Underpricing of Venture-backed IPOs: a meta-analytic approach

Listing firms are subject to underpricing because of asymmetry of information, but IPOs that are backed by a venture capitalist are subject to less underpricing. Although this condition is commonly verified by empirical evidence, there is a number of studies that find contrasting results. This paper aims to answer to the question: do venture capitalists effectively reduce underpricing at IPO? Evidence provides a negative answer, with venture-backed IPOs having higher underpricing, although with small effect. When performing meta-regression, results show that US studies, more recent samples and studies not controlling for age provide a higher estimation of the effect sizes.

Keywords: venture capital, underpricing, IPO, meta-analysis, meta-regression

JEL codes: G24, G10, G32

Introduction

Firms that go public are subject to underpricing, that is on average the IPO price is set below the price prevailing on the market right after the IPO. This phenomenon has found several explanations in the theory that all relate to asymmetries of information. Firms that go public are not known to the wide public of investors and their valuation is uncertain (firm characteristics and market conditions all influence underpricing). Setting a price lower than the "true" value of the firm encourages investors to subscribe the issue and compensate for the uncertainty and the opaqueness of the listing firm.

Venture capital is often found to be able to reduce underpricing at IPO for companies listing on a given market. The empirical contributions on this issue are numerous and often provide contrasting evidence, which can be due to the fact that studies analyse different time periods and sample. It is not therefore fully clear if venture capital (VC) is actually able to limit underpricing at IPO as some studies find, or if this is not the case (as other studies find).

This paper aims to answer to the following research question: do VC backed IPOs have a lower underpricing compared to their non VC backed peers?

To answer this question, we use a meta-analytic framework analysing the studies testing the relationship between the presence of VC at IPO and underpricing, measured on the first days of trading as the percentage change in price from the IPO price. To enable better comparability of studies, we focus on studies on European countries and on the US, published after 2001 and with a sample period after the year 2000, available on Scopus as at November 2015, that control for young and high-tech companies.

To the best of knowledge, this is one of the first studies to use this framework to study specifically underpricing using recent data and focusing on European and US markets.

Results show that on average the effect is in contrast with what predicted by the theories: in fact, we find a positive significant effect of VC on underpricing, but, at the same time the size is small. It seems hence that VC backing provides opposite results than what expected, but this evidence is in turn in line with previous meta-analysis provided on the performance of VC backed companies (with performance variously defined) (Daily et al., 2003; Rosenbusch, 2013).

When performing meta-regression, we find that the sign of the relationship between VC backing and underpricing appears to be linked to the control for age and to the use of samples focused on the US. These two latter study specifications make the coefficient of VC effect on underpricing to be higher, together with more recent sample periods.

The paper is organised as follows. Section 1 reviews the main theories on underpricing and on VC contribution to performance at IPO. Section 2 presents the methodology and the data collection. Section 3 presents the results and the last section concludes.

1. Literature Review

The empirical and theoretical literature has been working on the identification of the determinants of underpricing for decades. Underpricing is computed as the difference between the issue price (or IPO price) and the price prevailing at the end of the first trading day (Ibbotson, 1975; Ibboston and Ritter, 1995), that is generally positive, as on average the offering price is set below the price that prevails on the first trading day (Ibbotson and Ritter, 1995). While it is sufficiently clear and established that underpricing exists and that it represents a “loss” for equity owners that list their company on a stock exchange (often named as “money left on the table” - Ritter, 1987) and that this phenomenon is mainly due to asymmetries of information, it is less established what are the driving forces determining the amount of underpricing (Daily et al., 2003; see also Kennedy et al., 2006 who test for competing theories explaining underpricing) and even if VC backed companies show a lower underpricing at all (da Silva Rosa et al., 2003; Brau et al., 2004).

The main theories involving asymmetry of information can be summarised as follows. The first theory by Rock (1986) models a market with two types of investors, one group made of informed and one made of uninformed investors. According to the author, the uninformed investors would receive their full order only when the issue is overpriced as they are left with the stocks not subscribed by informed investors (the so-called “winner’s curse”). To compensate for this mechanism, offering price may be set at a discounted price than what expected to induce uninformed investors to subscribe the issue. Several researchers have then extended Rock’s setting. Among them, Beatty and Ritter (1986) who include a cost to acquire information for the group of uninformed investors and Carter and Manaster (1990) who further develop on risky IPOs.

Benveniste and Spindt (1989) discuss instead the “costly information hypothesis”. In this case, underpricing exists to enable investment banks to obtain private information by investors during the pre-selling period, when the offer price is set. Cascades also might be related to underpricing: when IPO occurs, some investors have to be induced to buy to induce other investors to buy on their turn. To induce the first move, the issue has to be underpriced (Welch, 1992).

Asymmetries of information also exist between issuer and investors. In this case, the issuer can send signals to the market to convey the expected value of the firm. Signalling theories also represent a key to understand underpricing (Bhattacharya, 1976; Ross, 1977). On this theory, much of the empirical literature using information from IPO prospectus is built (Daily et al., 2003).

The presence of VC is generally believed to act as signal of the good quality of the firm and VC backing at IPO is able to limit underpricing (Gompers, 1996; Jain and Kini, 2000; Belghitar and Dixon, 2012) also because of VCs experience and superior information on the issuer (Barry et al., 1990; da Rin et al., 2013). The presence of venture capitalists enables to limit the asymmetries of information between investors and issuer. This is also because of screening activities performed by venture capitalists that yields them to invest only in the best companies, and monitoring activities that further improve target performance (Megginson and Weiss, 1991). This effect is stronger when venture capitalists retain a relevant portion of stocks after the IPO and continue monitoring the firm (Barry et al., 1990). Venture capitalists are also able to limit underpricing thanks to their relationships with investment banks (Chemmanur and Loutskina, 2006).

At the same time, underpricing can be influenced by other factors that do not depend on VC intervention, such the hot or cold markets, the market characteristics (Ritter and Welch, 2002; Coackley et al., 2009; Bessler and Seim, 2012; Rosenbusch et al., 2013); and by several firm characteristics, such as firm age, size at IPO, (for a discussion on this issue, the reader might refer to Engelen and van Essen, 2010).

With reference to meta-analysis, considering jointly underpricing at IPO and venture capital, two main contributions have been provided by the literature. The first is by Daily et al. (2003) and focuses on IPO underpricing. They investigate 74 paper published between 1986 and 2000 to test the determinants of performance at IPO; among these, the authors also include venture capital equity, claiming that the presence of this type of investor in the capital of the IPO company has a negative relationship with underpricing. Nevertheless, they find the opposite result when analysing the impact of VC on the return at IPO and hypothesise that a moderator effect exists and that the impact of VC can be correctly read only when analysed in conjunction with other variables. Additionally, the authors claim that the cyclicality of capital markets may influence the impact of VC on underpricing. With specific reference to VC, again, the authors suggest that a non-linear relationship may hold, thus yielding counterintuitive results in the analyses that do not consider this issue.

The second relevant meta-analysis is by Rosenbusch et al. (2013) who instead focus on venture capital and its impact on firm performance, where performance also includes performance at IPO (that is, underpricing). They analyse 48 studies published (or released) between 1991 and 2010. The authors, in general, find that VC contributes positively to performance (defined broadly as stock market, growth or profitability of companies) but when restricting the sample on the papers including industry effects, the contributions to performance becomes negligible from a statistical point of view.

2. Data and Methodology

2.1 Data Selection

We selected all the papers available on Scopus as at Nov 2015 and published after 2001 that have the keyword "underpricing" in the abstract, title or keywords in all the scientific area. We obtained around 790 results. We then selected only the empirical papers that have the following characteristics:

- aim: test the relationship between the presence of venture capital and underpricing at IPO, defined as the percentage change of the price on the first day of trading from the IPO price.
- sample: European countries, or US. We excluded studies whose sample have IPOs from other countries, even if they include Europe or US countries, but we retained studies with just one or more European or US countries.
- period: after 2000. If the sample period starts before the year 2000 and ends after, we included the paper if the median of the sample years in the period considered in the study is higher than 2000.

- type of offering: equity IPOs. We excluded SEO, REITS and mixed papers that do not control only for IPOs
- type of company: studies that control for high-tech and young firms.

We excluded paper not written in English. We end up with 22 papers and 25 effect sizes.

2.2 Methodology Used

This study applies meta-analytical methods to quantitatively synthesize empirical evidence for the relationship between venture capital and underpricing. The main purpose of this meta-analysis is to make an appropriate aggregation of 'effect sizes' collected in a sample of studies. An example of effect size is the magnitude and sign of a correlation coefficient concerning a relationship of interest (Hunter & Schmidt, 2014). As noted by various scholars (Dalton & Dalton, 2005; Geyskens et al., 2009), it has become increasingly popular in management and financial research to quantitatively integrate research findings across a large number of studies to examine whether there are prevailing relationships among a set of variables.

In the present analysis we perform a meta-analysis and meta-regression on extracting regression slopes from the selected set of studies. In the meta-analytic literature sometimes, this is criticized because incomparability of different effect sizes (among others, due to different model formulations, different measurements) is allegedly supposed to exist across studies. The alternative to this is to select studies containing correlation coefficients only and synthesize them. However, the philosophy of meta-analysis is to extract as much information as possible from the selected studies. Moreover, evidence for relationships in economics and finance is much more retrievable from model coefficients rather than from simple correlation coefficients.

Finally, methods to transform regression slopes into partial correlation coefficients are widely used. In fact, problems and critics are much more focused on the side of performing meta-analyses of regression coefficients directly in the meta-analysis synthesis, that is using their values without any transformation to other effect sizes (Becker & Wu, 2007). For these reasons, we focus our attention on regression coefficients and their standard error, t-statistic or p-value. We then transform them into partial correlation coefficients as follows. Consider for simplicity (the extension to other types of models is straightforward) a multiple linear regression model of the form:

$$Y = \beta_0 + \beta_1 X_1 + \cdots + \beta_k X_k + \cdots \beta_p X_p + \epsilon \qquad \text{(eq. 1)}$$

and suppose that for a given study we have to convert the estimate $\beta^\wedge{}_k$ into the partial correlation coefficient for the variables X_k, r_{YX_k}. Suppose that together with the value of this estimate we have also its standard error $SE_{\beta^\wedge{}_k}$, or the correspondent t-statistic $t_{\beta^\wedge{}_k}$, or, directly, the p-value $p_{\beta^\wedge{}_k}$. Suppose also that we have the overall degrees of freedom $d = n - p - 1$ (n is the number of observations, p the number of independent variables). Then the partial correlation coefficient is obtained as follows.

- Partial correlation coefficient when coefficient estimates with their standard errors are extracted. In this case, we have:

$$r_{YX_k} = \sqrt{\frac{\left(\frac{\beta^\wedge{}_k}{SE_{\beta^\wedge{}_k}}\right)^2}{\left(\frac{\beta^\wedge{}_k}{SE_{\beta^\wedge{}_k}}\right)^2 + d}} \qquad \text{(eq. 2).}$$

The sign of r_{YX_k} is the same of the regression coefficient.

- Partial correlation coefficient when exact p-values are extracted (Thompson et al., 2011).

In this case, the normality assumption is assumed, and therefore the *z*-score corresponding to the *p*-value is computed.

- Partial correlation coefficient when t-statistics are extracted. Similarly to (2) in this case we have:

$$r_{YX_k} = \sqrt{\frac{\left(t_{\beta^\wedge k}\right)^2}{\left(t_{\beta^\wedge k}\right)^2 + d}} \quad \text{(eq. 3).}$$

- Coefficient estimates with their significance levels.

In this case, following Rindquist (2013), we set $t_{\beta^\wedge k}$ equal to the value of the *t*-statistic corresponding to the significance threshold and given degrees of freedom. For example, if an original study reports $\beta^\wedge{}_k = 1.5$ with $n = 54$, $p = 3$ and a (two-sided) significance level given by $**p < 0.05$, we get $t = 2.01$, that is the t value corresponding to $p = 0.05$. Then we use formula (3) to get the partial correlation coefficient. If a parameter estimate is reported not significant (with no other information than its value), we simply set $r_{YX_k} = 0$. This assumption is quite restrictive and tends to over-represent 0-valued partial correlation coefficients in the overall results.

The following pooling exercise to meta-analyse the partial correlation coefficients is performed through a random-effect analysis, according to the following steps. First, each r_{YX_k} is converted into a Fisher-transformed *z*-score:

$$z_{r_{YX_k}} = \frac{1}{2} ln\left(\frac{\left(1 + r_{YX_k}\right)}{\left(1 - r_{YX_k}\right)}\right) \quad \text{(eq. 4),}$$

which has an approximate normal distribution with standard error $SE\left(z_{r_{YX_k}}\right) = \sqrt{\frac{1}{n-3}}$ (eq. 5).

Second, each computed $z_{r_{YX_k}}$ is averaged across studies with weight w equal to:

$$w = \frac{1}{SE\left(z_{r_{YX_k}}\right) + v^\wedge} \text{ (eq. 6)}$$

where $v^\wedge$ is the estimated random-effect variance (see Field, 2001 or Hedges & Olkin, 1985).

The final average $\underline{z}_{r_{YX_k}}$ is obtained as a weighted average of the values of $z_{r_{YX_k}}$ computed for each estimate in the studies.

After this pooling exercise, the Fisher transform average $\underline{z}_{r_{YX_k}}$ is back-transformed to the average of the partial correlation coefficients by using the inverse of (4).

As for the meta-regression analysis, we use a standard meta-regression model as follows (Stanley & Jarrell, 1989):

$$r_{YX_k,i} = \beta_0 + \sum_{k=1}^{K} \beta_k D_{ik} + \varepsilon_i \text{ (eq. 7)}$$

where $r_{YX_k,i}$ is the effects size in study i, (i = 1,…, n), D_{ik} are K variables for study characteristics, and ε_i is an error term.

3. Results

3.1. Meta-analysis results

Meta-analysis results show that, on average, the size of the coefficient associated with the presence of VC at IPO is 2.2 percent (Table 1). It seems hence that VC backed IPOs show a higher degree of underpricing if compared to other IPOs. This result seems to contrast with what predicted by the theory, as VC backed have worse performance.

Nevertheless, also Rosenbusch et al. (2013) in their investigation found a negative sign of the impact of VC on performance, broadly measured (in contrast with the theory that holds that VC selects better companies and are able to boost their performance in the long run).

We report also the chi-squared test for heterogeneity, the I^2 statistic and the significance test for the effect size. The I^2 statistic is a percentage indicating the degree of the between-study heterogeneity (Higgins & Thompson, 2004; Harris et. al., 2008, p. 8;), and is calculated with the following formula, where Q is the Cochran's heterogeneity statistic and df is the degree of freedom:

$I^2 = \frac{Q-df}{Q} \times 100\%$ (eq. 8)

The value of I^2 lies between 0 percent and 100 percent, whereby negative values of I^2 are set to zero. This indicator is easily interpretable: the larger the value of I^2 the more heterogeneity can be observed. Although there is no absolute rule, a suggestive indication is that a low degree of heterogeneity is given when I^2 takes a value between 25 percent and 50 percent, a moderate level is achieved when I^2 is between 50 percent and 75 percent and a high degree of heterogeneity is assumed when I^2 is higher than 75 percent (Harris et. al., 2008, p. 18-19). Here we have a value ($I^2 = 76{,}6\, percent$) between moderate and high.

Figure 1 helps in clarifying the contribution of each study to the final result. The plot indicates whether the coefficient arising from each regression is positive or negative. The grey square indicates the size of the sample (also reported in number on the last right-hand side column), that is the representativeness of the sample included in the study, while the length of the horizontal line expresses the confidence interval (also reported in numbers on the next right-hand side column).

The diamond at the bottom of the figure represents the average overall coefficient, that is, the expected overall impact of VC on the underpricing of listing companies.

[Insert table 1 about here]

[Insert figure 1 about here]

To highlight if the results are influenced by the presence of studies conducted in the US, we differentiate the meta-analysis depending on the presence or absence of US studies in the sample (table 2, figure 3). Results show that the expected sign is positive and significant for US studies, while it is negative, but not significant for studies focusing on other countries. Additionally, being US studies the ones which weight the most, it is clear that the final overall result presented above is influenced mostly by US evidence. Similar conclusions can be drawn from the forest plot (figure 2), where the first block of studies is for non-US samples and the second for US ones.

[Insert table 2 about here]

[Insert figure 2 about here]

As further clarification of the results of each empirical investigation, we also build the funnel plot that shows if there is publication bias. Funnel plots are used to show the bias that might arise when small sample studies with no significant effect remain unpublished, while this would be in fact a result and would be evidence that has to be taken into account when analysing the relationship between the dependent and independent variable. (Rosenthal, 1979; Iyengar & Greenhouse, 1988; Duval and Tweedie, 2000 for a discussion of funnel methods). Funnel plots are simple scatterplots of the effects sizes estimated from individual studies against a measure of study weight, which in general is the inverse of the standard error of the estimates. Therefore, points representing studies with low weight should scatter widely at the bottom of the graph, whereas points representing studies with high weight should lie at the top of the graph and close to the pooled estimate. If the meta-analysis departs from this situation, then the presence of publication bias is suspected. We see from figure 3 that some studies suffer from publication bias, especially some of those considering US units only. Non-US studies are shown as circles and US studies as triangles. As it can be observed, most studies outside the confidence limits in the upper bound are the US, while there are also 3 non-US studies in the lower bound limit (which are Italian studies). Nevertheless, it has to be noted that the bias might be due to other factors. We also tested for the so-called small-study bias, that is the presence of systematic differences in the results of large and small studies caused by confounding factors such as differential study quality. The Egger's test (Egger et al., 1997) for small study bias resulted not significant and therefore no small-study bias was present.

[Insert figure 3 about here]

3.2. Meta-regression results

We perform meta-regression controlling for several study characteristics, described in table 3. The choice of variables is determined by the level of details provided in the study and by the use of a common set of variables. In fact, while it would be interesting to use a continuous variable to check for the effect of age, most of the studies do not provide a detailed description of the variable employed. This applies also to industry-specific effects, as some studies indicate the model tests for industry fixed effect, without specifying how many industry dummies are introduced in the model.

Additionally, we first introduce a dummy for the studies using a binary variable to control for the presence of VC at IPO (UnS) that hence do not provide information on the relative weight or importance of the Venture Capitalist as stakeholder in the company, but check for its presence. Nevertheless, we then drop it, as most of the studies apply this methodology to control for venture capital presence, given the difficulty in retrieving this type of information. This amendment, moreover, enables to improve significantly the significance of the linear model.

Finally, as JCR and SJR are highly correlated (86 percent), we use them one at a time. For the sake of synthesis, we present only results for SJR as this has a wider coverage of journals. Results do not change substantially.

Results are summarised in table 4. Evidence shows a significant effect of studies controlling for age and for the sample geographical area. Studies controlling for age deliver a lower effect size in the relationship studied. The second significant variable (US) implies that studies using the US as sample area yield a greater effect size (the coefficient linked to VC impact on underpricing is positive and higher than for non-US samples). In specification 4, when dropping the length of the sample period and the SJR variable, also the median year of the sample period becomes significant. This suggests that sample periods including more recent years provide higher effect size (higher coefficient between VC and underpricing).

Evidence provides hints for the evaluation of the effect of VC presence at IPO, suggesting that the ability of VC to limit underpricing does not emerge for US markets, where VC activity is more widespread and markets are probably more efficient when evaluating IPOs. Additionally, it would be interesting to evaluate if and how companies listing on US market are different (in size, industry, age) than the average company listing in Europe, where markets (with UK exception) are less mature. But, when controlling for age, everything else equal, VC appears to be able to signal the better quality of companies, as the coefficient becomes negative and significant, suggesting that the size effect is lower in those studies. Finally, more recent IPOs have a lower size effect, as if the ability of VC to signal quality had changed over time (or characteristics of VC backed companies had changed over time).

[Insert table 3 about here]

[Insert table 4 about here]

4. Conclusions

This study evaluates the contribution provided by the literature on the empirical evidence on the effect of the presence of a venture capitalist at IPO on the performance of the first trading day. The latter is commonly found to be high and positive, generating the so-called underpricing. VC backed companies are believed to be subject to less underpricing because of the signaling presence of the Venture capitalist. Nevertheless, empirical evidence is sometimes ambiguous. As it would probably be unfeasible to retrieve data for all the studies performed on this topic to control for the overall effect of VC at IPO, we investigate the effect of the presence of a VC at IPO on performance using a meta-analytic framework, focusing on companies listing in European countries or in the US since 2001 to find if the relationship arising from the studies is negative, as predicted by the theories, that is VC backing limits underpricing.

To this end, we selected all the studies available on Scopus database focusing on the empirical relationship between VC and IPO underpricing, published after 2001 and using a sample period starting from 2001 (or whose median is greater or equal to 2001) focusing on European countries or US.

Results show that on average the effect is in contrast with what predicted by the theories: in fact, we find a positive significant effect of VC on underpricing, of around 2 percent. The evidence is however consistent with previous results provided in the literature (Daily et al., 2003 and Rosenbush et al., 2013) that suggests a non-linear relationship might exist between the two variables or that other factors influence the size effect. This result is in part driven by the US studies that find a positive effect and that weight in the sample of studies considered because of the small standard error and wide sample used by the researchers.

When proceeding with the meta-regression, we find again that US samples drive substantially the results towards a positive and higher underpricing for VC backed IPOs, together with the age of the listing firms and, in a final specification, the median year of the sample period. In a nutshell, what emerges is that studies on US IPO, with more recent sample years and not controlling for age yield (respectively) a higher estimate of the impact of the presence of VC at IPO on underpricing.

Although presenting interesting innovative evidence on the latest studies on underpricing and VC contribution to listing firms, this study has some limitations. First of all, the research can be further extended by including more recent studies and by including other markets, although we believe it is necessary to differentiate between emerging and more mature markets. Additionally, also other sources of research papers, such as Google Scholar to cover journals not listed in Scopus, could be added. Finally, it could be interesting to evaluate how other firm and market characteristics influence the relationship between VC and underpricing, where available.

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** indicates the papers included in the meta-analysis and meta-regression.*

Tables

Table 1: meta-analysis

Study	ES	95 percent Confidence Interval		percent Weight
1	0.029	-0.082	0.140	1.12
2	-0.053	-0.154	0.049	1.34
3	-0.053	-0.172	0.066	0.98
4	0.037	-0.057	0.131	1.55
5	0.005	-0.062	0.071	3.09
6	0.060	0.018	0.102	7.85
7	0.095	0.048	0.142	6.28
8	0.077	0.028	0.126	5.82
9	0.063	-0.006	0.131	2.98
10	-0.241	-0.380	-0.101	0.71
11	0.143	0.067	0.219	2.38
12	0.008	-0.091	0.107	1.42
13	0.127	-0.049	0.303	0.45
14	-0.145	-0.309	0.018	0.51
15	0.114	-0.062	0.290	0.45
16	-0.232	-0.395	-0.07	0.52
17	0.018	-0.030	0.067	5.89
18	0.025	-0.023	0.073	5.89
19	-0.006	-0.037	0.026	13.56
20	0.093	0.048	0.139	6.68
21	0.012	-0.018	0.042	15.01
22	-0.041	-0.157	0.075	1.03
23	-0.223	-0.370	-0.076	0.64
24	-0.223	-0.370	-0.076	0.64
25	-0.016	-0.048	0.016	13.20
I-V pooled ES	0.022	0.010	0.034	100.00
Heterogeneity chi-squared = 102.53 (*d.f.* = 24) p = 0.000				
***I-squared* (variation in ES attributable to heterogeneity) = 76.6 percent**				
Test of ES=0 : *z*= 3.70 p = 0.000				

Table 2: meta-analysis differentiating between US and non-US studies.

Sample	Number of studies	Number of effect sizes	ES	95 percent Confidence Interval		percent Weight
US						
I-V pooled ES	12	13	0.044	0.029	0.059	63.61
non-US	10	12				
I-V pooled ES			-0.016	-0.035	0.004	36.39
Significance test(s) of ES=0						
US			z= 5.83		p = 0.000	
non-US			z= 1.56		p = 0.118	
Overall			z= 3.70		p = 0.000	
Only summary statistics per group of studies are reported.						

Table 3: variables used in the meta-regression and brief description

Variable name	Description
(UnS) Unknown Stake	A dummy equal to 1 for those studies for which the stakes of VC is not known, i.e. for the studies that do not verify the countervalue or the weight of the VC presence in the capital of the VC-backed firm, that commonty use a binary variable to check for VC presence at IPO
Industry	A dummy equal to 1 if the study controls for industry effects
Age	A dummy equal to 1 if the study controls for the age of firms at IPO
US	A dummy equal to 1 for US samples
Crisis	A dummy identifying studies that include the years from 2007 onwards
Length	Length of sample period, in years
Median	Median of sample period
SJR	Score obtained by the Scientific Journal Ranking – Scimago. If the journal is not available in the ranking, the value of the variable is 0
JCR	Score obtained by the Journal Citation Report – Web of Science. If the journal is not available in the ranking, the value of the variable is 0

Table 4: meta-regression results using ??? as dependent variable and explanatory variables

Variable	Model 1	Model 2	Model 3	Model 4
sjr	0.002	0.001	0.001	
UnS	-0.051			
Industry	0.025	0.032	0.028	0.026
Age	-0.133*	-0.125*	-0.122*	-0.118*
US	0.092*	0.084*	0.082*	0.084**
Crisis	0.045	0.057	0.044	0.041
Median	-0.028	-0.030	-0.028	-0.029*
Length	0.001	-0.001		
Constant	56.455	59.337	56.507	57.820*
N	25	25	25	25
R^2 Adj	-5.00%	2.78%	12.76%	21.42%
F Stat	1.339	1.542	1.865	2.298
legend: * p<0.1; ** p<0.05; *** p<0.01				

Appendix A

Table a1: List of papers used for the meta-analysis with main characteristics on sample and period of study.

N	Authors	Year	Sample area	Sample period	Sample period

				begins	ends
1	Bruton & al.	2009	UK	2000	2003
2	Chahine et al.	2009	UK	2000	2003
3	Chemmanur et al.	2010	US	1999	2004
4	Hanley	2010	US	1996	2005
5	Chahine & Filatotchev	2011	UK	1999	2003
6	Chahine & Goergen	2011	US	1997	2004
7	Ferretti & Meles	2011	Italy	1998	2008
8	Hao	2011	US	1996	2005
9	Capizzi et al.	2011	Italy	1998	2008
10	Hanley & Hoberg	2012	US	1996	2005
11	Johnson & Sohl	2012	US	2001	2007
12	Mogilevsky & Murgulov	2012	US	2000	2009
13	Song	2012	US	2000	2011
14	Wang & Wan	2013	US	2000	2007
15	Pennacchio	2013	Italy	1999	2012
16	Hoque	2014	UK	1999	2006
17	Akyol et al.	2014	Europe	1998	2012
18	Pennacchio	2014	Italy	1999	2012
19	Migliorati & Vismara	2014	France, Germany, Italy, UK	1995	2010
20	Benson et al.	2015	US	1995	2011
21	Bradley et al.	2015	US	1994	2011
22	Park et al.	2015	US	1998	2007

Figure 1: forest plot of the studies that show the coefficient for the VC effect on underpricning and the confidence level of the coefficient.

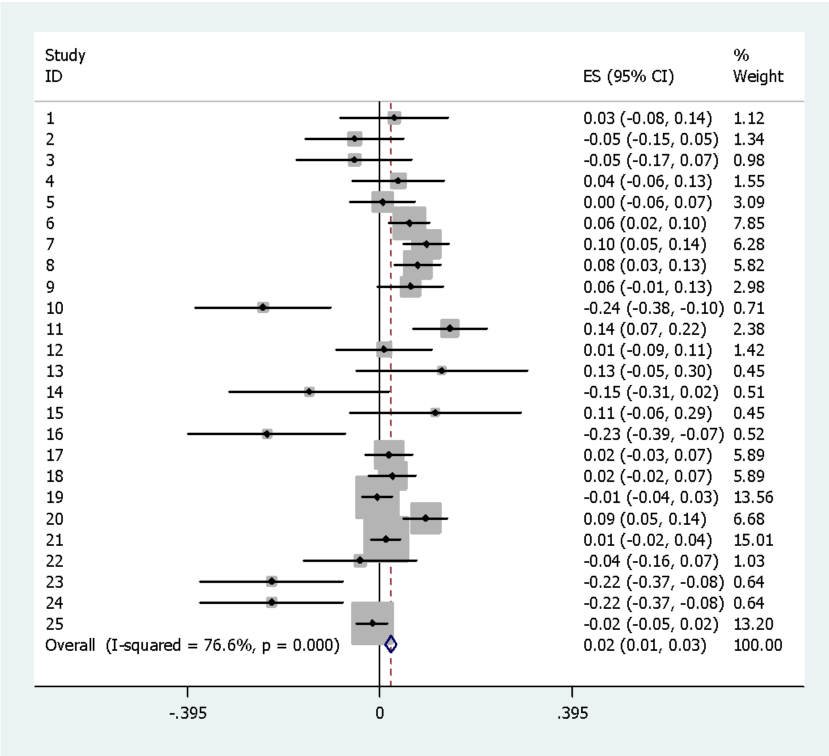

Figure 2: forest plot differentiating between non-US (upper part) and US (lower part) studies that show the coefficient for the VC effect on underpricning and the confidence level of the coefficient.

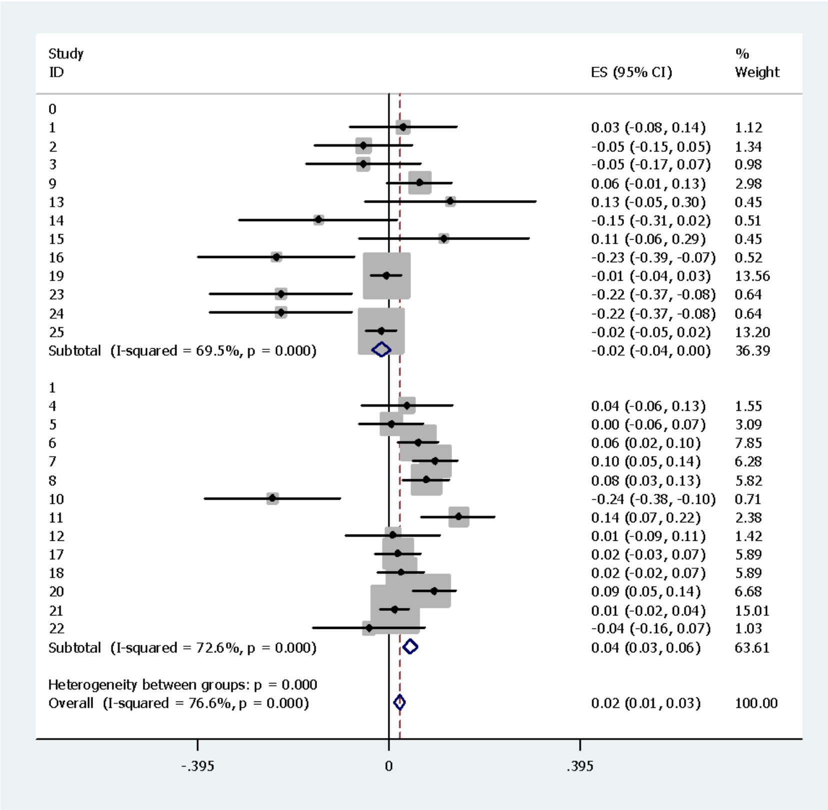

Figure 3: funnel plot with US studies (red triangles) and non-US studies (blue dots) that investigates the presence of small sample study bias.