based firms: A longitudinal analysis on the role of the type of investor’, unpublished working paper, (Politecnico di Milano, 2007).

Birley, S., ‘Finding the new firm’, *Proceedings of the Academy of Management Meetings*, Vol. 47, 1984, pp. 64–68.

Block, Z. and MacMillan, I., *Corporate venturing: Creating new business within the firm*, (Boston, MA: Harvard Business School Press, 1993).

Block, Z. and Ornati, O.A., ‘Compensating corporate venture managers’, *Journal of Business Venturing*, Vol. 2, 1987, pp. 41–51.

Blundell, R. and Bond, S.R., ‘Initial conditions and moment restrictions in dynamic panel data models’, *Journal of Econometrics*, Vol. 87, 1998, pp. 115–143.

Bond, S.R., Hoeffler, A. and Temple, J., ‘GMM estimation of empirical growth models’, unpublished working paper, CEPR Discussion Paper, 2001, No. 3048.

Bond, S.R. and Meghir, C., ‘Dynamic investment models and the firm’s financial policy’, *Review of Economic Studies*, Vol. 61, 1994, pp. 197–222.

Bond, S. and Van Reenen, J., ‘Microeconometric models of investment and employment’, in Heckman, J.J. and Leamer, E.E. eds. *Handbook of econometrics*, (Amsterdam: Elsevier), Vol. 6, 2007.

Bottazzi, L. and Da Rin, M., ‘Venture capital in Europe and the financing of innovative companies’, *Economic Policy,* Vol. 17, 2002, pp. 229–270.

Bottazzi, L., Da Rin, M. and Hellmann, T., ‘Who are the active investors? Evidence from venture capital’, *Journal of Financial Economics* (forthcoming), 2008.

Carpenter, R.E., Fazzari, S.M. and Petersen, B.C., ‘Financing constraints and inventory investment: A comparative study with high-frequency panel data’, *Review of Economics and Statistics*, Vol. 80, 1998, pp. 513–519.

Carpenter, R.E. and Petersen, B.C., ‘Capital market imperfections, high-tech investment, and new equity financing’, *Economic Journal*, Vol. 112, 2002a, pp. F54–F72.

Carpenter, R.E. and Petersen, B.C., ‘Is the growth of small firms constrained by internal finance?’, *Review of Economics and Statistics*, Vol. 84, 2002b, pp. 298–309.

Chan, Y.S., ‘On the positive role of financial intermediation in allocation of venture capital in a market with imperfect information’, *Journal of Finance*, Vol. 38, 1983, pp. 1543–1568.

Chesbrough, H.W., ‘Making sense of corporate venture capital’, *Harvard Business Review*, Vol. 80, 2002, pp. 90–99.

Cleary, S., ‘The relationship between firm investments and financial status’, *Journal of Finance*, Vol. 54, 1999, pp. 673–692.

Cleary, S., ‘International corporate investment and the relationships between financial constraint measures’, *Journal of Banking & Finance*, Vol. 30, 2006, pp. 1559–1580.

Colombo, M.G., Delmastro, M. and Grilli, L., ‘Entrepreneurs’ human capital and the start-up size of new technology-based firms’, *International Journal of Industrial Organization*, Vol. 22, 2004, pp. 1183–1211.

Colombo, M.G., and Grilli, L., ‘Funding gaps? Access to bank loans by high-tech start-ups’, *Small Business Economics*, Vol. 29, 2007, pp. 25–46.

Colombo, M.G., Grilli, L. and Piva, E., ‘In search for complementary assets: The determinants of alliance formation of high-tech start-ups’, *Research Policy*, Vol. 35, 2006, pp. 1166–1199.

Denis, D.J., ‘Entrepreneurial finance: An overview of the issues and evidence’, *Journal of Corporate Finance*, Vol. 10, 2004, pp. 301–326.

Dixon, W.J., ‘Simplified estimation from censored normal samples’, *Annals of Mathematical Statistics*, Vol. 31, 1960, pp. 385–391.

Dushnitsky, G., ‘Limitations to inter-organizational knowledge acquisition: The paradox of corporate venture capital’, unpublished working paper, (Wharton School, University of Pennsylvania, 2007).

Dushnitsky, G. and Lenox, M.J., ‘When do firms undertake R&D by investing in new ventures?’, *Strategic Management Journal*, Vol. 26, 2005a, pp. 947–965.

Dushnitsky G., Lenox M.J., ‘When do incumbents learn from entrepreneurial ventures? Corporate venture capital and investing firm innovation rates’, *Research Policy*, Vol. 34, 2005b, pp. 615–639.

Engel, D., ‘The impact of venture capital on firm growth: An empirical investigation’, discussion paper, (Mannheim: Centre for European Economic Research, ZEW), 2002, No. 02-02.

Engel, D. and Heger, D., ‘Differences in public and private venture capital companies’ activities: Microeconometric evidence for Germany’, unpublished working paper, (Essen: RWI, 2006).

Erickson, T. and Whited, T.M., ‘Measurement error and the relationship between investment and *q*’, *Journal of Political Economy*, Vol. 108, 2000, pp. 1027–1057.

Ernst, H., Witt, P. and Brachtendorf, G., ‘Corporate venture capital as a strategy for external innovation: An exploratory empirical study’, *R&D Management*, Vol. 35, 2005, pp. 233–242.

Fazzari, S.M., Hubbard, R.G. and Petersen, B.C., 'Financing constraints and corporate investment', *Brookings Papers on Economic Activity*, Vol. 1, 1988, pp. 141–206.

Ferreira, M.A. and Vilela, A.S. 'Why do firms hold cash? Evidence from EMU countries', *European Financial Management*, Vol. 10, 2004, pp. 295–319.

Gilchrist, S. and Himmelberg, C., 'Evidence on the role of cash flow for investment', *Journal of Monetary Economics*, Vol. 36, 1995, pp. 541–572.

Gimeno, J., Folta, T., Cooper, A. and Woo, C., 'Survival of the fittest? Entrepreneurial human capital and the persistence of underperforming firms', *Administrative Science Quarterly*, Vol. 42, 1997, pp. 750–783.

Gomes, J., 'Financing investment', *American Economic Review*, Vol. 91, 2001, pp. 1263–1285.

Gompers, P.A., 'Optimal investment, monitoring, and the staging of venture capital', *Journal of Finance*, Vol. 50, 1995, pp. 1461–1489.

Gompers, P.A., 'Corporations and the financing of innovation: The corporate venturing experience', *Federal Reserve Bank of Atlanta Economic Review*, Vol. 4, 2002, pp. 1–16.

Hall, R.E. and Jorgenson, D.W., 'Tax policy and investment behavior', *American Economic Review*, Vol. 57, 1967, pp. 391–414.

Himmelberg, C.P. and Petersen, B.C., 'R&D and internal finance: A panel study of small firms in high-tech industries', *Review of Economics and Statistics*, Vol. 76, 1994, pp. 38–51.

Hsu, D.H., 'What do entrepreneurs pay for venture capital affiliation?', *Journal of Finance,* Vol. 59, 2004, pp. 1805–1844.

Hsu, D.H., 'Venture capitalists and cooperative start-up commercialization strategy', *Management Science*, Vol. 52, 2006, pp. 204–219.

Hubbard, R.G., ‘Capital-market imperfections and investment’, *Journal of Economic Literature*, Vol. 36, 1998, pp. 193–225.

Jensen, M., ‘Agency costs of free cash flow, corporate finance and takeovers’, *American Economic Review*, Vol. 76, 1986, pp. 323–329.

Jorgenson, D.W., ‘Capital theory and investment behavior’, *American Economic Review*, Vol. 53, 1963, pp. 247–259.

Kadapakkam, P., Kumar, P.C. and Riddick, L.A., ‘The impact of cash flows and firm size on investment: The international evidence’, *Journal of Banking and Finance*, Vol. 22, 1998, pp. 293–320.

Kaplan, S.N. and Strömberg, P., ‘Venture capitalists as principals: Contracting, screening and monitoring’, *American Economic Review*, Vol. 91, 2001, pp. 426–430.

Kaplan, S.N. and Zingales, L., ‘Do investment-cash flow sensitivities provide useful measures of financing constraints?’, *Quarterly Journal of Economics*, Vol. 112, 1997, pp. 169–215.

Kaplan, S.N. and Zingales, L., ‘Investment-cash flow sensitivities are not valid measures of financing constraints’, *Quarterly Journal of Economics*, Vol. 115, 2000, pp. 707–712.

Mairesse, J., Hall, B.H. and Mulkay, B., ‘Firm-level investment in France and the United States: An exploration of what we have learned in twenty years’, *Annales d’Economie et de Statistique*, Vol. 55, 1999, pp. 27–69.

Manigart, S., Baeyens, K. and Van Hyfte, W., ‘The survival of venture capital backed companies’, *Venture Capital—An International Journal of Entrepreneurial Finance*, Vol. 4, 2002, pp. 103–124.

Manigart, S., Baeyens, K. and Verschueren, I., ‘Financing and investment interdependencies in unquoted Belgian companies: The role of venture capital’, in Butzen, P. and Fuss, C. eds. *Firms’ investment and finance decision*, (Cheltenham: Edward Elgar, 2003).

Manigart, S., De Waele, K., Wright, M., Robbie, K., Desbrières, P., Sapienza, H. and Beekman, A., 'Venture Capitalists, investment appraisal and accounting information : A comparative study of the USA, UK, France, Belgium and Holland', *European Financial Management*, Vol. 6, 2000, pp. 389-403.

Modigliani, F. and Miller, M.H., 'The cost of capital, corporation finance, and the theory of investment', *American Economic Review*, Vol. 48, 1958, pp. 261–297.

Morgado, A. and Pintado, J., 'The underinvestment and overinvestment hypotheses: An analysis using panel data', *European Financial Management*, Vol. 9, 2003, pp. 163-177.

Moyen, N., 'Investment-cash flow sensitivities: Constrained versus unconstrained firms', *Journal of Finance*, Vol. 59, 2004, pp. 2061–2092.

Myers, S. and Majluf, N., 'Corporate financing and investments decisions when firms have information that investors do not have', *Journal of Financial Economics*, 13, 1984, pp. 187–221.

Pawlina, G. and Renneboog, L., 'Is investment-cash flow sensitivity caused by agency costs or asymmetric information? Evidence from the UK', *European Financial Management*, Vol. 11, 2005, pp. 483–513.

Siegel, R., Siegel, E. and MacMillan, I., 'Corporate venture capitalists: Autonomy, obstacles, and performance', *Journal of Business Venturing*, Vol. 1, 1988, pp. 275– 293.

Stein, J., 'Agency, information, and corporate investment', in Constantinides, G., Harris, M. and Stulz, R. eds. *Handbook of the economics of finance*, (Amsterdam, North Holland: Elsevier, 2003).

Stiglitz, J.E. and Weiss, A., 'Credit rationing in markets with imperfect information', *American Economic Review*, Vol. 71, 1981, pp. 393–410.

Stuart, T.E., Hoang, H. and Hybels, R., ‘Interorganizational endorsements and the performance of entrepreneurial ventures’, *Administrative Science Quarterly,* Vol. 44, 1999, pp. 315–349.

Tykvova, T., ‘How do investment patterns of independent and captive private equity funds differ? Evidence from Germany’, *Financial Markets and Portfolio Management*, Vol. 20, 2006, pp. 399–418.

Tykvova, T. and Walz, U., ‘How important is participation of different venture capitalists in German IPOs?’, *Global Finance Journal*, Vol. 17, 2007, pp. 350–378.

Ueda, M., ‘Banks versus venture capital: Project evaluation, screening, and expropriation’, *Journal of Finance*, Vol. 59, 2004, pp. 601–621.

Vogt, S.C., ‘The cash flow/investment relationship: Evidence from U.S. manufacturing firms’, *Financial Management*, Vol. 23, 1994, pp. 3–20.

Windmeijer, F., ‘A finite sample correction for the variance of linear efficient two-step GMM estimators’, *Journal of Econometrics,* Vol. 126, 2005, pp. 25–51.

Tables

Table 1. Distribution of sample firms across industries and geographical areas

Distribution of sample firms according to Industry (Internet and telecommunications services, Software, ICT manufacturing, Biotechnology and pharmaceutics, Automation and robotics) and Geographical area (Northwest, Northeast, Centre, South). Percentages in the Total Sample column relate to the total number of sample firms. Percentages in the VC, IVC and CVC-backed columns relate to the total number of firms in the sector or geographical area. Forty-six sample firms obtained financing from IVC and/or CVC investors. Of these firms, 13 were invested in by only IVC funds, 27 received only a CVC investment and 6 were invested in by both IVC and CVC investors. Four of these latter firms operate in Internet and telecommunications services and two in software; five are located in the northwest and one in the northeast geographical area. These investments were not syndicated. The 'VC-backed firms' category also includes three firms that were invested in by bank-controlled VC funds and three firms that were invested in by governmental VC funds. Four of these operate in ICT manufacturing, one in software and one in Internet and telecommunications services. One is located in the northwest, four in the northeast and one in the central geographical area.

Industry	*Total sample*		*VC-backed*		*IVC-backed*		*CVC-backed*	
	N.	*%*	*N.*	*%*	*N.*	*%*	*N.*	*%*
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.	*%*	*N.*	*%*	*N.*	*%*	*N.*	*%*
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

Table 2. Descriptive statistics on regression variables

Descriptive statistics on (1) the ratio between the increase in a firm's book value of tangible and intangible assets net of depreciation between periods t–1 and t ($I_{i,t}$) and the beginning-of-period-t book value of tangible and intangible assets ($K_{i,t-1}$); (2) the ratio between firm i's cash flows after taxes and before dividends in period t ($CF_{i,t}$) and $K_{i,t-1}$; (3) the ratio between firm i's sales in period t ($S_{i,t}$) and $K_{i,t-1}$; (4) the squared ratio between firm i's total current and long-term debt at the end of period t ($D_{i,t}$) and $K_{i,t-1}$. The top half of the table reports statistics of the raw values of the ratios, the bottom half of the table reports statistics on winsorised (2% each tail) values of the ratios. The columns report number of observations (N), mean, median, standard deviation (divided in overall, between and within cross sectional units), skewness, and kurtosis of each ratio.

Variable	*N.*	*Mean*	*Median*	*Std. Dev.*			*Skewness*	*Kurtosis*
				Overall	*Between*	*Within*		
Not winsorised								
$I_{i,t}/K_{i,t-1}$	2,229	2.121	0.454	24.323	7.795	22.796	38.306	1,638.241
$CF_{i,t}/K_{i,t-1}$	2,229	1.231	0.465	14.229	5.735	13.139	30.509	1,144.257
$S_{i,t}/K_{i,t-1}$	2,229	64.465	10.481	1,523.892	469.328	1,425.324	42.930	1,920.720
$(D_{i,t}/K_{i,t-1})^2$	2,229	202,777.2	24.885	8,899,515	2,740,216	8,327,088	46.863	2,204.455
Winsorised 2% each tail								
$I_{i,t}/K_{i,t-1}$	2,229	1.051	0.454	1.768	1.094	1.573	3.250	14.324
$CF_{i,t}/K_{i,t-1}$	2,229	0.859	0.465	1.695	1.276	1.328	2.458	11.720
$S_{i,t}/K_{i,t-1}$	2,229	20.342	10.481	27.643	22.877	18.206	2.802	11.270
$(D_{i,t}/K_{i,t-1})^2$	2,229	326.080	24.885	1,079.545	871.023	789.465	5.005	28.359

Table 3. Investment–cash flow sensitivity of non-VC-backed firms

Estimate results of the relationship between investments and cash flows for non-VC-backed firms. $I_{i,t}$ is the increase in a firm's book value of tangible and intangible assets net of depreciation between periods t–1 and t. $K_{i,t-1}$ is the beginning-of-period-t book value of tangible and intangible assets. $CF_{i,t}$ is firm i's cash flows after taxes and before dividends in period t. $S_{i,t}$ is firm i's sales in period t. $D_{i,t}$ is firm i's total current and long-term debt at the end of period t. Small and large firms are, respectively, below and above sample median for total assets. All ratios are winsorised at the 2% threshold. The dependent variable is the ratio between period t investments in fixed and intangible assets and the book value of total assets at the beginning of period t. All estimates include year dummies (coefficients are omitted from the table). Estimates are derived from two-step system GMM with finite sample correction (Windmeijer, 2005). AR(1) and AR(2) are tests of the null hypothesis of, respectively, no first- or second-order serial correlation. Sargan–Hansen is a test of the validity of the overidentifying restrictions based on the efficient two-step GMM estimator. The non-linear test for cash flow shifts is defined in Section 5; its p-value is based on the 'delta' method. p-values in parentheses; degrees of freedom in square brackets. ***, ** and * indicate, respectively, significance levels of <1%, <5% and <10%.

Variable	*All firms*		*Large firms*		*Small firms*	
$I_{i,t-1}/K_{i,t-2}$	0.0279		0.0235		0.3705	
	(0.745)		(0.843)		(0.761)	
$(I_{i,t-1}/K_{i,t-2})^2$	0.0038		0.0064		–0.0005	
	(0.749)		(0.688)		(0.9772)	
$CF_{i,t}/K_{i,t-1}$	0.1928	***	0.1326		0.3476	***
	(0.001)		(0.165)		(0.000)	
$S_{i,t}/K_{i,t-1}$	0.0189		0.0260	**	0.0304	**
	(0.131)		(0.032)		(0.047)	
$(D_{i,t}/K_{i,t-1})^2$	0.0001		0.0000		–0.0004	
	(0.768)		(0.9698)		(0.3438)	
No. of observations	1,604		878		726	
Sargan–Hansen	99.08 [95]		111.08 [95]		90.84 [95]	
AR(1)	–4.352	***	–3.703	***	–2.724	***
AR(2)	0.4918		–0.8646		1.379	
Sensitivity to cash flow shifts (pseudo-Wald test)	0.198	***	0.136		0.361	***

Table 4, panel a. Investment–cash flow sensitivity

Estimate results of the relationship between investments and cash flows for the whole sample. $I_{i,t}$ is the increase in a firm's book value of tangible and intangible assets net of depreciation between periods t–1 and t. $K_{i,t-1}$ is the beginning-of-period-t book value of tangible and intangible assets. $CF_{i,t}$ is firm i's cash flows after taxes and before dividends in period t. $S_{i,t}$ is firm i's sales in period t. $D_{i,t}$ is firm i's total current and long-term debt at the end of period t. $VC_{i,t}$, $IVC_{i,t}$ and CVC$_{i,t}$ are time-varying dummy variables equal to 1 if firm i received equity financing, respectively, from VC, IVC and CVC investors in or before period t. All ratios are winsorised at the 2% threshold. The dependent variable is the ratio between period t investments in fixed and intangible assets and the book value of total assets at the beginning of period t. All estimates include year dummies (coefficients are omitted from the table). Estimates are derived from two-step system GMM with finite sample correction (Windmeijer, 2005). AR(1) and AR(2) are tests of the null hypothesis of, respectively, no first- or second-order serial correlation. Sargan–Hansen is a test of the validity of the overidentifying restrictions based on the efficient two-step GMM estimator. Lagged dependent variables, VC, IVC, CVC and relative interaction terms are treated as predetermined. The three columns in Panel (a) report estimates of, respectively, equations (1), (2) and (3) in the text. Firms that have received equity capital from governmental and bank-controlled VC funds (six firms) are excluded from the sample in equation (3). Panel (b) reports tests for sensitivity of firm's investments to cash flow shocks and shifts as defined in Section 5. Using equation (1) we estimate Pooled sensitivities; using equation (2) we compute VC-backed and non VC-backed sensitivities; using equation (3) we compute non VC-backed, IVC-backed and CVC-backed sensitivities. p-values for non-linear tests on the parameters are based on the 'delta' method. p-values in parentheses; degrees of freedom in square brackets. ***, ** and * indicate, respectively, significance levels of <1%, <5% and <10%.

Variable	*Equation (1)*	*Equation (2)*	*Equation (3)*
$I_{i,t-1}/K_{i,t-2}$	0.0519	0.0472	0.0138
	(0.399)	(0.510)	(0.892)
$(I_{i,t-1}/K_{i,t-2})^2$	0.0001	0.0007	0.0042
	(0.989)	(0.911)	(0.706)
$CF_{i,t}/K_{i,t-1}$	0.1911 ***	0.2081 ***	0.2299 ***
	(0.000)	(0.002)	(0.003)
$S_{i,t}/K_{i,t-1}$	0.0372 ***	0.0200 ***	0.0184 ***
	(0.001)	(0.000)	(0.001)
$(D_{i,t}/K_{i,t-1})^2$	–0.0004	0.0001	0.0002
	(0.226)	(0.735)	(0.300)
$VC_{i,t}$		0.8565 **	
		(0.014)	
$VC_{i,t}\cdot(CF_{i,t}/K_{i,t-1})$		0.1158	
		(0.468)	
$IVC_{i,t}$			0.5505
			(0.280)
$IVC_{i,t}\cdot(CF_{i,t}/K_{i,t-1})$			–0.1741

					(0.453)	
$CVC_{i,t}$					0.3666	
					(0.400)	
$CVC_{i,t} \cdot (CF_{i,t}/K_{i,t-1})$					0.3100	*
					(0.085)	
No. of observations	1.839		1.839		1.796	
Sargan–Hansen	108.30		120.19		109.11	
	[103]		[152]		[186]	
AR(1)	–5.007	***	–5.238	***	–4.650	***
AR(2)	0.466		0.360		0.110	

Table 4, panel b. Investment–cash flow sensitivity

	Equation (1)	*Equation (2)*	*Equation (3)*
Sensitivity to CF shocks (Wald test)			
Pooled sample	0.1911 ***		
	(0.000)		
Non-VC-backed		0.2081 ***	0.2299 ***
		(0.002)	(0.003)
VC-backed		0.3239 *	
		(0.051)	
IVC-backed			0.0557
			(0.786)
CVC-backed			0.5398 ***
			(0.008)
Sensitivity to CF shifts (pseudo-Wald test)			
Pooled sample	0.2016 ***		
	(0.001)		
Non-VC-backed		0.2184 ***	0.2331 ***
		(0.002)	(0.003)
VC-backed		0.3400 **	
		(0.049)	
IVC-backed			0.0565
			(0.786)
CVC-backed			0.5473 ***
			(0.004)

Appendix A: The sample

In this appendix we describe the procedure used to build the sample of NTBFs analysed in this work.

First, Italian high-tech entrepreneurial ventures that were established in 1980 or later and remained independent up to the end of 2003 (see Section 3) were identified. Unfortunately, official national statistics data do not provide a reliable description of the population of Italian NTBFs. The main problem is that in Italy most individuals who are defined as 'self-employed' by official statistics are actually salaried workers with atypical employment contracts. Unfortunately, on the basis of official data, such individuals cannot be distinguished from entrepreneurs who create new firms. The RITA population included all NTBFs that were mentioned (a) in the lists of members of industry associations in the relevant sectors, (b) in the lists of participants in industry trades fairs and expositions and (c) in on-line and off-line commercial firm directories. Firms that made use of the advertising services of the local Chambers of Commerce and were advertised in the national financial press and in specialised industry magazines and reports were also included. Although it is certain that some firms that match the criteria defined above were neglected, the RITA population provides as accurate coverage as possible of the Italian population of NTBFs. In particular, note that to be mentioned by the information sources used to build the RITA population, firms must incur some costs. So an additional advantage of the RITA population is that companies created exclusively for tax-saving purposes are not considered. For obvious reasons, these companies are unlikely to make any investments or to obtain VC financing; therefore, their inclusion would bias the estimates of the investment–cash flow sensitivity of NTBFs and the effects of VC financing on firms' investments.

Altogether, 1,974 firms were selected for inclusion in the database. For each firm, a contact person (i.e. one of the owner–managers) was identified. In the first quarter of 2004 a questionnaire was sent to the contact person either by fax or by e-mail. Among other data, the questionnaire provides information on firms' access to VC financing. In particular, respondents were asked to indicate the identity of their VC investors and the year in which the first round of VC financing was obtained from each VC investor. Answers to the questionnaire were checked for internal coherence and were compared with publicly available information (essentially, data provided by firms' annual reports and websites and by the financial press). In several cases, phone or face-to-face follow-up interviews were conducted with firms' owner–managers. This final step was crucial to be sure that data were reliable. These survey-based data were then matched with longitudinal standardised balance sheet data provided by the Analisi Informatizzata delle aziende (AIDA) and CERVED databases for the period 1994–2003. Thus, the sample analysed in this work includes all firms for which we were able to combine survey information and balance sheet data.

Appendix B: Derivation of the parallel cash flow shift test

To measure the dependence of a firms' investments on long-run parallel variations in cash flows we derive the expected increase in the equilibrium investment rate (i.e. as $t \to \infty$) following a *permanent* marginal increase in cash flows starting from an equilibrium in which firms' expected investment rate is nil. Firms' investment rate is described by equations (1)–(3) in the text.

From equation (1) one obtains:

$$E\left[i_{j,t} \middle| i_{j,t-1}, cf_{j,t}, s_{j,t}, d_{j,t}\right] = \beta_1 i_{j,t-1} + \beta_2 i_{j,t-1}^2 + f(cf_{j,t}, s_{j,t}, d_{j,t}, j, t), \quad \text{(A.1)}$$

where lowercase letters indicate values normalised by the beginning-of-year value of a firm's fixed and intangible assets $K_{j,t-1}$.

The firm starts from an initial equilibrium condition of nil investments if

$\forall t : f(cf_{j,t}, s_{j,t}, d_{j,t}, j, t) \equiv 0$.

Suppose now that we perturbate the cash flow stream by a permanent increase Δcf from time $t = 0$ onwards. To derive the long-run sensitivity of a firm's investments to such a (marginal) increase we proceed by induction. The expected investment rate Δi in period 1 is easily computed as

$$E[\Delta i_{j,1}] = \beta_1\beta_3\Delta cf + \beta_2\beta_3^2\Delta cf^2 + \beta_3\Delta cf \ .$$

The sensitivity of period 1 investments to marginal increases in cash flows is hence given by

$$\lim_{\Delta cf\to 0}\frac{E[\Delta i_{j,1}]}{\Delta cf} = \lim_{\Delta cf\to 0}\left(\beta_1\beta_3 + \beta_2\beta_3^2\Delta cf + \beta_3\right) = \beta_3(1+\beta_1). \qquad \text{(A.2)}$$

For any given time period t, remembering that the unperturbed investment rate is nil, the following relationship holds:

$$E\left[\Delta i_{j,t}\right] = \beta_1 E\left[\Delta i_{j,t-1}\right] + \beta_2 E\left[\Delta i_{j,t-1}\right]^2 + \beta_3\Delta cf \ .$$

The sensitivity of investments in period t to a marginal increase in cash flows is hence given by

$$\lim_{\Delta cf\to 0}\frac{E[\Delta i_{j,t}]}{\Delta cf} = \lim_{\Delta cf\to 0}\left[\frac{E[\Delta i_{j,t-1}]}{\Delta cf}\left(\beta_1 + \beta_2\frac{E[\Delta i_{j,t-1}]}{\Delta cf}\Delta cf\right) + \beta_3\right] = \beta_3 + \beta_1\left(\lim_{\Delta cf\to 0}\frac{E[\Delta i_{j,t-1}]}{\Delta cf}\right), \qquad \text{(A.3)}$$

where the final term derives from the fact that

$$\forall t: \lim_{\Delta cf\to 0}\left|\frac{E[\Delta i_{j,t-1}]}{\Delta cf}\right| < +\infty .$$

This condition is easily proved by induction from equation (A.2).

Substituting equation (A.2) into equation (A.3) we obtain

$$\lim_{\Delta cf\to 0}\frac{E[\Delta i_{j,t}]}{\Delta cf} = \beta_3\left(\sum_{k=0}^{t}\beta_1^k\right),$$

which implies that, if $|\beta_1| < 1$,

$$\lim_{t\to\infty}\left(\lim_{\Delta cf\to 0}\frac{E\left[\Delta i_{j,t}\right]}{\Delta cf}\right) = \beta_3\left(\sum_{k=0}^{\infty}\beta_1^k\right) = \frac{\beta_3}{1-\beta_1} .$$

The derivation of the tests for equations (2) and (3) follows along the same lines.

■

Table A.1. Investment cash flow sensitivity for different winsorising thresholds

Tests of the sensitivity of firm's investments to cash flow shocks and shifts as defined in Section 5. Estimates are derived from two-step system GMM with finite sample correction (Windmeijer, 2005) on equation (3) using 1% and 5% winsorising thresholds. *p*-values for non-linear tests on the parameters are based on the 'delta' method. *p*-values in parentheses; degrees of freedom in square brackets. ***, ** and * indicate, respectively, significance levels of <1%, <5% and <10%.

	Winsorised 1%		*Winsorised 5%*	
Sensitivity to CF shocks (Wald test)				
Non-VC-backed	0.1291	*	0.3310	***
	(0.095)		(0.000)	
IVC-backed	–0.0630		0.1051	
	(0.749)		(0.549)	
CVC-backed	0.6051	***	0.3865	*
	(0.000)		(0.089)	
Sensitivity to CF shifts (pseudo-Wald test)				
Non-VC-backed	0.1281	*	0.3427	***
	(0.099)		(0.000)	
IVC-backed	–0.0625		0.1088	
	(0.748)		(0.599)	
CVC-backed	0.6004	***	0.4002	**
	(0.000)		(0.088)	