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Pennacchio, Luca

University of Napoli "Federico II"

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Abstract

This paper analyses the role of venture capitalists in Italian Initial Public Offerings (IPOs). Between 1999 and 2012 venture capital backed IPOs are on average less underpriced than non-venture backed IPOs. By using both a matching and a regression-based approach to account for the non-random distribution of venture financing across firms, I show that the underpricing difference is actually due to the causal effect of venture capital backing and that the raw comparison of the sample means underestimates such an effect. The result is consistent with the certification hypothesis, that is, certifying that the value of issuing firms reflects all relevant inside information, venture capital backing reduces the asymmetric information problem that arises in the IPO process.

JEL classification: G24, G32, G14.

Keywords: Venture capital, IPOs, Certification Hypothesis, Underpricing.

Department of Economics and Statistics (DISES), University of Napoli "Federico II", Via Cintia Monte S. Angelo - 80126 Napoli, Italy. E.mail: l.pennacchio@unina.it

I. Introduction

The object of the paper is to shed some light on the role of venture capitalists in Italian IPOs.

The importance of venture capital is widely recognized in both developed and emerging countries. Providing an important source of equity funding and often supporting the management of financed firms with their domain expertise, venture capitalists facilitate the birth and the growth of new firms, especially in high technological industries. Moreover they facilitate the entrepreneurs in dealing with other financing providers: private investors, financial intermediaries, and lastly, equity markets. The floatation on stock exchanges is of particular interest because, in addition to represent a source of capital for issuing firms, it is the most profitable exit route for venture capital investors that decide to dismiss their investments in financed firms. Indeed, Gompers and Lerner (2004) report that, although IPOs constitute a small fraction of the total venture capitalists portfolio, they contribute to the highest returns, from 30% to more than 50% of the total.

A measure that is widely used in the economic literature to examine the role of venture capitalists in IPOs is the underpricing: the difference between the price of the shares in the first day of trading and the price of the shares offered to investors. The analysis of the venture capital backing's effect on the IPO underpricing is a suitable way to investigate whether venture capitalists are able to reduce the asymmetric information that arises in the IPO process and the cost of flotation for the issuers. Many theories explain the underpricing in a context of asymmetric information between the actors involved in the IPO, typically issuing firms, underwriters and investors (Baron, 1982; Rock, 1986; Benveniste and Spindt, 1989; Beatty and Ritter, 1986). According to such theories, the underpricing represents a proxy of the ex-ante uncertainty regarding the issue that increases with the increasing of the degree of information asymmetries (Eckbo, 2008). In addition, Jenkinson and Ljungqvist (2001) state that the underpricing can be thought also as a cost of going public. The IPO involves two types of costs for the issuing firms: direct costs (e.g. underwriting fees, selling commissions, legal expenses, accountancy and audit fess) and indirect costs. The underpricing is considered as the main indirect cost for the original owners, whether they sell their own existing

shares or they sell new shares resulting from a capital increase. In the former case the wealth loss is obvious because the original shareholders could have sold their shares at a higher price than the offering price. In the latter case the wealth loss occurs via the dilution of the original shareholders' stakes in the company. Also Ritter (1998) considers the underpricing as an indirect cost of going public and defines the dollar amount of underpricing per share times the number of offered shares as 'money left on the table'. Following such part of the literature, the focus of this paper is the relationship between venture capital backing and underpricing.

Given the contrasting results of empirical literature, the debate about the role of venture capitalists in IPOs is still open and of particular interest. With respect to the large body of studies that investigate the context of the United States, the present paper evaluates the case of Italy where very little has been said. To my knowledge only Ferretti and Meles (2011) analyze the Italian IPOs, finding mixed evidence in favour of the certification hypothesis. In particular, they show that companies backed by private equity syndication investors, i.e. backed by more than one institutional investors, are less underpriced than other companies. The underpricing difference is not significant when companies are backed by single private equity investors or bank-based private equity investors. With respect to the work of Ferretti and Meles that considers all private equity investors, I focus on the specific category of venture capitalists. Moreover, this paper relies on more rigorous and reliable methodologies to account for the endogeneity in the receipt of venture capital backing. The venture financing is not randomly distributed across firms but is an endogenous choice of entrepreneurs and venture capitalists. This involves a selectivity bias in the receipt of venture financing that can lead to incorrect estimates of the causal effect of venture capital backing on the IPO underpricing.

Considering the IPOs that took place on the Italian stock exchange between 1999 and 2012, this analysis provide empirical evidence that the presence of venture capital investors in the shareholding of issuing firms reduces the extent of the IPO underpricing. Descriptive statistics document that Venture Capital (VC) backed IPOs are less underpriced than non-VC backed ones,

whether the mean or the median value of the underpricing are considered. Taking into account the endogeneity in the receipt and provision of the venture financing, this empirical analysis proves that the underpricing differences are statistically significant and directly attributable to the venture backing causal effect. An advantage of this work is that the results are not "samples and methodologies-dependent". The main result holds whether I consider all the IPOs carried out in the Italian stock exchange or I compare sub-samples of VC backed and non-VC backed IPOs in a matching framework, as well as by estimating a treatment effect model in a regression-based approach.

As a further result I find that also high quality underwriters are able to certify the IPOs they manage and that their certification is complementary to the certification provided by venture capital investors. The result is consistent with the theoretical model of Tirole (2006) where various well-informed agents are able to certify the value of issuing firms. On the contrary, in contrast with part of the literature, it emerges that VC backed IPOs are not managed by more prestigious underwriters than non-VC backed IPOs. The reputation of underwriters that manage VC backed IPOs is slightly higher than that of other underwriters but the difference is not statistically significant.

The venture capital certification is of particular interest for a country such as Italy. Italian firms, typically small-sized and familiarly managed, often face difficulties in raising finance both on credit and capital market. A well established venture capital industry may contribute to solve, or at least to mitigate, the financing problems faced by Italian firms.

The rest of the paper is organized as follows. Section II provides a summary of theoretical and empirically-grounded hypotheses on the role of venture capitalists in the IPO market, paying special attention to the relationship between venture capital backing and underpricing. Section III presents descriptive statistics of Italian IPOs and highlights some differences between venture capital backed and non-venture capital backed IPOs. In particular, VC backed IPOs are less underpriced than non-VC backed IPOs and the underpricing difference is statistically significant. This result is tested with both a matching and a regression-based approach in section IV. The methodologies, controlling for

the differences between the two groups of issuers and the self-selection bias induced by the endogenous choice in the receipt of venture financing, point out that the lower underpricing of VC backed IPOs is actually attributable to the venture capital backing's causal effect. Section V concludes the paper.

II. A selected review about the role of venture capitalists in initial public offerings

In the economic literature the role of venture capitalists is still controversial. Early studies develop and empirically test the so-called certification hypothesis: venture capitalists are well-informed agents about the value of issuing firms they have in the portfolio and their role is to certify that the issue price reflects all available inside information. In such a way the venture capital certification reduces the information asymmetries that arise in the IPOs process and consequently the extent of the underpricing. A testable implication of the certification hypothesis is that VC backed firms are expected to be less underpriced than non-VC backed ones, being the underpricing difference attributed to the venture capital certification.

Boot and Smith (1986) develop a model that provides a theoretical framework for the certification hypothesis. In their paper an underwriter, i.e. an investment bank that handles the IPO, can be employed to certify that the issue price is consistent with the inside information about the future prospects of the firm. The key assumption of the model is that an asymmetric information problem arises in the IPO process between insiders that are shareholders and outsiders who are potential new investors. Considered the moral hazard problem, insiders cannot reveal their private information unilaterally in a credible way and outside investors are unable to acquire this kind of information.[1]

Tirole (2006) generalizes the model of Boot and Smith and argues that issuers can reduce informational asymmetries not only by hiring an underwriter with high reputation, but also by

[1] Private information consists both of Hard and Soft information. While Hard information is easily to be conveyed to outsiders, Soft information cannot be directly verified by anyone other than the agent who produces it (Stein, 2002). In the IPO process for instance, beyond financial statements and plans available in a codified form of spreadsheets and reports, the outsiders need to evaluate the competence and the honesty of the firms' management and ownership. New investors may not be able to acquire such information or, alternatively, the cost of information acquisition may be too high.

asking to other well-informed agents to certify the quality of the issue (rating agencies, independent analysts, auditors, venture capitalists, etc). The certifying agents must have an incentive to become informed about the firm's value and have to take some actions to convey their information to prospective investors. The actions can be a rating, a report or, as in the case of venture capitalists, a non-negligible stake in the issuing firm. There are no doubts that venture capitalists are well-informed investors. As Gompers and Lerner (2004) notes, venture capitalists are specialized in collecting and evaluating information on start-up and growth companies and may partly overcome the informational asymmetries that arise in an IPO process. Megginson and Weiss (1991) argue that venture capitalists are able to certify the issues because they have a reputational capital at stake. They indeed bring to the market more firms over time and have a very strong incentive to establish a trustworthy reputation in order to retain access to the IPO market on favourable terms. A good reputation for competence and honesty will also allow venture capitalists to establish enduring relationship with fund managers and other institutional investors who are both main investors in venture capital funds and important buyers of shares in IPOs. Moreover Shalman (1990) documents that the value of the reputation is greater than the maximum possible benefit obtained by certifying falsely. These two conditions make the certification role of venture capitalists truthful for outsiders.

Consistent with the certification hypothesis, various empirical analysis find that VC backed IPOs are less underpriced than non-VC backed IPOs. Magginson and Weiss (1991) find evidence that venture capital backing significantly reduces both the underpricing and the gross spreads of US IPOs. They also show that VC backed firms join the market with underwriters who have higher reputation than underwriters of non-VC backed firms. Similarly Barry *et al.* (1990) provide empirical evidence that the presence of venture capitalists in the ownership structure of issuing firms reduce the extent of underpricing.

In contrast with previous works, recent analysis do not find statistically significant differences in the underpricing of the two groups of IPOs. Some authors even find an opposite result, that is, venture capital backed IPOs are *more* underpriced than non-VC backed (Francis and Hasan, 2001;

Peggy and Wahal, 2004; Arikawa and Imad'eddine, 2010; Elston and Yang, 2010). Such a finding casts doubts about the validity of the certification hypothesis and re-opens the debate on the role of venture capitalists. In particular, Lee and Wahal examining a sample of more than 6000 US IPOs between 1980 and 2000 find that VC backed IPOs experience higher underpricing than comparable non-VC backed IPOs. The authors also replicate the samples used by Megginson and Weiss and Barry et al. and in both cases they do not find significant differences in the underpricing between VC backed and non-VC backed IPOs.

An implication of these analysis is that shareholders of VC backed firms, due to the transfer of wealth to new shareholders, bear higher listing costs than shareholders of non-VC backed firms. Why such shareholders, and venture capitalists in particular, are willing to bear this cost? Two major hypothesis have been proposed in the literature. Some authors suggest that venture capitalists may be subsequently compensated for leaving money on the table. Indeed, underwriters can preferentially allocate to them shares of other underpriced IPOs in exchange of high underpricing in IPOs that they have in portfolio. For instance, Loughran and Ritter (2002) provide examples in which venture capitalists are allocated with shares of underpriced IPOs that they subsequently sell to the market to obtain high profits. A different explanation relies on the grandstanding hypothesis proposed by Gompers (1996). Venture capital operators maximize the returns of their investments (mainly) by taking public the firms that they have financed and then, once the investment is liquidated, they return the funds to the original providers (for instance pension funds). Taking many companies public helps venture capitalists to establish a good reputation with fund providers and to raise more money for future investments. Then, venture capital firms are willing to bear the cost of the underpricing in order to taking public as many companies as possible.

The two explanations are not convincing in general. The former refers to the activity that largely occurred just in the early years of the 2000 in the US while the differences in the IPO underpricing are a persistent phenomenon, existing before as well as afterwards such period. The latter explanation does not seem valid for all venture capitalists but, as Gompers argues, the fundraising is

an important issue mostly for young venture capitalist firms. Moreover, the hypothesis have been thought with the US financial system in mind where the venture capital is an important source of finance for firms and many IPOs are venture backed. In such a market, due to the possibility of taking public repeated companies, the reputation may be a relevant feature for venture capital firms. In different financial markets, like the Italian one, the venture capital industry is less developed and only few IPOs are venture backed. As a consequence, venture capital firms may be less careful with their reputation on the capital market and may prefer to maximize the proceeds of each investment.

Alternatively, Rossetto (2008) suggests an explanation that may conciliate the two opposite findings. The author recognizes that VC backed IPOs are less underpriced than non-VC backed IPOs during normal periods of activity, but the reverse happens during hot issue periods. Observing such regularity, she proposes a theoretical model in which, when IPOs are driven by the initial investor's decision to liquidate the original investment in order to finance a new venture, the equilibrium of the underpricing increases. This happens in hot issue periods, when the availability of profitable new investments is high and venture capital investors, in order to exploit such opportunities, try to liquidate quickly their investments in the financed firms throughout an IPO. On the contrary, in normal periods venture capitalists tend to maximise the return of each IPO they have financed.

In a recent paper Chemmanur and Loutskina (2007) re-consider the role of venture capitalists and propose a third hypothesis: the market power hypothesis. The authors argue that the underpricing is not the most appropriate measure to evaluate the role of venture capitalists and propose an alternative measure which they refer as the offer price to intrinsic value ratio. By using such a variable, they show that the role of venture capitalists is not that of certifying the value of the issuing firm but primarily that of marketing the IPO to other financial market operators (analysts, investment banks, institutional investors) in order to obtain higher valuations for the firm they take public, both in the IPO and in the secondary market. In such a way the presence of venture capitalists in the issuing firms helps shareholders, including venture capitalists itself, to maximize

the proceeds of the IPO. Without getting in the heart of the matter about which measure is the most appropriate, the role of marketing the IPOs seems to be more suitable for the underwriters than for the venture capitalists. Indeed, in the IPO process is the underwriter that estimates the value of the issuing company, sets the IPO price and advertises the offering to other financial operators. One alternative interpretation to the results of Chemmanur and Loutskina could be that venture capital backed IPOs are able to attract more prestigious underwriters and it's just such underwriters that obtain higher valuations for the IPOs they manage.[2]

III. Italian IPOs and venture capital

The empirical analysis considers the IPOs that took place on the Italian stock exchange between 1999 and 2012.[3] During this period a total of 188 firms joins the market, 65 of which are VC backed. The distinction between VC backed and non-VC backed IPOs is based on the data collected by the Italian Private Equity and Venture Capitalists Association (AIFI) and published in the yearly Venture Backed IPO Market Report. Data for balance sheet variables and firm characteristics (i.e. sales, total asset, age, size, etc.) come from the prospectus of listing firms, while data for market variables and IPOs characteristics (i.e. index return, oversubscription, price range, underpricing, etc.) come from Borsa Italia Spa, the company that manages the Italian stock exchange.

In the first two years of the analysed period, the stock market is affected by the speculative bubble of internet stocks. In these years we observe numerous IPOs, 69 or, in percentage terms, the 37% of the whole sample. Subsequently the number of IPOs noticeably reduces and only in the sub-period 2005-2007, when 64 companies go public, the activities on the Italian equity market intensify again. In the rest of the period we observe very few IPOs and every year the number of firms that go public is lesser than 10. The time-series distribution of VC backed IPOs closely follows that of all

[2] The author in a subsequent paper (Chemmanur and Krishnan, 2012) highlights the relevance of underwriters in marketing the IPOs that they manage.

[3] Some IPOs of the Alternative Investment Market, the market of the Italian stock exchange devoted to small and medium enterprises with high potential growth, are excluded from the analysis due to the lack of the official listing prospectus.

IPOs and the number of the former IPOs increases with the increasing of the total number of IPOs. On average, approximately 35% of total IPOs are venture capital backed and, with the exclusion of the last two years of the sample, the yearly percentage of VC backed IPOs ranges between the 20% and the 50%. The IPO activity appears closely linked with the sentiment of the market. In particular, the yearly number of IPOs increases if in the year before the market has been bullish and decreases if the market has been bearish (the correlation between the number of IPOs and the lag of the index return is 0.66). These data are consistent with the presence of waves in the IPOs activity (Ibbotson and Jaffe, 1975; Lowry and Schwert, 2002) and that, according with the window of opportunity theory developed by Ritter (1991), both VC and non-VC backed IPOs are planned when the market offers better conditions in order to maximize the net proceeds of the issues.

[TABLE 1]

It is widely recognized that VC backed IPOs are significantly clustered across industry and geographical localization. In the US context for instance, Megginson (2004) reports industry concentration in the areas of information technology (telecommunications, computers, software and IT services), biotechnology and health care. Chen *et al.* (2009) document geographic clustering of both venture capital firms and venture capital financed companies in three cities (San Francisco, Boston and New York) and Gompers and Lerner (1998) note that 50% of all venture capital backed IPOs are headquartered in California, Massachusetts and Texas. In the Italian case there is more than one similarity with the USA's, but also some interesting distinctive features. Table 2 reports the classification of Italian IPOs by sectors of activity according to the Industry Classification Benchmanrk (ICB), the official classification used by Borsa Italia.[4] The industries with a higher number of VC backed IPOs are Industrials, Consumer Goods and Consumer Services. The Health care is the industry with the highest percentage of VC backed IPOs (almost the 80%). On the

[4] The ICB uses a system of 10 industries, partitioned into 20 super-sectors, which are further divided in 41 sector. For the sake of space, the table 2 only shows the classification at industry level.

contrary, Utilities, Financials and Technology show a low percentage of VC backed IPOs and Oil & Gas have no IPO venture capital backed. The super-sectorial classification (not reported to save space) shows, on the one hand, that, like in the US IPOs, many Italian VC backed IPOs belong to the Biotechnology and Health Care super-sectors, as well as to the Telecommunications and Software and Computer Services. On the other hand the presence of VC backed IPOs in the Food and Beverage and in the Retail Consumer Services super-sectors is a peculiarity of the Italian case. Lastly, in the financials industry, it is interesting to note that all the VC backed IPOs are to be found in the Financial Services super-sector while no IPOs venture capital backed belong to the Banks, Insurance or Real Estate super-sector.

[TABLE 2]

The geographic distribution of VC backed IPOs is highly heterogeneous. Considering the region (NUTS 2 level) where issuing firms are headquartered, we notice that two regions, Lombardia and Emilia Romagna, account for more than 60% of total VC backed IPOs (see Table 3 that reports data for regions with at least the 2% of the total IPOs) while in the regions of the South only 2 IPOs are venture capital backed (the 3% of total VC backed IPOs). However, it is worth to note that this heterogeneity concerns all the Italian IPOs, not only the VC backed ones.

Acconcia *et al.* (2011) show that a different geographic variable, i.e. the physical distance between issuing firms and the stock exchange, affects both the firms' propensity of going public and the IPO underpricing. Assuming that the greatest part of investors are clustered in the financial centre (especially institutional investors), they argue that the asymmetric information problem that arises between insider of the issuing firms and outside investors increases with the increasing of the issuers' physical distance from the financial centre. I have calculated the average distance for VC backed and non-VC backed IPOs and I have found that, on average, non-VC backed IPOs are headquartered closely to the Stock Exchange than VC backed ones. Following the interpretation of

Acconcia *et al.*, the venture backing appears to be able to overcame the asymmetric information problem.

[TABLE 3]

Looking at the characteristics of the companies that went public, Italian VC backed firms appear younger and smaller than non-venture backed ones (Table 4). The average age of the latter IPOs is 21 years while that of the former IPOs is more than 25. These data also show that Italian firms are much older than the US ones when they decide to go public: as reported for instance by Lee and Wahal (2004), the average age of US venture backed and non venture backed IPOs are respectively 7 and 14.7 years. The smaller size of VC backed IPOs is highlighted by the average of the market value, total asset and revenue. In particular, the mean total asset of non-VC backed IPOs is more than eight times the mean value of VC backed ones. Furthermore, balance sheet variables show that VC backed IPOs are less profitable and less indebted than non-VC backed: both the ROE and the ROS indicators, as well as the debt-equity ratio, are much lower for the former IPOs.

Differences between the two groups of IPO also exist in the characteristics of the offer. VC backed IPOs have a restricted book-building price range than non-VC backed IPOs. If we consider the width of the price range as a proxy of the uncertainty regarding the value of issuing firms (Hanley, 1993; Prabhala and Puri, 1998), the data suggest that the evaluation of the firm's value is an easier task in the presence of venture backing. Moreover, when they join the market, VC backed IPOs offer a larger percentage of their shares than non-VC backed. On the other hand, the data on the gross spread point out that the VC backed and non-VC backed IPOs pay a similar amount of fees to the underwriters syndicate. The mean and median values for the former IPOs are slightly greater than for the latter but, as we will see in next sections, differences are not statistically significant. The finding contrast with various analysis that find an opposite result, that is, the presence of venture capital as shareholder in the issuing firm reduces the gross spread. I also calculate a proxy

for the underwriter reputation. According to Megginson and Weiss (1991), the variable measures for each underwriter the share of total euro amount offered to the market by all IPOs included in the sample. For IPOs handled by more than one underwriters, the greatest of the underwriters' market share is used as a proxy of the quality.[5] The descriptive statistics reported in the table below suggest that VC backed and non-VC backed IPOs are managed by underwriters with similar reputation.

[TABLE 4]

Finally, it is widely documented that venture capitalists usually retain a large part of their stake in financed firms after the IPOs. For instance, Megginson and Weiss (1991) report that on average US venture capitalists own a large capital stake both before (36.6%) and after (26.3%) the floatation. In the case of Italy the average stake of venture capitalists before the IPO is 36.5%, similar to the US one, and equals to 17.2% immediately after. In 19 cases, almost the 30% of total VC backed IPOs, Italian venture capitalists hold, before the offer, the control of the issuing firms (after the offer the percentage lowers to 7.7%). Then, the data show that also in Italy venture capitalists own a large stake in the issuing firm. With respect to the US venture capitalists, Italian ones sell a lager part of their stakes in the financed companies.

[TABLE 5]

In sum, the descriptive analysis documents some peculiarities of Italian IPOs venture capital backed and some important differences with non-VC backed ones. Such results will be useful for the choice of control variable in section III, when matching procedures will be used to assess the causal effect of the venture capital backing on the IPO underpricing.

Underpricing distribution and tests of hypothesis

[5] See the appendix A for the ranking of underwriters by reputation.

Descriptive statistics of the first day return are reported in Table 6. The underpricing is calculated as usual: it is the percentage change in stock's price from the offering price to the closing price on the first day of trading. The VC backed IPOs are much less underpriced than non-VC backed. The mean and median underpricing of the former IPOs are 7.5% and 1.2% while the latter IPOs show values of 15.5% and 4.9%. The difference in the underpricing appears a persistent phenomenon throughout the entire period and various sub-periods. Indeed, in the periods 1999-2001 and 2002-2004 the mean underpricing of non-VC backed IPOs is more than twice bigger than that of VC backed IPOs. This holds also in subsequent years, even if the values of the underpricing for the two groups of IPOs are closer.

It is of particular interest to underline that the underpricing of VC backed IPOs has a lower standard deviation (24.9) than non-VC backed ones (52.1): the standard deviation test between the two groups rejects the null hypothesis of equality (p-value 0.00). This means that the evaluation of IPOs non-VC backed is affected by a higher degree of uncertainty with respect to IPOs that receive venture financing.

In order to analyse the underpricing difference between the two types of IPOs I rely both on the classic equality of mean test and non-parametric test of hypothesis. The results are shown in table 6. Looking at the equality of mean test I have ambiguous results with the statistical significance that is sensitive to the presence of some outliers. Indeed, the underpricing difference between VC backed and non-VC backed firms is statistically significant only at the 10% level in the whole but becomes highly significant if the IPOs with the higher underpricing of the two groups (i.e. Finmatica 532.6%, Chl 181.7%) or the observations considered as outliers according to the standard approach of Hamilton (1992) are excluded[6]. However, the small size of the sample and the fact that the underpricing variable is not normally distributed suggest the inappropriateness of the classical tests

[6] An observation i is considered as severe outlier if its underpricing value is smaller than $Q(25)-3IQR$ or greater than $Q(25)+3IQR$, where $Q(25)$ is the 25th percentile, $Q(75)$ is the 75th percentile and IQR is the inter-quartile difference.

of hypothesis. The total number of companies that went public in the analysed period is indeed quite low, only 188 observations, and the low p-values of both the Shapiro-Wilk test and Jarque-Bera test (values not reported in the table) reject the null hypothesis that the underpricing is normally distributed. On the contrary, the variable shows strong skeweness and curtosis and a mean value three times higher than the median value, pointing out a clear positive asymmetry.

Then, as alternative strategy I also perform non-parametric tests of hypothesis. The major advantage of such tests is that they do not make any assumption about the probability distribution of the underpricing variable (are distribution free). In particular I use the Kolmogorov-Smirnov (KS) test, the Wilcoxon rank-sum test and the equality of medians test. The Kolmogorov-Smirnov test is one of the most useful and general non parametric methods for comparing two samples. The null hypothesis is that the samples are drawn from populations with the same distribution (without specifying what that common distribution is) and the KS statistic is calculated as the distance between the empirical distribution functions of the two samples. Also the Wilcoxon runk-sum test verifies whether two independent samples are drawn from populations with the same distributions and can be considered the equivalent of the Student's t-test applied to normality distributed variables. The test, unlike the KS test, use the random variable rank to calculate the Wilcoxon W statistic and it is more appropriate in dealing with large samples. The equality of medians test assess whether two samples are drawn from populations with the same median. The test computes the median of the two joint samples, then classifies the original observations depending on whether they are above or below the median. Lastly, the data are cast into a 2x2 contingency table and a Pearson's chi-squared test is performed.[7]

In general, the three tests reject the null hypothesis at usual statistical levels (Panel B of the table reports the p-values of each one), showing that the differences in the underpricing between VC backed IPOs and non-VC backed ones are statistically significant.

[7] For more details on non-parametric tests see, amongst others, Gibbons and Chakraborti (1992), Nonparametric Statistic Inference.

[TABLE 6]

The tests of hypothesis suggest that the presence of venture capitalists as shareholders in issuing companies reduces the extent of the IPO underpricing. However, descriptive statistics have shown that the VC backed and non-VC backed IPOs differ in some important characteristics: issuers venture capital backed are smaller and younger, less profitable and less indebted than non-venture capital backed ones. The former IPOs are also headquartered in few regions and clustered by sector of activities. Failing to account for such differences may lead to biased conclusions about venture backing effect on the IPO underpricing. In the next section I present two approaches that provide unbiased estimate of venture backing causal effect.

IV. The causal effect of venture capital backing on the IPO underpricing

The main object of this section is to verify whether the difference in the underpricing between VC backed and non-VC backed IPOs is due to the causal effect of the venture capital backing. The raw comparison between the two groups of IPO conducted in section III assumes that the provision of venture financing is randomly distributed across firms. In this case the causal effect is simply the difference between the average underpricing of the two groups of IPO. Instead, as pointed out by several authors, venture capital backing represents an endogenous choice of issuing firms and venture capitalists. For instance, if only large companies are interested and receive the venture capital backing, their lower underpricing may be due to the firm size rather than the venture capital backing. Such a choice introduces a selectivity bias both in the provision of venture funding and in the characteristics of VC backed IPOs. To overcome the problem I rely on two different strategies: a matching-based approach that compares VC backed IPOs to sub-samples of non-VC backed ones and a regression-based approach that, by estimating a treatment effect model, explicitly handle the endogeneity of the venture capital backing.

Matching based approach

The first paper that compare VC backed and non-VC backed IPOs with a matching procedure is Megginson and Weiss (1991). The authors match IPOs of the two groups in the same industry and as closely as possible by offering size. The analysis covers the period 1983-1987, but not all VC backed IPOs are considered. They exclude IPOs with an offering amount smaller than 3 million dollars and an offer price less than 5$, as well as firms without offering prospectus available or firms misclassified as having venture capital participation. These constraints reduce the sample size of VC backed IPOs from 390 to 320 observations. Also Lee and Wahal (2004), analysing the period 1980-2000, compare VC backed IPOs and non-VC backed ones by applying a similar matching procedure. With respect to Megginson and Weiss, their matching requires, furthermore, that, due to the long period analyzed, the non-VC backed IPO takes place within 2 years of the compared VC backed IPO. Also in this analysis the VC backed IPOs considered are not the entire population: on a total of 2383 IPOs they include in the sample only 2208.

As preliminary strategy of matching I replicate the procedure described above, comparing VC backed IPOs to various sub-samples of non-VC backed IPOs matched as closely as possible by industry and offering size. Then I test if the differences in the underpricing of the two groups are statistically significant. For the firm's sector of activity, I rely on the International Classification Benchmark (ICB) at the industry level described in the Table 2. The differences between VC backed IPOs and non-VC backed IPOs are shown in Table 7, with regard to both the mean and median underpricing. The results are obtained using different matching procedures: in column 1 the matching is conducted without replacement and without constraints on the year of listing, in column 2 the matching is conducted with replacement but without year restriction, while in column 3, in addition to replacement, the matching procedure also requires that non-VC backed IPOs take place between two years before or two years after the matched VC backed IPOs.

The extent of mean underpricing differences are sensitive to the matching procedure and decrease from -16.5%, in the matching without constraints, to -7.7% in the matching with replacement and constraint on the year of listing. However, the underpricing median differences are quite unvaried with respect to the alternative matching strategies and highly statistically significant.

[TABLE 7]

As an alternative to this intuitive matching procedure, I use the propensity score matching (PSM), a statistical methodology that allows to select comparable IPOs in a more rigorous way. The PSM is used to estimate the causal effects in non-experimental settings, with the aim of providing unbiased estimates of an intervention, or treatment, on an outcome variable, an observable characteristic of the population units. Even if the PSM is widely applied in evaluating public policies, empirical applications can be found in various fields of research where there are a treatment, a group of treated units and a group of non-treated units. The quantity of interest, at least for policy evaluation, is the difference between the participants' outcome with and without treatment, what in the literature is defined as the Average Treatment effect on the Treated (ATT). Applying the methodology to this analysis, I consider the venture capital backing as the treatment, VC backed IPOs as the treated units and non-VC backed IPOs as the non-treated units. The underpricing, the variable of interest, is the outcome of the treatment. I define Y as the underpricing and D as a binary variable indicating whether an IPO is venture capital backed. In particular Y_1 and Y_0 are respectively the underpricing for a VC backed IPO and for a non VC backed IPO, D_i equals 1 if the IPO i is venture capital backed and 0 otherwise. I am interested in the average effect of venture capital backing on the underpricing of VC backed IPOs.

In an ideal world, for each observation, two values of the outcome of interest would be observed: $Y_{1,i}$ if the IPO i is venture capital backed ($D_i = 1$) and $Y_{0,i}$ if the same IPO were not venture capital

backed ($D_i = 0$). In such a case the causal effect of venture backing could simply be computed as $E(Y_1 - Y_0 \mid D = 1)$, that is, the average underpricing difference between the IPOs venture capital backed and the same IPOs in absence of venture backing (the ATT of the analysis). However, in the real world only one of the potential outcomes for each IPO is observed, depending on whether the IPO is venture capital backed or not. If an IPO is venture backed just $Y_{1,i}$ is observed while $Y_{0,i}$, the underpricing for the same IPO i in the absence of venture backing, is not observed and it is defined as the counterfactual outcome. As noted by Holland (1986) the problem of missing values for the counterfactuals is the fundamental problem of causal inference.

The common strategy is to proxy the counterfactual outcome with $E(Y_0 \mid D = 0)$ that, in this context, is the average observed underpricing for non-VC backed IPOs. Heckman and Smith (1995) highlight that such a choice introduces a selection bias if the treatment assignment is not random because, for instance, of the self-selection of units in the program. Rubin (1974) and Rosenbaum and Rubin (1983) demonstrate that, holding certain conditions,[8] the selection bias vanishes and matching the observations of the two groups on the basis of the so-called balancing score, i.e. a function of a vector X of relevant observable characteristics, it leads to unbiased estimates of the causal effect. The general idea is to find, from the group of non-treated units, observations that are similar to treated units in terms of the observable characteristics X . The major advantage is that the matching procedure can be conditioned only on the propensity score and not on all the variables included in X , reducing a multidimensional problem to a mono-dimensional one. As balancing score, Rosenbaum and Rubin propose the propensity score that can be obtained with a two stage procedure: in the first step the probability of receiving the venture backing is estimate by a probit or logit regression in which the dependent variable is D, the binary variable for venture capital

[8] The discussion of these hypotheses is beyond the object of the paper. For more details see, amongst others, Rosenbaum and Rubin (1983), Barnow *et al.* (1980), Lechner (1999), Imbens (2004), Heckman *et al.* (1999).

backing, and the covariates are the observed characteristics of the vector X.[9] In the second step $\hat{p}(X)$, the predicted probabilities of the first step, are used as the propensity scores in order to match observations belonging to the two groups. In this study it means that VC backed IPOs are matched with a control sample of non-VC backed IPOs on the basis of $\Pr(D=1|X)$, the probability to be funded by venture capitalists.

Various algorithms can be used to match observations on the basis of the propensity scores.[10] Table 8 reports the results obtained by using the Nearest-Neighbour matching (NN), without and with caliper (column 1 and 2), and the Kernel Matching (column 3). All the matching are with replacement, that is, a non-treated unit can be used more than once as a match. This improves the quality of the matching and reduces the selection bias when, as in our data, the propensity score distribution is very different for the treated and non-treated groups. The NN is one of the most straightforward and often used algorithms where each treated unit (VC backing IPO) is matched to the comparison non-treated unit (non-VC backed IPO) with the closest propensity score. However, given that it is a one to one matching, it can faces the problem of bad matches when the difference in propensity scores between the pairs of matched observations is very high. This can be avoided by imposing a threshold of tolerance on the maximum propensity score distance (caliper), usually determined as a quarter of the standard deviation of the $\hat{p}(X)$ (Rosenbaum and Rubin, 1985). Hence, an unit from the comparison group is chosen as a matching partner for a treated unit that lies within the propensity range and is closest in terms of propensity score.

Also using the caliper option, the NN algorithm contrasts each treated unit with only one non-treated unit and can discard important information on the latter group of units. An alternative way is to rely on weighted matching estimators, such as the Kernel Matching (KM). The KM uses a

[9] This equation is not a deterministic model and the significance of the estimates, as noted by Khandker *et al.* (2010), is not very informative and could be misleading. In other words, causality is not the object of this stage of the PSM in which only is required that $X \perp D \mid \hat{p}(X)$.

[10] For a recent and comprehensive discussion of different algorithms see, among others, Caliendo and Kopeinig (2008).

weighted average of all non-treated, depending on the choice of the kernel function, to construct the counterfactual matches for each participant.

The PSM, in estimating the variance of the treatment effect, fails to account for the variance attributable to the derivation of the propensity score in the first step of the procedure. In order to overcome such problem I rely on bootstrapped standard errors (50 replications, as usual).[11]

Given that the plausibility of matching, as well as the sensitivity of results, depends on the choice of X in the first stage regression, I estimate three specifications of the model with different set of covariates. In Panel A I replicate the specification used in Lee and Wahal (2004), including as covariates the logarithm of the offering's net proceeds, the underwriter reputation and dummies variables for the region of firms' headquarter, the year of listing and the sector of activity. In Panel B I add the firm size (proxied by the logarithm of the firm market value) and the logarithm of the age; in Panel C I enlarge the set of covariates with the ebitda, a proxy of the firm profitability, and the debt-equity ratio, a proxy of the degree of firm total debts.

The average differences in the underpricing between VC backed and non-VC backed IPOs, the t-statistics and the 95% confidence intervals are summarized in Table 8. In Panel A are reported the estimates of the model with the fewest control variables. The advantage of such specification is a larger sample size with respect to other specifications that suffer from missing data in the further controls. The average underpricing difference is -23%, statistically significant at the 5% level, and the confidence interval range between -44% and -2%. Applying the caliper constraint, the difference in the underpricing and the confidence interval slightly decrease but the significance increases. The results obtained with the Kernel Matching confirm that the underpricing difference is negative and statistically significant. It is interesting to notice that all the estimated underpricing differences are greater than the raw differences between all the VC backed and all the non-VC backed IPOs computed in section III. In Panel B and C the sample size reduces respectively to 164 and 153 observations but the results remain statistically significant, with the exception of those

[11] In literature there are several examples of the PSM with bootstrapped standard errors. See for instance Lechner (2002), Black and Smith (2004) and Sianesi (2004).

obtained with the KM on the more comprehensive specification (the underpricing difference is quite low, -3.5%, and the confidence interval is between -15.8% and +8.7%, indicating that the average difference in not statistically negative).

The results of the PSM confirm that VC backed IPOs are less underpriced than non-VC backed ones. The estimated underpricing difference is statistically significant and also larger than that shown by the descriptive statistics. In addition, and more important, the methodology allows to directly attribute the lower underpricing of the former IPOs to the causal effect of the venture backing.

[TABLE 8]

I also use the PSM to assess the impact of venture capital backing on the gross spread and the reputation of underwriters that manage the IPOs. Replicating all the above specifications with these two variables as outcome, the results (not showed for the sake of space) point out that the differences between VC backed and non-VC backed IPOs are not statistically significant. The finding is in contrast with some authors' beliefs, who find that companies with venture capital investors as shareholders pay lower gross spread and hire higher quality underwriters than other companies.

Regression based approach

In this section I evaluate the impact of venture capital backing on IPO underpricing by using a regression-based approach. With respect to the matching approach, the main advantage is that I control the robustness of the venture capitalists certification for additional variables, as for instance the certification provided by the underwriters. The dependent variable is the first day return and a

dummy variable accounts for the venture capital backing. According to the notation used in the previous section, the general estimated equation can be written as:

$$Y_i = \beta_0 + \beta_1 D_i + \delta X_i + \alpha_t + \varepsilon_i \qquad (1)$$

where Y_i is the first day return, D_i is the dichotomous variable equals to 1 if IPO i is venture capital backed and 0 otherwise, X_i is the vector of control variables, δ is the vector of coefficients associated with controls and ε_i is the error term. The main coefficient of interest, β_1, measures the difference in the mean underpricing between IPOs backed and IPOs not backed by venture capital investors. The time fixed effects α_t are included in all the specifications of the model to control for the cyclical nature of the underpricing.[12]

Given the above discussion, the dummy variable D_i cannot be treated as exogenous because whether or not a firm receives the venture backing is based on self-selection. In that case, the dummy variable is endogenous and the ordinary least square do not provide consistent estimates of the causal effect β_1.[13] In order to account for the endogenous nature of the venture capital backing a treatment effect model is used to estimate the equation (1). The model is a particular case of more general self-selection models and allows to estimate the causal effect of an endogenous binary variable on a continuous observed variable.[14] In the treatment effect model the equation (1) is the equation of primary interest and the receipt of venture capital backing is modeled as the outcome of an unobserved latent variable D_i^*, such as:

[12] Some authors observe that the validity of the certification hypothesis is time-dependent. For instance, Coakley *et al.* (2009) studying the IPOs issued on the London Stock Exchange between 1985-2003, show that the difference between the underpricing of VC backed and non-VC backed IPOs is negative over the entire period but it is statistically significant only excluding the internet bubble years (1998-2000).

[13] Technically $E(\varepsilon_i \mid X_i) \neq 0$, or in words, the conditional mean assumption of the disturbance is violated and the OLS estimator is biased and inconsistent.

[14] For a basic discussion of the treatment effect model see Greene (2008), while for a review of more general self-selection models see Maddala (1983).

$$D_i^* = \gamma W_i + u_i \qquad (2)$$

with

$$D_i = \begin{cases} 1, & if \quad D_i^* > 0 \\ 0, & otherwise \end{cases} \qquad (3)$$

where W_i is a vector of exogenous covariates that affect the receipt of venture funding.[15] The model is estimated by the two step estimator derived in Maddala (1983). In the first stage probit estimates of the treatment equation (2) are obtained:

$$\Pr(D_i = 1 \mid W_i) = \Phi(W_i \hat{\gamma}) \qquad (4)$$

These estimates are used to compute the hazard h_i:

$$h_i = \begin{cases} \phi(W_i \hat{\gamma}) / \Phi(W_i \hat{\gamma}), & for \quad D_i = 1 \\ -\phi(W_i \hat{\gamma}) / \{1 - \phi(W_i \hat{\gamma})\}, & for \quad D_i = 0 \end{cases} \qquad (5)$$

where ϕ is the standard normal density function.

Lastly, the parameter of interest β_1 is obtained in the second step by augmenting the equation (1) with the hazard h_i. Table 9 summarizes the estimates obtained with maximum likelihood method.

[15] In the treatment effect model the error terms ε and μ are correlated and bivariate normally distributed. In my case ρ, the correlation between the error terms, is positive and the ordinary least square will overestimate the coefficient β_1.

As a preliminary analysis, in column 1 I start with a bivariate ordinary least square regression between the underpricing and the venture capital backing (*Venture Backing*). Such a first step is useful in order to compare the point estimates of β_1 in the various specification of the model. In column 2 I also replicate the regression proposed by Megginson and Weiss (1991). The underpricing is regressed on the dummy variable for the venture capital backing, the size of the offering (*Size*), the age of the issuing firms (*Age*) and the underwriter reputation (*Underwriter Reputation*). For all the regressors I expect a negative relationship with the underpricing. Ritter (1987) has documented that, due to economies of scale, with the increasing of the amount offered the cost of going public decreases. In addition, I notice that the variable is highly correlated with the size of the issuers. For instance, the correlation with the market value of issuing firms is 99%, with the total asset is 60% and with the net asset is 89%. Then, the variable can also be considered as a proxy of the issuing firms' size. The size and the age of the issuers are also considered in the literature as proxies of the ex-ante uncertainty regarding the price of firm's shares. Indeed, Leland and Pyle (1977) argue that a correct evaluation of young and small firms is a difficult task for the outside investors. The underwriter reputation is included in the model in order to separate the certification provided by venture capitalists and the one provided by the underwriter that manage the offer.

In column 3 I extend the set of controls introducing additional variables that the empirical literature has identified as determinants of the IPO underpricing. The variable *Distance* accounts for the geographic localization of issuing firms and measures the physical distance (in kilometres) between the headquarter of issuers and Milan, the city where is located the Italian stock exchange. Acconcia *et al.* (2011) consider such a variable as a proxy of the asymmetric information between insiders of issuing firms and outside investors and provide empirical evidence that it is positively correlated with the underpricing. Following their reasoning, I expect that the farther away is the listing firm, the higher is the level of the underpricing. The width of the preliminary IPO price range (*Range*) refers to the indicative prices set at the beginning of the book-building procedure. According to

Hanley (1993), I hypothesize that a wider price range is typical for IPOs with high uncertainty. Then, I expect a positive relationship with the underpricing**.** *Revision* measures the revision of the IPO price relative to the average value of the price range and it is considered as a proxy of the information gathered by the underwriter during the roadshow. Cornelli and Goldreich (2003) show that the variable is positively correlated with the underpricing. The gross spread (*Fees*), defined as the fees charged by the underwriter in percentage of the IPO price, represents with the underpricing, the main cost of going public.[16] Prabhala and Puri (1998) observe that such a cost is usually higher for IPOs harder to price and then consider the gross spread as a proxy of the risk associated to the IPOs. Also for this control variable I expect a positive relationship with the underpricing. *Greenshoe* is the ratio between the number of shares dedicated to the greenshoe option and the total number of shares sold to the market. Benveniste and Spindt (1989) argue that the greenshoe option reduces the risk of the issue and consequently the extend of the expected underpricing.[17] I also add the dummy variable *Bank Uw* that is equals to 1 if the IPO underwriter is a bank that owns equity of the issuing firm and 0 otherwise. This control is of particular interest for the Italian bank-based financial system where banks are often founders or financiers of issuing firms.[18] Furthermore, in order to account for the possible joint certification provided by underwriters and venture capitalists, I also include in the regression an interaction term between the underwriter reputation and the venture capital backing (*Venture Backing – Underwriter Reputation*) equals to 1 if the IPO is VC backed and is handled by high quality underwriters. Lastly, a further important control is the sector of activity in which the issuing firms operate. Bradley and Jordan (2002) for instance, after controlling for the industry effect, do not find any difference in the underpricing of VC and non VC backed IPOs. I rely on the ICB classification summarized in Table 2.

In the last two column I estimate the equation of column 3 by the treatment effect model to account for the endogeneity in the receipt the venture capital backing. According to the data summarized in

[16] Chen and Ritter (2000) for example, show that in the US IPOs the gross spread is closely clustered around the 7%.
[17] See the appendix B for more details on the explanatory variables.
[18] A similar role of the underwriters is documented also by Elston and Yang (2010) in the German context.

section III, the exogenous variables that could affect the receipt of venture funding are the size and the age of issuing firms, the return of the market index, the distance from the headquarter of the stock exchange and the dummies for the sector of activity.

Finally, in column 5 I combine the regression-based approach with the propensity score matching, by adding to the equation estimated in column 4 the constraint that $\hat{p}(X)$, the estimated propensity score obtained with the matching approach, ranges between the first and the last decile.[19]

The results are consistent with the previous discussion. The dummy for the venture backing, the main variable of interest, is statistically significant at usual levels in the various specifications and it is negatively correlated with the first day return: IPOs venture capital backed are less underpriced than IPOs non-venture capital backed. It is interesting to notice that when I account for the endogeneity problem by using the treatment effect model the coefficient of the dummy is greater, in absolute value, than those predicted by the OLS. In other words, the OLS estimate of the venture capital backing effect is biased upward. The proxy of the underwriter reputation shows the expected negative sign and it is statistically significant. This means that, as highlighted by other studies (Johnson and Miller, 1988; Carter and Manaster, 1990; Carter *et al.*,1998), also high quality underwriters are able to certify the IPOs they handle and that their certification is a complement to the one provided by venture capitalists. Such a finding represents further support in favour of the certification hypothesis. Lastly, the underpricing significantly reduces when the underwriters also have a stake in the issuing firm while does not significantly change when high quality underwriters manage IPOs venture capital backed. The other controls are in general statistically significant with the expected signs. In particular, the fees paid to the underwriters are positively correlated with the underpricing. This mean that IPOs with low underpricing, as for instance VC backed IPOs, are associated with low fees, excluding a possible trade-off between indirect and direct cost of going public.

[19] Given the discussion of section 3, all specification of the model are estimated excluding the IPOs considered as severe outliers.

[TABLE 9]

V. Conclusions

During the period 1999-2012, VC backed IPOs are less underpriced than non-VC backed ones. Using different methodologies that allow to explicitly handle the endogeneity in the receipt of venture funding, I conclude that the difference in the average underpricing between the two groups of IPOs is actually due to the causal effect of venture capital backing.

Contrasting with some part of the literature, I do not find significant differences in the reputation of underwriters managing the offers, neither in the gross spread paid to the underwriters. Lastly, descriptive statistics suggest that venture capitalists tend to take public younger and smaller firms with lower profitability, lower revenues and less debts than other issuing firms.

The provided empirical evidence indicates that venture capital backing play an important role in the reduction of information asymmetries between issuing firms and outside investors, and consequently of the IPO underpricing. Given that the underpricing is considered as the main indirect cost of floatation, the result suggests that an efficient venture capital industry may help to overcome the so called "funding gap" – the financing problems faced by new and small firms – with wide advantages for the overall economy. This is particularly true for the case of Italy where the financial system, given the opacity and the family management of domestic firms, is strongly affected by relevant information asymmetries between outside investors and insiders of firms. From this point of view, also the government would be actively engaged in promoting programs to support the venture capital industry, as, for instance, it has occurred in other European countries such as Germany and United Kingdom.

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APPENDIX A

Ranking of underwriters by the reputation in the Italian IPO market.

The table reports the reputation of underwriters that manage Italian IPOs. The proxy of the reputation is computed according to Megginson and Weiss (1991). The reputation for each underwriter is the market share of the total euro amount offered to the market by all the 188 companies that went public in the period 1999-2012. If an IPO is handled by more than one underwriter, the amount offered to the market is equally divided between the underwriters. For IPOs handled by more than one underwriters, the greater of the underwriters' market share is used as a measure of the reputation. Only underwriters with more than the 0.5% of the market share are shown.

Underwriter	Market share
Mediobanca	27.86
Merrill Lynch	20.57
Banca IMI	11.63
Morgan Stanley	4.77
Goldman Sachs	4.38
Credit Suisse First Boston	4.38
Unicredit	3.91
Ubs Warburg	3.87
Monte dei Paschi	2.26
Intermonte SIM	2.07
DLj International Securities	1.55
Banca Leonardo	1.40
Banca Caboto	1.37
Abn Amro Rotschild	1.30
Intesa Bci	1.08
Lehman Brothers	1.02
Deutsche Bank	0.95
Shroder Salomon Smith Barney	0.68
Citigroup	0.58
Abaxbank	0.50

APPENDIX B

Definition of main variables

Variable name	Definition
Underpricing	$\left[\frac{P - P_{IPO}}{P_{IPO}}\right] * 100$ where P is the closing price in the first day of trading and P_{IPO} is the offer price of the stocks.
Venture Backing	Dummy variable equals to 1 if the IPO is venture capital backed and 0 otherwise.
Size	Number of issuing stocks times the IPO price.
Age	Difference between the year of IPO and the year of establishment.
Underwriter Reputation	Measures the underwriter reputation. See Appendix A for more details.
Distance	Physical distance in kilometres between the financial centre of Milan and the headquarter of the issuer.
Range	Width of the preliminary book-building price range computed as: $\left[\frac{P_{\max} - P_{\min}}{P_{\min}}\right] * 100$ where $P_{\min}$ and $P_{\max}$ are respectively the bottom and the top price of the book-building range.
Fees	The gross spread that underwriters receive for manage the IPO. In percentage terms of the net proceeds of the issue.
Market Value	Number of total issuer shares times the IPO price.
Oversubscription	Ratio between the number of institutional investors that have requested the shares and the number of institutional investors that get the shares.
Greenshoe	Ratio between the number of shares dedicated to the greenshoe option and the total number of shares offered to investors in the IPO.
Revision	Percentage change of the IPO price with respect to the book-building price range. The variable is computed as follows: $\frac{P_{IPO} - P_{\min}}{P_{\max} - P_{\min}}$ where P_{IPO} is the offer price of the stocks and $P_{\min}$ and $P_{\max}$ are respectively the bottom and the top price of the book-building range.

Table 1. Italian IPOs by year of listing

Year	Total Number of IPOs	Venture capital backed IPOs		Market Return
		Number	% of total IPOs	
1999	27	9	33.3	22.3
2000	42	12	28.6	1.7
2001	17	4	23.5	-26.2
2002	5	1	20.0	-26.0
2003	4	2	50.0	11.8
2004	8	4	50.0	16.9
2005	15	6	40.0	13.3
2006	21	8	38.1	17.5
2007	28	12	42.9	-7.7
2008	6	3	50.0	-48.4
2009	4	2	50.0	19.5
2010	8	2	25.0	-13.2
2011	2	0	0.0	-26.2
2012	1	0	0.0	0.9
	188	65	34.6	

Table 2. Industry distribution of VC backed IPOs

	Total IPOs	VC backed IPOs	% of VC backed IPOs
Oil & Gas	3	0	0.0
Basic Materials	3	1	33.3
Industrials	39	15	38.5
Consumer Goods	35	15	42.9
Health Care	9	7	77.8
Consumer Services	27	10	37.0
Telecommunications	5	2	40.0
Utilities	15	2	13.3
Financials	27	6	22.2
Technology	25	7	28.0
	188	65	34.6

Table 3. Geographic distribution of IPOs

Region	Total IPOs		VC backed IPOs		
	Number	% of total IPOs	Number	% of total	% of regional IPOs
Emilia Romagna	38	20.4	16	24.6	42.1
Friuli	6	3.2	3	4.6	50.0
Lazio	17	9.1	3	4.6	17.6
Lombardia	66	35.5	24	36.9	36.4
Marche	4	2.1	1	1.5	25.0
Piemonte	18	9.7	8	12.3	44.4
Toscana	16	8.5	3	4.6	18.8
Veneto	15	8.1	4	6.1	26.7
	non-VC backed IPOs		VC backed IPOs		
Mean distance from the stock exchange	178.2		216.7		

Table 4. Characteristics of VC backed and non-VC backed IPOs

	VC backed IPOs		non-VC backed IPOs	
	Mean	Median	Mean	Median
Panel A: Firm characteristics				
Age	20.9	13	25.2	16
Capitalization (Market value)	326	176	1082	230
Total asset	235	77	1946	102
Net asset (Patrimonio Netto)	73	24	413	21
Revenue	238	89	569	104
Offer proceeds	120	60	340	79
Debt Equity	0.84	0.74	2.1	0.84
Roe (%)	38	0.37	60	0.44
Ros (%)	-1.8	0.11	13	0.14
Panel B: Offering characteristics				
Oversubscription	1.2	1.08	1.3	1.14
Greenshoe (%)	11.3	11.1	10.7	11.5
Range	26.5	25	32.2	25
Revision	0.27	0.32	0.28	0.36
Share offered	37.1	35.1	32.1	30
Underwriter reputation	9.4	3.9	9.6	3.9
Gross spread	4	4.15	3.8	3.95

Table 5. Descriptive statistics of the venture capitalists' shares in issuing firms

	VC backed IPOs *(N=65)*
Average stake of venture capitalists in the listing firm before the IPO	36.5% [28.8%]
Average stake of venture capitalists in the listing firm after the IPO	17.2% [10%]
Average stake of venture capitalists sold in the IPO (%)	56.01% [50.01]
Number of IPOs where venture capitalists own more than the 50% of the shares before the offer	19 (29.2%)
Number of IPOs where venture capitalists own more than the 50% of the shares after the offer	5 (7.7%)
Number of IPOs where venture capitalists sell 100% of their stakes	9 (13.8%)

Medians in brackets and percentage of total VC backed IPOs in parentheses

Table 6. Descriptive statistics of the IPO underpricing and tests of hypothesis on the underpricing difference between VC backed and non-VC backed IPOs

	Mean	Median	St. Dev.	Skewness	Kurtosis	Min	Max	Obs
Panel A: descriptive statistics of the underpricing								
Total IPOs	12.7	3.9	44.7	9.0	99.9	-20.0	532.6	188
VC backed IPOs	7.5	1.2	24.9	5.5	38.0	-7.8	181.7	65
non-VC backed IPOs	15.5	4.9	52.1	8.2	80.6	-20.0	532.6	123

The mean underpricing in various sub-periods

	VC backed IPOs	non-VC backed IPOs
1999-2001	10.1	22.3
2002-2004	-3.1	2.5
2005-2007	6.9	8.2
2008-2012	9.3	12.3

Panel B: Test of hypothesis on the underpricing difference between VC backed and non-VC backed IPOs

Test of hypothesis	Statistic	p-value
Equality of means tests:		
- Whole sample	t = 1.42	0.083
- Excluding IPOs with underpricing<180	t = 2.54	0.000
- Exckuding IPO with underpricing<61.2	t = 1.57	0.050
Non parametric tests:		
Kolmogorov-Smirnov Test	combined KS = 0.206	0.038
Wilcoxon Rank-Sum Test	z = 1.99	0.046
Nonparametric equality-of-medians test	χ^2 = 3.97	0.046

Table 7. Underpricing differences between VC backed and non-VC backed IPOs in a matching approach

	(1)	(2)	(3)
Mean differences	-16.5* (-1.77)	-14.3** (-2.49)	-7.7* (-1.76)
Median differences	-5.7*** (6.32)	-7.5** (5.2)	-5.6** (4.43)

t-statistics for mean tests and chi-squared for median tests in parentheses

***, **, * statistically significant at 1, 5 and 10% level.

Table 8. Propensity score analysis: the causal effect of venture capital backing on the IPO underpricing

	(1)	(2)	(3)
Panel A. Control variables: net proceeds, underwriter reputation, sector dummies, headquarter-regional dummies and year dummies. (188 obs.)			
Underpricing differences	-23.01**	-22.91***	-16.81**
t-statistics	(-2.15)	(-2.72)	(-2.19)
Confidence Intervals (95%)	(-44; -2.02)	(-39.43; -6.39)	(-31.95; -1.77)
Panel B. Control variables: net proceeds, underwriter reputation, sector dummies, headquarter-regional dummies and year dummies, firm size and firm age. (164 obs.)			
Underpricing differences	-26.19**	-25.9***	-15.61**
t-statistics	(-2.52)	(-2.85)	(-2.02)
Confidence Intervals (95%)	(-46.57; -5.81)	(-43.21; -7.97)	(-30.78; -0.43)
Panel C. Control variables: net proceeds, underwriter reputation, sector dummies, headquarter-regional dummies and year dummies, firm size and firm age, ebitda and debt-equity ratio. (153 obs.)			
Underpricing differences	-16.71**	-25.59***	-3.58
t-statistics	(-2.41)	(-2.93)	(-0.57)
Confidence Intervals (95%)	(-30.51; -3.12)	(-42.69; -8.50)	(-15.88; 8.71)

***, **, * statistically significant at 1, 5 and 10% level.

Table 9. Regression analysis: the effect of venture capital backing on the IPO underpricing

$Y = underpricing$	(1)	(2)	(3)	(4)	(5)
Venture Backing	-2.87** (-2.59)	-3.16*** (-3.19)	-4.63* (-1.89)	-6.02** (-2.19)	-7.13** (-1.97)
Bank Uw			-4.51* (-1.84)	-4.52** (-1.98)	-4.23* (-1.74)
Venture Backing – Underwriter reputation			0.22 (1.03)	0.22 (1.14)	0.21 (1.15)
Size		-1.27** (-2.79)	-1.79** (-2.38)	-2.03*** (-2.66)	-1.24* (-1.88)
Age		-1.35* (-1.84)	-1.54** (-2.17)	-1.51** (-2.16)	-0.93* (-1.69)
Underwriter Reputation		-0.06 (-1.17)	-0.16* (-1.85)	-0.15* (-1.81)	-0.18*** (-2.62)
Distance			0.02*** (3.66)	0.02*** (3.74)	0.01*** (4.52)
Range			0.06*** (3.22)	0.06*** (3.55)	0.06*** (3.37)
Fees			1.59 (1.61)	1.57* (1.75)	1.85** (2.04)
Greenshoe			-0.34** (-2.29)	-0.34** (-2.55)	-0.33** (-2.00)
Revision			7.70*** (8.13)	8.03*** (9.94)	7.29*** (7.90)
Constant	7.63*** (7.67)	61.06*** (15.38)	0.54 (0.06)	4.98 (0.98)	4.69 (0.92)
Year Dummies	yes	yes	yes	yes	Yes
Industry Dummies	no	no	yes	yes	yes
Observations	181	181	168	163	148
Pseudo R^2	0.16	0.20	0.42	-	-
Wald Test (p-value)	-	-	-	0.05	0.06

***, **, * statistically significant at 1, 5 and 10% level.