

VENTURE-CAPITAL CERTIFICATION IN EUROPEAN IPOs

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Abstract

This paper examines venture-capital certification in European initial public offerings (IPO) between 2002 and 2015. More specifically, we investigate how venture-capital backing impacts measures of the indirect issuance costs of an IPO, such as IPO underpricing and the opportunity cost of issuance, as well as the quality of the issuing firm's lead underwriter. We find no evidence of venture-capital certification in the form of lower IPO underpricing, but we do find that VC-backing is associated with a lower opportunity cost of issuance. We also find that VC-backed firms manage to engage the services of higher quality underwriters. This VC certification effect appears to be primarily due to certification of penny stock IPOs.

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I.Introduction

The venture-capital industry and the role that it plays in the capital-formation process is a topic of great interest within the academic literature. Despite extensive coverage, the influence it has on initial public offerings (IPOs) still remains debatable. Earlier studies claim that venture capitalists (VCs) certify the IPOs they are involved with. These studies find support for VC certification, because they observe lower IPO underpricing and higher prestige underwriters. On the other hand, more recent studies find no proof of venture-capital certification and even find evidence that venture-capitalist backing of an IPO is associated with higher levels of IPO underpricing. Dolvin & Jordan (2004) and Dolvin (2005) shed new light on this discussion by illustrating that IPO underpricing is actually the product of two underlying components: Economic overhang and the true opportunity cost of issuance. They state that the conflicting results in the literature regarding the certification effects of venture capitalists may be caused by an improper measurement of indirect issuance costs and, thus, of certification. At the same time, the hot-issue market theory attributes the inconsistencies in the literature to changing market conditions (Benveniste et al., 2002; Loughran & Ritter, 2004; Lowry & Schwert, 2002; Ritter, 1984; Rossetto, 2008). This theory states that in times of stable markets, the presence of venture capitalists reduces IPO underpricing, while in 'hot-issue' periods, they invoke greater IPO underpricing. This may explain why results from research of IPOs in the period leading up to the dot-com bubble contradict those from earlier research. Our paper is primarily based on the theories of Dolvin (2005) and hot-issue markets. In contrast to the existing academic literature, which focuses almost entirely on the U.S. markets, we use a sample of European VC-backed and non-VC-backed IPOs that occurred in the period 2002-2015. Based on the early literature, we evaluate the VC certification effect by examining abnormal first-day returns, as a proxy for IPO underpricing, and underwriter quality. In accordance with Dolvin (2005), we also analyze the effect of VC-backing on the

true opportunity cost of issuance (OCI), rather than on IPO underpricing. Lastly, we investigate whether the theory of hot-issue markets holds true for our sample. In other words, we test the hypothesis that venture capitalists certify IPOs in normal market circumstances, but give up their certification role during hot-issue markets.

We analyze a set of 651 European IPOs that occurred in the period 2002-2015, of which 151 are VC-backed and 500 are non-VC-backed. Our results support the theory that VCs certify the IPOs of the firms they back. Although we find no proof of VC certification on the level of IPO underpricing, both the OCI and the ability to engage the services of prestigious underwriters appear to be influenced in a beneficial manner by VC backing. In addition, we also find that VCs give up on their certification role in lowering the costs of issuance during hot-issue markets, but that they primarily attract higher-prestige underwriters during hot-issue periods.

This paper is structured as follows. Section II gives an overview of the VC industry and the existing literature on IPO underpricing and venture-capital certification. Section III presents our sample selection procedure. The methodology is presented in section IV. The empirical results are discussed in Section V. Finally, Section VI summarizes the conclusions.

II. Background

This paper investigates VC certification for European IPOs and how the relation between VCs and IPO underpricing, the true cost of issuance, and underwriter prestige changes during hot-issue markets. This section reviews the related literature on the venture-capital industry, the IPO underpricing phenomenon, the opportunity cost of issuance, hot-issue markets, and the impact of VC-backing in general.

The Venture-capital industry

Dolvin (2005) uses the following definition of venture capitalists: “*Venture capitalists can be defined as specialized organizations that pool funds from high net worth individuals or organizations and subsequently invest those funds in smaller, high-growth, information-problematic firms. In exchange for this investment, venture capitalists generally receive some form of equity ownership.*”

Why do firms engage the services of a venture capitalist? The answer covers many angles. Firms backed by VCs are young, entrepreneurial, and information problematic¹. Therefore, they have little access to sources of external financing (Dolvin, 2005). The uncertainty and high information asymmetry that characterizes such firms makes external financing risky and, thus, costly. VCs scrutinize potential investment targets and monitor their investments closely. Accordingly, the presence of a VC can reduce information asymmetries and alleviate financial constraints. This facilitates additional external financing. Venture capitalists thus fill up a gap in the financing industry and play a major role in the development of young, often innovative firms. They are primarily a source of funding, but as they are active investors, they

¹ Information-problematic firms experience significant information asymmetries with their stakeholders and external parties. Information asymmetries occur when there is a discrepancy in the information that is available to different parties in a transaction.

provide value-adding services as well (Chemmanur & Chen, 2014; de Bettignies & Brander, 2007). They often take a seat on the board of directors, mentor founders, facilitate additional fundraising, recruit management, and provide strategic inputs (Da Rin et al., 2011; Gorman & Sahlman, 1989; Sahlman, 1990). This way, they actively influence the development of their portfolio firms. Venture capitalists also tend to concentrate their investments in a limited number of industries. This allows them to build a network, identify potential targets and limit risks (Dolvin, 2005). These industries are typically innovative, high-growth sectors, focused on high-end technology such as software, information technology, biotechnology, life sciences, and sustainable energy (Da Rin et al, 2011; Lee & Wahal, 2004). Often, partners and associates in venture-capital funds have considerable experience in those industries. They bring along market expertise and an extensive network of managers, suppliers and customers for their portfolio firms to tap into (Dolvin, 2005). This creates a relationship that benefits both parties.

Venture capital remains a niche form of investment. Da Rin et al. (2011) conduct a survey of earlier VC research. They find that in the U.S.A., only 0.11% of new companies founded between 1985 and 2010 received venture-capital financing. In the late 1990s, more specifically, this percentage increased to 0.22% (Puri & Zarutskie, 2012). Other studies in the U.S. market report that less than 1% of start-ups receive venture-capital financing (Robb & Reedy, 2012) and that 2% of equity financing of small businesses is provided by venture capitalists (Berger & Udell, 1998). Concerning the European market, Berger & Schaeck (2011) report that 6% of small businesses in their survey obtained VC financing. In terms of quantity, the relative importance of VC financing is marginal, but the VC industry is gaining importance in Europe (Bottazzi et al., 2004). However, VC-backed IPOs account for 35% of all IPOs in the U.S.A. between 1980 and 2005 (Ritter, 2011). We have no data on the fraction of European IPOs that are VC-backed.

Ultimately, a VC seeks a return on investment for its partners. Once the firm has grown to a certain stage, the VC typically exits in order to collect the return and reinvest the funds in new ventures. The most common exit strategies are: taking the venture public through an IPO, acquisition by another company, repurchase of shares, sale of shares to another external investor, reorganization of the company, and liquidation of assets (Gladstone, 1989). The latter occurs in the event of failure. The most profitable and therefore preferred way of exiting is the IPO (Dolvin, 2005). Barry et al. (1990) report that 35% of VC exits in their sample took place in the form of an IPO. Of these, 96% were profitable. Acquisition by another company was the second most common way of exiting and accounted for 22% of the exit strategies in their sample. Only 59% of these exits were profitable. Black & Gilson (1998) find that the average return for exit via an IPO is 60%, whereas this is only 15% for acquisitions. In this paper, we focus entirely on exit through an IPO. Typically, VCs retain most of their shares until some time after the offering in order to prevent negative signaling towards outside investors. Often, a VC is contractually obligated to retain its shares during a 'lock-up period' of several months. Thus, the real exit of the VC only occurs some time after the IPO.

Compared to the U.S.A., the VC industry in Europe is relatively young and only experienced its first boom in the late 1990s. Nevertheless, European VCs do not appear to behave very differently from their American counterparts. They also carry out monitoring activities and regularly take board seats in their portfolio companies. Investments are also diversified across high-technology industries, similar to the ones targeted by American VCs (Bottazzi et al., 2004). There are, however, some particularities distinctive of the European venture-capital market. It is smaller and less volatile than in the U.S.A. (Megginson, 2004) and European VCs monitor less than their U.S. counterparts (Schwienbacher, 2005). In the beginning of the millennium, investments mostly stayed within Western Europe, but nowadays the European VC market is more internationally oriented than the U.S. market and the number of cross-

border investments has been increasing (Bottazi et al., 2004). Cross-Atlantic integration has not yet been established in the VC industry, although there have already been some examples (Megginson, 2004). The 2014 European Private Equity Activity report of the EVCA² confirms that this is still the case. See Figure 1 for a geographic breakdown of VC fundraising in Europe (EVCA, 2015).

The European VC market, although relatively integrated across borders, consists of different national markets, which are subject to different local regulations. While in the U.S.A., most of the VC-backed IPOs become listed on NASDAQ, Europe has several national stock markets for high-growth firms. For example, there is the ‘Neuer Markt’ in Germany, the ‘Euro.NM’ in Belgium, the ‘Nouveau Marché’ in France, and the ‘Nuovo Mercato’ in Italy. The IPO process differs significantly between these countries (Giudici & Roosenboom, 2004). For instance, an important particularity in the German market is that commitments made by investors in the book-building period are legally binding. As a consequence, revisions of the initial price range³ seldom occur and IPOs are never priced above the preliminary price range (Aussenegg et al., 2002). Such institutional differences may have an impact on the pricing of IPOs and, therefore, on IPO underpricing as well. We come back to the effects of these differences below.

The importance of the European VC industry has fluctuated over time. The evolution of the European private equity (PE) fundraising amount is shown in Figure 2. The amount of funds raised and invested by the European PE industry rose steadily until 2006. Particularly, the amount of raised funds peaked to an unprecedented high. PE funds raised and invested plummeted in 2009. In 2011, pre-2005 levels were reached again.

² European Private Equity and Venture Capital Association

³ When filing an IPO, a company must register with the Securities and Exchange Commission (SEC). In the IPO prospectus, the company provides a range of prices within which it expects to take the issue to the market (Lowry & Schwert, 2004). This price range is developed by the underwriter of the IPO.

Figure 1 The European VC industry: Sources of fundraising anno 2014 (EVCA, 2015)

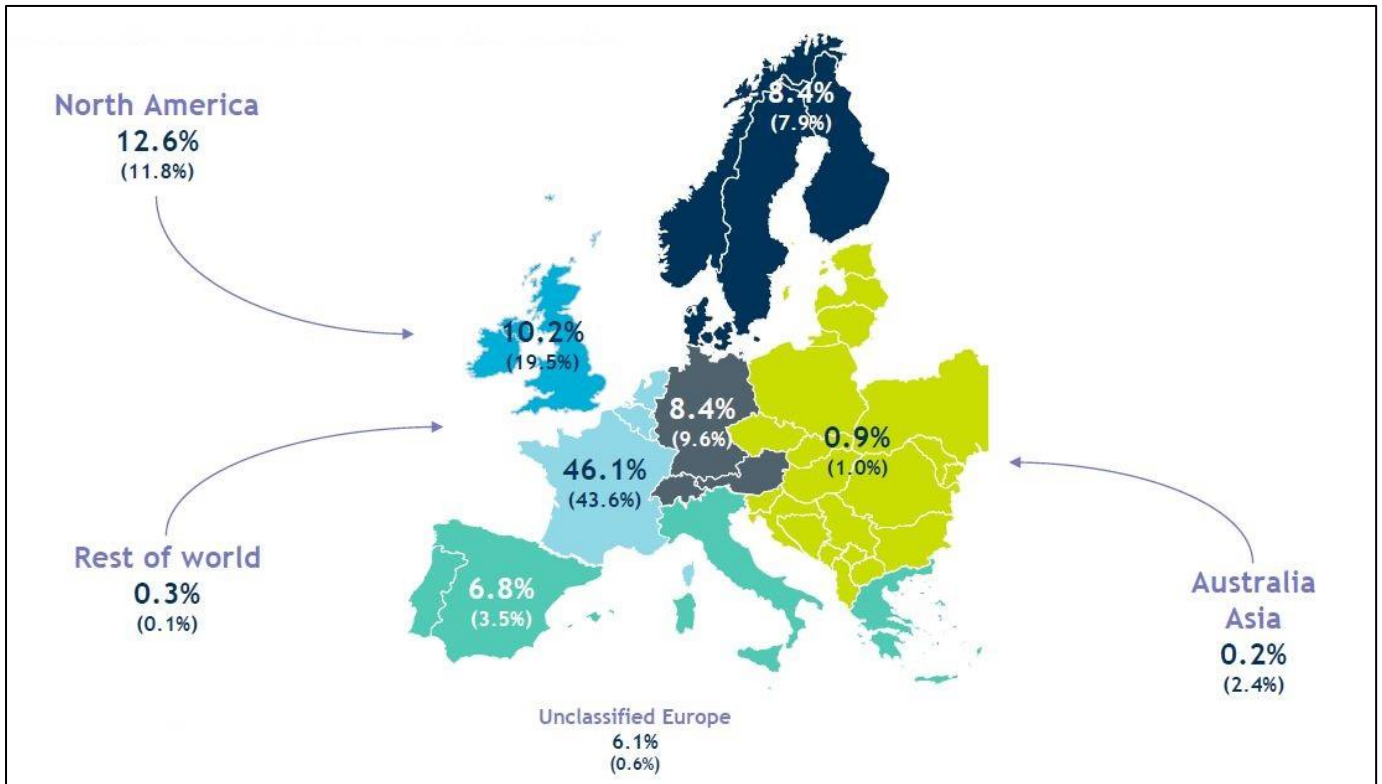
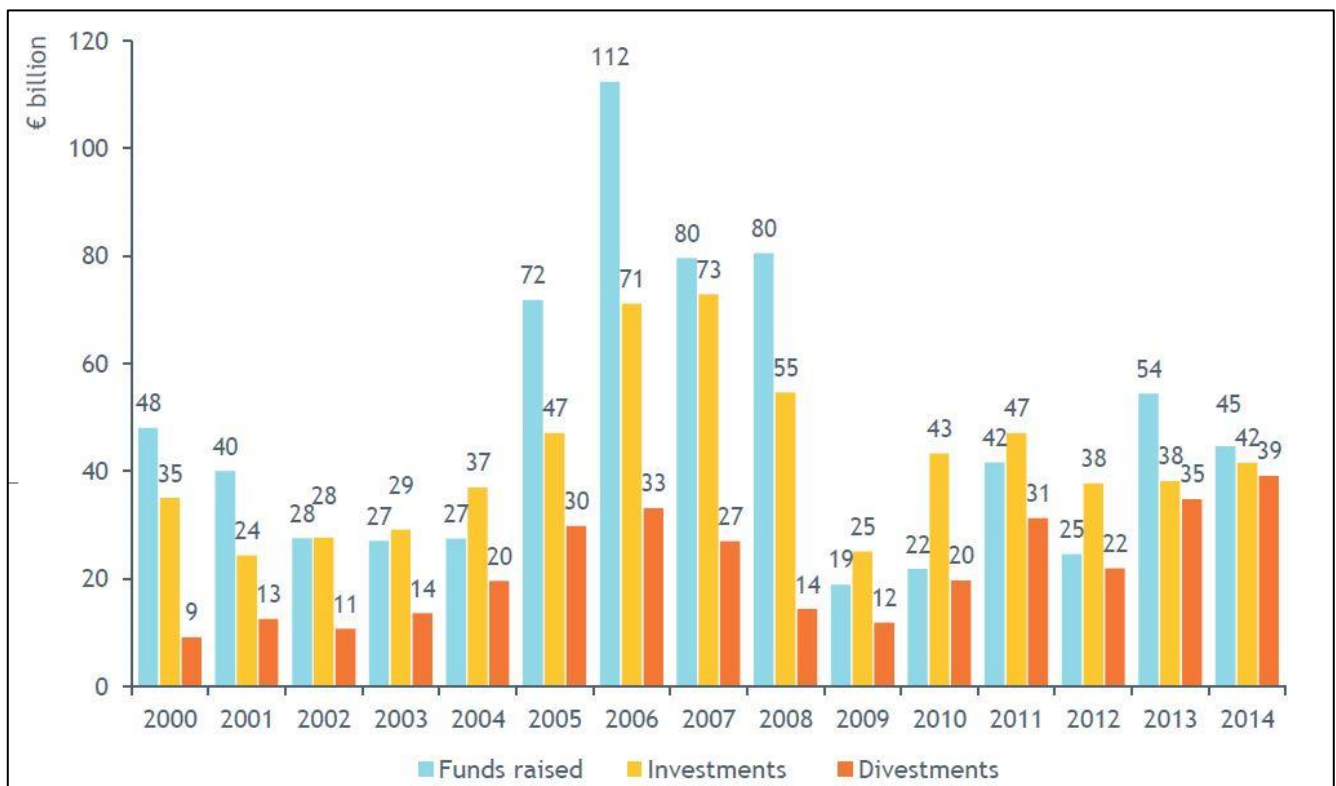


Figure 2 The European PE industry: Fundraising (EVCA, 2015)



Except for a poor year 2012, European PE industry has maintained its level since 2011. Specifically, VC funds raised €4.1 billion in 2014. This meant a decrease of 12% compared to 2013. Overall, venture capital the accounts for 9% of the total annual PE fundraising. The level of investments has been relatively stable over the last five years (EVCA, 2015). The evolution of venture-capital investment is shown in Figure 3.

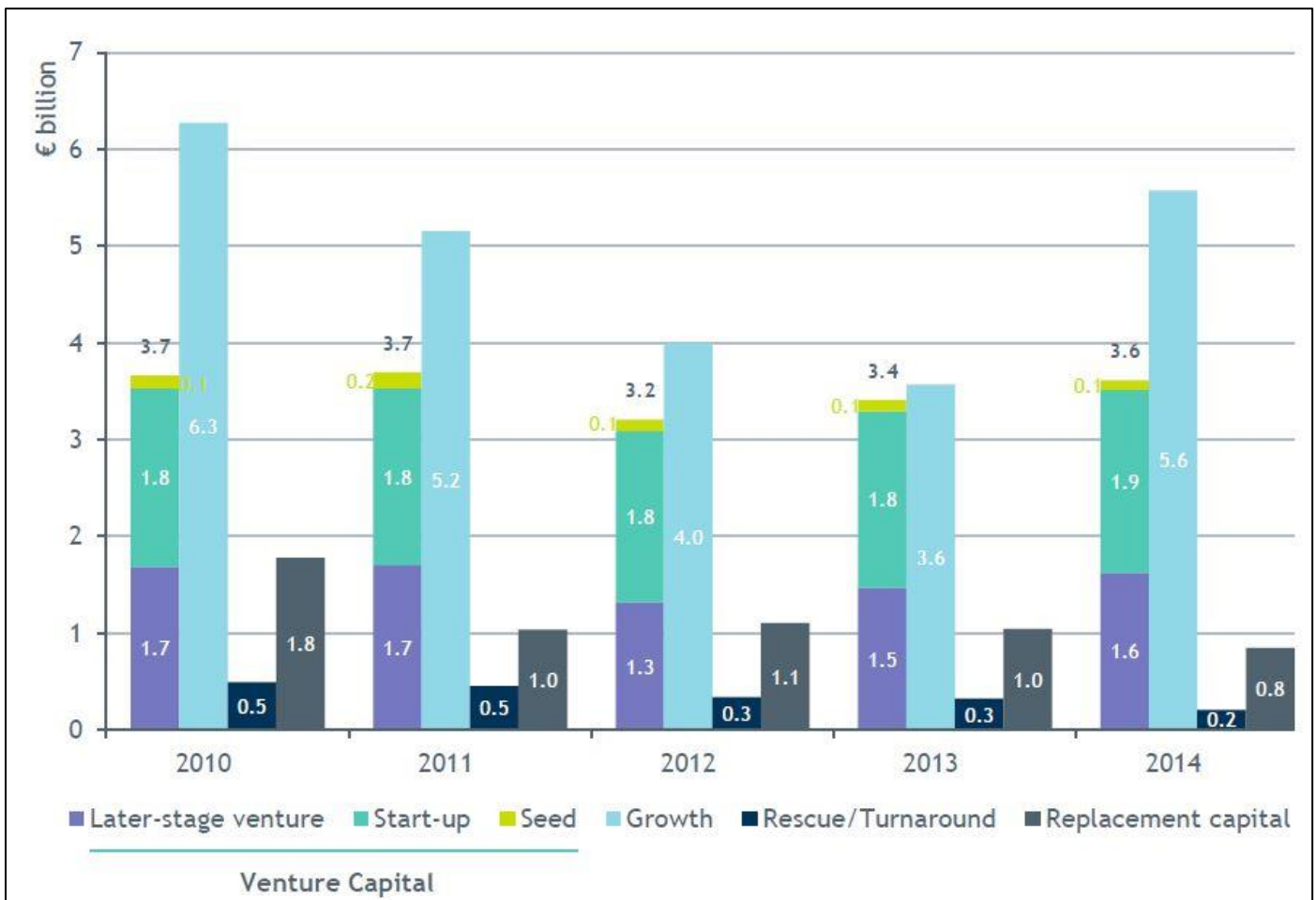
IPO underpricing

Next, we discuss the ‘IPO underpricing’ phenomenon, as we hypothesize that IPO underpricing is reduced by the presence of venture-capital investment. As mentioned above, the preferred exit strategy for a VC is an IPO. IPO underpricing is a phenomenon that occurs during such an IPO and is extensively dealt with in the academic literature⁴. IPO underpricing is the difference between the offer price and the price that a share is worth intrinsically. First-day returns (initial returns) are commonly used in the literature as a proxy for IPO underpricing and both terms are used interchangeably. The degree of IPO underpricing varies from year to year and from market to market. In the U.S.A., it steadily rose from the ‘70s onwards, peaking during the internet bubble of the late ‘90s, after which it declined again (Ljungqvist et al., 2006). IPO underpricing can be seen as a transfer of wealth from the pre-IPO shareholders of the issuing firm to the outside investors, or as a cost that companies bear when they go public (Gompers, 1996; Griffin et al., 2007; Muscarella & Vetsuypens, 1989; Ritter, 1987).

The IPO underpricing phenomenon has been examined extensively, but the literature has of yet been unable to provide a conclusive explanation for its occurrence. Discussing all of the different theories exceeds the scope of this paper. Nonetheless, of specific interest to our

⁴ Logue (1973), Ibbotson (1975) and Reilly (1977) were among the first in the literature to document IPO underpricing.

Figure 3 VC industry: Investments (EVCA, 2015)



paper are the theories based on information asymmetries. These assume that certain external investors, or the issuing firm, are better informed than the external investors. IPO underpricing then originates as a means of attracting investors to the IPO (Ljungqvist, 2007).

In this regard, Rock (1986) introduces the winner's curse theory: informed investors are more knowledgeable about the intrinsic value of shares offered than uninformed investors. The informed investors only bid in attractive IPOs, whereas the uninformed investors also invest in unattractive IPOs. The 'winner's curse' imposed on the uninformed investors implies that they receive all the shares they bid for in unattractive offerings, whereas they are partly crowded out of the market by the informed investors whilst bidding for attractive offerings. Subsequently, uninformed investors obtain below-average returns. In the extreme case, the uninformed investors are completely crowded out of attractive offerings and only obtain

shares in overpriced IPOs. Due to subsequent losses, they refrain from participating in the IPO market in the future. Despite that, Rock (1986) assumes that their presence in the market is necessary as there are not enough informed investors to meet the supply of attractive IPOs. In order to entice the uninformed investors into the market, their expected returns must be non-negative. For this reason, *ex ante*, all IPOs are expected to be underpriced. An extension to this theory, formulated by Ritter (1984), is that the degree of uncertainty about the true value of the firm defines how high the IPO underpricing must be. The greater this uncertainty, the greater the winner's curse problem and, hence, the greater the IPO underpricing must be.

During an IPO, the issuing firm makes use of an underwriter. This is a financial services entity that is enlisted to administer the offering procedure and to distribute the securities to investors. In return for a commission, the underwriter purchases the issued shares at a predetermined price and sells them to interested investors. The offer price for this sale is decided upon during a procedure called 'book-building'. When a firm issues new shares, the demand for shares is uncertain. If some investors are better informed than either other investors or the company (Rock, 1986), collecting information becomes one of the key tasks of an underwriter. The underwriter uses book-building to elicit indications of interest from investors. The investors make commitments to buy shares at a certain price and, thus, the underwriter extracts information on their willingness to pay for an offered share. However, informed investors are not very keen on revealing their private information, as they know that this may lead to a higher offer price and, as a consequence, a lower return. Benveniste & Spindt (1989) model how investment bankers use indications of interest from their client investors to determine the offer price and to allocate new offerings in a book-building procedure. The process is modeled as an auction, constructed by the underwriter to extract private information. Voluntary IPO underpricing is granted to compensate the disclosure of this information: when the underwriter learns that an issue is in high demand, the offer price is

raised, but not to the full market value. In other words, the underwriter only partially adjusts the offer price to the private information. The difference that remains is IPO underpricing, which is a rent to the investor who provides the information and a cost to the issuer. This theory is known as the information-extraction or partial-adjustment theory. Consistent with this theory, Weiss- Hanley (1993) finds that the offerings with upward price range revisions are the ones that are the most underpriced at their offering. The partial-adjustment theory also leads to a hot-issue markets theory, which we discuss below.

Another assumption is that the issuing firm, rather than certain external investors, is more informed about its intrinsic value. Welch (1989) formulates a signaling theory, stating that high-quality issuers underprice their offerings deliberately to distinguish themselves from low-quality issuers. The ‘signal’ is the offer price. Post-IPO, the issuers can then recollect the cost of the IPO underpricing in future issuing activity, because, by then, outside investors have obtained enough information to be certain that the shares are indeed of high quality. Low-quality issuers have the incentive to mimic the actions of their higher-end counterparts, but they risk being unmasked by investors in a later stage. They are then not able to recuperate the cost of IPO underpricing in subsequent offerings. Therefore, they will refrain from doing so. In consequence, the adverse selection to which uninformed investors are prone is alleviated.

Information asymmetry can also lead to an information disparity between the issuer and the underwriter. In this case, the relationship between the two can be seen as a principal-agent relation, where the issuer is the principal and the underwriter is the agent (Baron, 1982). Underwriting fees are typically proportional to IPO proceeds, and thus inversely related to IPO underpricing. This provides a countervailing incentive to keep IPO underpricing low (Ljungqvist, 2007). Despite that, it is plausible that the underwriting bank’s private benefits of IPO underpricing greatly exceed the implied loss of underwriting fees (Loughran & Ritter,

2002). For instance, it has been documented that underwriters receive side payments from investors in return for the allocation of underpriced shares. Also, underwriters might allocate underpriced stock to executive managers in companies, in the hope of gaining future investment banking business, a practice known as ‘spinning’. The spinning theory is discussed more extensively below. Brief, the underwriter may have an interest to deliberately underprice the issue. Once again, with higher uncertainty about the value of the firm, the information asymmetry between issuer, underwriter, and external investors is greater. Accordingly, the role of the underwriter becomes more valuable, which results in greater IPO underpricing. Empirical observations support this theory. IPO underpricing and proxies for uncertainty are positively related to each other (Ritter, 1984).

The papers mentioned above form the fundamentals of the IPO underpricing theory and are based on the assumption of information asymmetries. It is generally accepted in the literature that these theories at least partly explain the IPO underpricing phenomenon, even though more recent theories based on institutional, control, and behavioral arguments exist as well.

The question arises how IPO underpricing is affected by the presence of a venture capitalist. This paper investigates which of the traditional as well as the more recent theories on the matter hold true in a set of recent European IPOs. Specifically, we hypothesize that because of venture-capital certification, VC-backed IPOs are less underpriced than non-VC-backed ones. Moreover, we test whether this relation changes during hot-issue markets.

The impact of venture-capital backing

Early research: VC certification and Screening & Monitoring

The extensive academic research on IPO underpricing includes a body of work that focuses on the role of venture capitalists in the capital-formation process. The screening and monitoring hypothesis and the venture-capital certification theory are both products of that

research. The former suggests that venture capitalists only invest in qualitative companies, after thorough screening, and subsequently bring superior expertise and monitoring to their portfolio companies. This increases the operating performance of their portfolio firms. According to the VC certification theory, VCs are able to signal that quality to outside investors and other external parties by investing their reputational capital in their portfolio firms, thereby reducing uncertainty about share value during an IPO. Ultimately, both roles complement one another and are hypothesized to raise the offer price investors are willing to pay. Hence, they reduce the degree of IPO underpricing in VC-backed IPOs. This idea has both been supported and rejected throughout the relevant literature. As of today, no conclusive consensus has been reached. Our paper contributes to this ongoing debate by investigating the impact of VC-backing on a set of recent European IPOs.

Pioneering the literature on the impact of VCs in IPOs, Barry et al. (1990) examine a set of 438 VC-backed IPOs between 1978 and 1987, and compare them to a control sample of 1123 non-VC-backed IPOs. Evidence is found that VCs participate actively in their portfolio firms and monitor them. First of all, VCs appear to specialize in a limited number of industries, which is consistent with the claim that VCs invest in industries in which their expertise is greatest. Therefore they are able to carefully screen the firms they invest in. Furthermore, they hold concentrated equity positions in their portfolio firms and regularly serve on the board of directors. This allows them to play a valuable monitoring role.

Besides screening and monitoring, the venture-capital certification theory states that VC-backed IPOs should be less underpriced than non-VC-backed ones, because VC-backing certifies the quality of the firm going public to uninformed investors. These are then prepared to pay a higher offer price, which leads to reduced IPO underpricing, as compared to IPOs without VC-backing. Examining the influence of underwriters on the pricing of new offerings, Booth & Smith (1986) first introduced the underwriter-certification hypothesis:

given an information asymmetry between corporate insiders and external investors, the underwriter certifies that the issue price reflects all available and relevant inside information and that it is consistent with the true value of the firm's future earnings prospects. The underwriter thus acts as a third party, which reassures the prospective investors about the quality of the issued equity. This reassurance stems from the fact that the underwriter, by committing to the IPO, invests its reputational capital in the issue. A fair and successful outcome is in the underwriter's own best interest. If such an outcome is not attained, this could hurt the underwriter's future business⁵ (Carter & Manaster, 1990). VCs can influence the information asymmetry between insiders and external investors in a similar manner. The VC then certifies the quality of the firms that it has invested in.

Meggison & Weiss (1991) also conduct some of the earliest research on the impact of VC-backing in IPOs and find evidence for such venture-capital certification. Their results show that venture capitalists manage to convey additional information to that provided by the underwriter, or at least that they confirm the underwriter's signaling role. Meggison & Weiss construct a sample of 320 VC-backed and non-VC-backed IPOs that took place in the U.S.A. between 1983 and 1987, matched by industry and offering size. Similar to underwriter certification, there needs to be reputational capital at stake in order for a VC to credibly convince outside investors of its information advantage and certification role. Meggison & Weiss (1991) find that the effects of both screening and monitoring, as well as certification appear to be recognized by the capital markets. This manifests itself in the observation that VC-backed IPOs are associated with higher-quality underwriters and auditors, and that these IPOs are also more invested in by large institutional investors. On average, VC-backed firms

⁵ Carter & Manaster (1990) confirm this hypothesis and take it further by claiming that higher-quality and higher-prestige underwriters are associated with greater certification. With regards to this, they distinguish the factors that determine underwriter reputation and construct an underwriter ranking that assigns a higher score to more prestigious underwriters.

are underwritten by underwriters who underwrite a significantly larger percentage of the IPO market as lead underwriter and who are involved in a larger number of issues. Compared to non-VC-backed firms, the IPOs of VC-backed firms are, thus, underwritten by higher-quality underwriters. This is confirmed by several authors who use the Carter & Manaster (1990) underwriter ranks as an indicator for underwriter quality (Barry et al., 1990; Bradley & Jordan, 2002; Chemmanur & Loutskina, 2006; Lee & Wahal, 2004). Besides the screening and monitoring and certification argument, this is also attributed to the fact that VCs are able to build relationships with these parties because of their repeated activity in the IPO market. Our paper tests for this form of VC certification by examining the effect that VC-backing has on underwriter quality. We use Migliorati & Vismara's (2014) alternative for the Carter & Manaster (1990) underwriter rank. Migliorati & Vismara remark that, in contrast to the integrated U.S. IPO market, European markets are individual domestic markets with only limited cross-border integration. Consequently, many European underwriters are specialized and highly reputable in their respective home markets, but are hardly active abroad. Therefore, 67.5% of all European underwriters do not figure on the widely-used Carter & Manaster (1990) underwriter rank list. The use of Carter-Manaster ranks in European IPO research thus results in biased samples that only include large international underwriters.

A mechanism that strengthens VC certification toward outside investors is that VCs retain a larger portion of their shares than insiders in non-VC-backed IPOs (Barry et al., 1990; Megginson & Weiss, 1991). In an IPO insiders are usually subjected to a 'lock-up period'⁶, which is often contractually fixed. During the lock-up period, they are prohibited to sell shares. By retaining shares after the IPO, the VC signals its belief in the firm's prospects. In

⁶ The lock-up period is typically around 180 days, during which insiders are not allowed to sell their shares. It is a commitment device designed to alleviate the information asymmetry with outside investors (Brav & Gompers, 2003). Venture capitalists are looking to liquidate their investment in the short to medium term. They have an incentive to reduce the time of the lock-up period. VCs generally sell large parts of their shares at the expiration of the lock-up period (Field & Hanka, 2001).

the sample of Megginson & Weiss, only 43.3% of the VCs sell any shares in the IPO, with the median VC selling no shares at all. For this reason, the credibility of the information provided by the VCs is enhanced by the fact that they are major shareholders before and remain major shareholders after the IPO.

Finally, the impact of VC-backing through screening, monitoring, and certification should manifest itself in reducing the IPO underpricing of IPOs. Barry et al. (1990) report a negative influence of VC-backing on IPO underpricing. First-day returns are regressed against proxies for monitoring quality, such as the number of involved VCs, the duration of the presence of the VC, the age of the VC, and the fraction of the equity owned by the VC. The results indicate that better monitoring quality leads to lower IPO underpricing, thereby supporting the hypotheses described above. In their sample, Megginson & Weiss (1991) observe lower IPO underpricing in VC-backed IPOs as compared to non-VC-backed IPOs. They find an average initial return for VC-backed IPOs of 7.1% as compared to 11.9% for non-VC-backed IPOs. The difference is statistically significant. Moreover, the average gross spread⁷ as a percentage of the offer price is also significantly lower for VC-backed firms than for non-VC-backed firms. This means that the two components of the costs of going public are lower for VC-backed IPOs: the indirect cost of IPO underpricing and the direct costs, such as underwriter compensation, auditor and legal expenses. Therefore, net proceeds of an issue are larger for VC-backed firms.

To conclude, early research finds support for the screening, monitoring and certification roles of VCs in IPOs. We base ourselves largely on this pioneering work to examine recent European IPOs for signs of venture-capital certification and hypothesize that VC-backing reduces IPO underpricing and is associated with higher quality underwriters.

⁷ Gross spread is the cost associated with the IPO process and includes underwriter and auditor compensation, legal costs, etc.

Later research: alternative hypotheses

As mentioned earlier, the academic literature on the effect of VC-backing on IPO underpricing is rather inconsistent. Later research namely finds little support for the venture-capital screening, monitoring, and certification hypotheses or even completely rejects them. Some studies find no significant difference in IPO underpricing between VC-backed and non-VC-backed IPOs, while others attribute the difference to other factors than VC-backing.

Amongst those studies that do not find evidence for VC certification, Francis & Hasan (2001) question the VC certification theory. They dig deeper into the underlying components of IPO underpricing, by distinguishing factors in the premarket (pre-offering) or in the aftermarket (post-offering). Francis & Hasan argue that if the certification theory is true, VC-backed IPOs should be characterized by less deliberate IPO underpricing in the premarket than non-VC-backed IPOs. Deliberate IPO underpricing refers to the underpricing, which insiders intentionally cause. The remainder of the first-day return is determined by aftermarket factors, such as underwriter price support⁸. Using a sample of 845 U.S. IPOs between 1990 and 1993, Francis & Hasan (2001) estimate the maximum price that can be set for an IPO, with the information available in the premarket period. They use a stochastic frontier estimator to determine this price⁹. The estimation for both VC-backed⁹ and non-VC-backed premarket IPO underpricing is then compared with the initial aftermarket return, in order to identify whether the source of the difference in IPO underpricing lies in premarket or in aftermarket factors. Francis & Hasan (2001) first find that VC-backed IPOs have higher initial returns than non-

⁸ Part of the contract between issuer and underwriter is that the underwriter is committed to interfere in the market after the IPO if the share price falls below the IPO price in a specified period of time after the offering. The underwriter commits to buy shares in order to keep the stock price at a minimum level. Providing price support is thus costly for the underwriter (Derrien, 2005; Francis & Hasan, 2001).

⁹ A point on the stochastic frontier represents the maximum price that would prevail for a given IPO if all parties had full information. The difference between any given offer price and the estimated maximum price would then be the result of random error alone. There would be no systematic IPO underpricing, and the frontier price could be computed using OLS. If there is deliberate IPO underpricing, there is a systematic one-sided error. This error will appear in the form of skewness in the residuals (Francis & Hasan, 2001).

VC-backed IPOs, which is at odds with the VC certification theory. Second, the degree of deliberate premarket IPO underpricing appears to be significantly higher for VC-backed IPOs than for non-VC-backed IPOs. This suggests that the more severe IPO underpricing in VC-backed IPOs is caused in the premarket, which contrasts the VC certification hypothesis. Their interpretation of the results is that the higher degree of IPO underpricing is deliberately induced as a means of compensation to investors in the premarket.

Likewise, Bradley & Jordan (2002) initially find that VC-backed firms are generally associated with significantly higher levels of IPO underpricing. They examine a sample of 3325 IPOs between 1990 and 1999. However, after controlling for industry and underwriter quality effects, the VC dummy in their regression becomes insignificant. VCs tend to concentrate in industries with relatively large IPO underpricing. In these industries, there appears to be no difference between the IPO underpricing of VC-backed and non-VC-backed offerings. Their results indicate that the presence of a venture capitalist seems meaningless in predicting the level of IPO underpricing. Rather, the quality of the underwriter and especially the firm's industry appear to be of importance.

Smart & Zutter (2000) find the age of the VC to be of significant influence. They also find average initial returns of VC-backed IPOs to be higher than those of non-VC-backed offerings. They attribute this to the fact that in their examination period, the number of VCs in the industry increases. This lowers the average age of the VCs. The association between higher IPO underpricing and younger VCs is consistent with the grandstanding hypothesis formulated by Gompers (1996). The grandstanding hypothesis says: "*Young venture-capital firms take companies public earlier than older venture-capital firms in order to establish a reputation and successfully raise capital for new funds.*" Establishing a reputation is critical to the success of future fundraising. As taking a company public signals the venture capitalist's quality, VCs are willing to bear the cost of higher IPO underpricing. Therefore, younger VCs

have a tendency to ‘grandstand’ by taking their portfolio firms public earlier and at a larger discount. Fundraising is less of a problem for older VC firms because their reputation is already more established. As a result, companies backed by young venture capitalists are younger and more underpriced at their IPO than those backed by established VCs (Gompers, 1996). Smart & Zutter (2000) suggest that the increasing tendency among VCs to ‘grandstand’ may cause increasingly higher degrees of IPO underpricing in VC-backed IPOs compared to non-VC-backed IPOs.

In turn, Lee & Wahal (2004) observe greater IPO underpricing in VC-backed IPOs than in comparable non-VC-backed IPOs in their sample from 1980 until 2000, after controlling for endogeneity in the receipt of VC funding. Venture-capital investment does not occur randomly, but is the result of a choice by the venture capitalist. This means that, inherently, VC-backed and non-VC-backed firms have certain non-random differentiating characteristics. For instance, VC-backed IPOs show significant clustering across both industry and geographical dimensions. Lee & Wahal argue that, consequently, a selection bias may occur. This bias distorts inferences made using traditional research methodologies. Using matching methods to account for this bias, they find very different results than the previous research on data from 1980-2000. They find that the average first-day return of VC-backed IPOs is larger than that of non-VC-backed IPOs, and use the grandstanding hypothesis (Gompers, 1996) to explain this finding. The theory holds up with Lee & Wahal’s (2004) findings, because the age and experience of a VC are inversely related to IPO underpricing in their regression. Nonetheless, the methodology of Lee & Wahal exceeds the scope of this paper.

Explaining the irregularities in the literature

Chemmanur & Loutskina: the market power hypothesis

Chemmanur & Loutskina (2006) shed new light on the conflicting results within the literature. They suggest a new perspective on the debate and use a different methodology. According to their research, three economic roles of a venture capitalist exist when taking portfolio firms public. Besides the ‘screening and monitoring’ theory (Barry et al., 1990) and the VC certification hypothesis (Megginson & Weiss, 1991), the paper introduces a third role: *“The market power hypothesis captures the notion that venture capitalists develop long-term relationships with various participants in the IPO market (underwriters, institutional investors and analysts) due to their role as powerful repeated players in that market. These relationships enable them to attract great participation by these market players in the IPOs of firms backed by them, thus obtaining a higher price for the equity of these firms. Venture capitalists may be motivated to obtain a higher valuation for the IPOs of firms backed by them, due to concern for the reputation with their own venture fund investors and entrepreneurs.”* The market power hypothesis implies that a VC’s objective is to obtain the highest possible offer price for the IPO firm, rather than the price closest to the firm’s intrinsic value. In this respect, the market-power hypothesis differs from the certification hypothesis. Furthermore, Chemmanur & Loutskina (2006) argue that IPO underpricing may not be an appropriate way to measure the economic roles of VC-backing in IPOs. Initial returns simply reflect the difference between the IPO offer price and the first-day closing price of a firm’s stock. For it to be a meaningful measure, the assumption is made that the closing price on the first day of trading is not affected by VC-backing and that it equals the intrinsic value of that stock. If that assumption is violated, IPO underpricing is no longer a meaningful way to distinguish the different economic roles of a VC in an IPO. Instead, Chemmanur & Loutskina (2006) propose four new measures: first, the ratio of the offer price to the intrinsic value of a

firm's share, second, the ratio of the closing price to the intrinsic value of a firm's share. Both are measures of the certification hypothesis as well as the market-power theory. The third measure concerns the involvement of other key market players in IPOs. These key players are institutional investors, underwriters, and analysts. The degree of their involvement is a measure of a VC's market power. The specific variables studied are underwriter reputation, analyst coverage, and the fraction of equity sold to institutional investors. Lastly, the operating performance of the firm post-IPO is a measure of firm quality. The specific results of Chemmanur & Loutskina (2006) are outside the scope of this paper. However, they strongly support the market power hypothesis, weakly support the screening and monitoring role, and reject the VC certification theory.

Dolvin: the opportunity cost of issuance

Dolvin (2005) also tries to uncover the cause of the irregularities in the literature and puts forward yet another new insight. He examines a set of 4606 IPOs over the period between 1986 and 2000. Dolvin & Jordan (2004) claim that the traditional academic literature has mistakenly been estimating the cost of issuance by measuring the initial return on the offer price. They state that underpricing correctly measures the return to the investors in the IPO, but that it does not accurately reflect the opportunity cost of going public. Because of underpricing, pre-existing shareholders suffer from dilution in the value of their shares. Dolvin & Jordan claim that the dilution they experience may be smaller than suggested by the level of the initial return. They find that high levels of underpricing are associated with high levels of share retention by pre-existing investors. With higher share retention, much of the cost of underpricing is offset, because in absolute terms there is less money left on the table¹⁰.

¹⁰ Traditionally, money left on the table is calculated as: Number of shares sold x difference between the closing price on the first day of trading and the offer price. (Loughran & Ritter, 2002)

Rather than underpricing, the relevant indirect cost of the IPO to the issuing firm, is money left on the table relative to pre-existing shareholder wealth (Barry, 1989). Dolvin & Jordan (2004) define the true opportunity cost of issuance as money left on the table relative to pre-existing shareholder wealth, and demonstrate that the initial return can be seen as the product of the opportunity cost of issuance and economic overhang. Money left on the table (*MLOT*) is defined as follows:

$$MLOT \equiv N_o(P_1 - OP) \equiv N_{o,s}(P_b - OP) + (N_b - N_{o,s})(P_b - P_1)$$

Where OP is the offer price, P_1 is the first-day closing price, P_b is the equity value per share before the offering, N_o is the number of shares offered, $N_{o,s}$ is the number of secondary shares¹¹ sold in the IPO, and N_b is the number of shares prior to the offer. So money left on the table is the sum of two components: the total opportunity cost to selling shareholders, which they incur because they sell shares at a price below their potential market value, and the total value dilution suffered by shareholders who retain their shares.

In accordance with Barry (1989), Dolvin & Jordan (2004) define the pre-IPO equity value per share as follows:

$$P_b = P_1 + \frac{N_{o,p}(P_1 - OP)}{N_b}$$

Where $N_{o,p}$ is the number of primary shares offered. As defined above, the opportunity cost of issuance (OCI) is the money left on the table relative to the total pre-existing shareholder value (E):

$$OCI = \frac{MLOT}{E} = \frac{N_o(P_1 - OP)}{P_b N_b}$$

¹¹ Primary shares are newly issued shares in the IPO that did not exist before the offering. Secondary shares on the other hand are shares that were already in the hands of pre-existing shareholders before the IPO, but are also sold at the time of offering.

Substituting for P_b yields the explicit formula for estimating the OCI:

$$OCI = \frac{N_o(P_1 - OP)}{P_1N_a - N_{o,p}OP}$$

Where N_a is the sum of N_b and $N_{o,p}$, the total number of shares after the IPO. Dolvin & Jordan (2004) decompose the OCI into two components: IPO underpricing and the offering size as a percentage of pre-existing shareholder wealth:

$$OCI = \left[\frac{N_o(P_1 - OP)}{N_oOP} \right] \times \left[\frac{N_oOP}{P_1N_a - N_{o,p}OP} \right]$$

This last equation can be rearranged as follows, showing that the initial return as a proxy for IPO underpricing can be decomposed into two components:

$$Initial\ Return = \frac{P_1 - OP}{OP} = \left[\frac{N_o(P_1 - OP)}{P_1N_a - N_{o,p}OP} \right] \times \left[\frac{P_1N_a - N_{o,p}OP}{N_oOP} \right]$$

$$Initial\ Return = OCI \times EconOver$$

The economic overhang (*EconOver*) is a measure of the value of shares retained by the pre-existing owners of a firm before the IPO and is driven primarily by share overhang, which is defined as the ratio of shares retained to shares offered (Bradley & Jordan, 2002; Dolvin & Jordan, 2004). The true cost of issuance, or the opportunity cost of issuance (OCI), is defined as the true percentage wealth loss to pre-existing owners. This is the true money left on the table relative to pre-existing owners' equity value. The described decomposition shows that the initial return is irrelevant as a measure of the cost of going public, when share retention is high. Dolvin (2005) attributes the conflicting results in the existing literature to the observation that VCs are associated with greater share retention and that in the late 1990s, share retention strongly increased, compared to the 1980s and the early 1990s. This caused the relation between the opportunity cost of issuance and underpricing to become less transparent. Ljungqvist & Wilhelm (2003) also show that insiders, including VCs, sold fewer

shares in the IPOs that took place in the late 1990s. This led to higher levels of economic overhang and may have led to increased underpricing. For this reason, the rejection of the certification hypothesis during that period could be a mistake. Dolvin (2005) argues that VC certification results in a reduced aggregate issuance cost, but that this does not necessarily translate into lower underpricing. Dolvin's results indicate that VCs are associated with lower issuance costs, which suggests a valuable certification role. However, they are also associated with greater share retention, which creates a conflict with regards to IPO underpricing. This confirms Dolvin's suspicion of opposing dynamics in the underlying components of underpricing. Even so, these findings do suggest a valuable certification role, as most value may be created when issuance costs decrease, although underpricing increases. On top of this, Dolvin (2005) discovers that penny stocks (i.e. offerings with an offer price below \$5), are more susceptible to VC capital certification than other stocks. This is also confirmed in a more recent paper by Bradley et al. (2008). An explanation might be that penny stock IPOs are more information problematic, because they are usually smaller firms, which increases the potential for valuable VC certification (see above argument). We also investigate whether this is true for our sample. Our results concerning penny stock certification are presented under the robustness checks in Section V.

In this paper, we build forth on Dolvin's (2005) idea by calculating the true cost of issuance for our own sample and by examining the effects of VC-backing on this measure.

The influence of timing: hot-issue markets

The inconsistency in the academic literature regarding the impact of VC-backing on IPO underpricing first started in the early 2000s, when research began on IPO data from the 1990s. It became clear that these later studies did not confirm the results obtained by earlier research on data from the 1980s. This raised the question whether the changing circumstances and

dynamics specific to those periods may have influenced the degree of IPO underpricing and the underpricing difference between VC-backed and non-VC-backed IPOs. Dolvin (2005) suggests that changes in the underlying components of IPO underpricing are at the root of conflicting results from different time periods, but that overarching market mechanisms perhaps also play a role. This paper investigates whether there is a difference in the degree of IPO underpricing over different time periods in our sample. More specifically, we divide our sample into IPOs that took place in a hot-issue market and IPOs that did not take place in such markets.

Hot-issue markets are recognized in the literature as periods in time during which the number of IPOs increases dramatically and IPO underpricing rises (Rossetto, 2008). The existence of such periods was first documented by Ibbotson & Jaffe (1975) and later also by Ritter (1984) and Ibbotson & Ritter (1995). According to Loughran & Ritter (2004), the average first-day return on all IPOs was 7% in the 1980s. It doubled to almost 15% during 1990-1998, and surged to 65% during the internet bubble years of 1999-2000. Underpricing of VC-backed IPOs increased even more strongly during this period. In 2001-2003, the average initial returns on all IPOs reverted to 12%. In the early 1980s, such a booming market situation arose when conditions were extremely favorable for oil companies. This caused a large number of natural resources companies to go public (Ritter, 1984). The bubble years of 1998-2000, associated with a multitude of IPOs in Internet applications and new communication technology ventures, are another example of a hot-issue market.

Although there is enough evidence to prove the existence of market cyclicity, the question still remains what drives those hot-issue markets. Benveniste et al. (2002) and Lowry & Schwert (2002) suggest that information spillovers between firms from the same sector induce them to go public in the same period. They describe the following mechanism: first, the level of average initial returns in the market at the time of filing an IPO contains no information

about the eventual IPO underpricing. Because the lengthy registration periods of different IPOs overlap, the information acquired by underwriters in this period contributes to the first-day return. A high return in the IPO market is associated with positive information learned by the underwriter in the registration period. On the one hand, this causes initial returns to be serially correlated. On the other hand, high initial returns are a signal that companies can raise more money in an IPO than previously thought. Lowry & Schwert (2002) find a significant positive relation between initial returns and future IPO volume. They claim that initial returns are correlated with investor optimism arising in an industry.

The prospect theory (Loughran & Ritter, 2002) proposes another explanation. It states that issuers care more about the change in their wealth than about the absolute level of their wealth. In an issue, there is an upward price adjustment when positive information is acquired during the registration period. Upward price revisions are associated with higher IPO underpricing and more money left on the table (Bradley & Jordan, 2002). However, compared to the anticipated level of IPO proceeds, there is a net gain. Despite the higher dilution, pre-issue shareholders only remember the good news that their wealth is higher than expected. The prospect theory contends that initial returns can be predicted based on public information, which leads to a theory of hot-issue markets. Specifically, one firm's IPO provides information about industry prospects, which induces similar companies to go public soon thereafter.

Lowry (2003) finds that IPO volume fluctuations are related to the business cycle, which is intuitive. In addition, Rajan & Servaes (1997), and Ljungqvist et al. (2006) show that investor over-optimism drives IPO prices. This causes lower-quality firms to go public for opportunistic reasons in hot-issue periods.

Benveniste & Spindt (1989) describe the partial-adjustment theory for the expropriation of investor sentiment in the price setting by the underwriter of an offering. Underwriters face a

trade-off in setting the price of an IPO in the book-building period: by setting a higher price, they earn a higher compensation in the form of the underwriter spread, but they also face a higher potential cost of price support. If retail investors (noise traders) are bullish at the time of the offering, the underwriter anticipates their sentiment and sets price ranges aggressively. However, noise traders can also turn bearish over the price-support period. Cook et al. (2006) provide evidence that retail investors indeed drive prices. They find that initial returns decline when the average stock-purchase size in the IPO rises. Smaller purchase sizes show the presence of a larger percentage of retail investors, rather than institutional investors. The private information of noise traders, if positive, is partially incorporated into the IPO offer price. If the information is negative, it is more fully incorporated because underwriters try to avoid losses on overpriced issues (Lowry & Schwert, 2002). The upward adjustment is only partial because the underwriter is concerned about the performance of the stock price in the aftermarket and the potential for costly price support (Derrien, 2005). Indeed, as the difference in opinion between rational (institutional) and sentimental (retail) investors increases, both the offer price and the IPO underpricing increase (Ljungqvist et al., 2006). Moreover, if noise trader sentiment is bullish, all the firms in the industry appear to be overpriced in the long run, not only the offering firm (Derrien, 2005; Loughran & Ritter, 2004). Consequently, in hot-issue periods, valuations are high.

Aussenegg et al. (2002) show that partial-adjustment may also occur due to institutional factors. Therefore institutional differences between for example the U.S.A. and European countries may impact IPO underpricing over time.

Loughran & Ritter (2004) investigate another explanation for the variation of IPO underpricing over time: the changing issuer-objective hypothesis. This hypothesis consists in fact of two hypotheses: the analyst-lust hypothesis and the spinning hypothesis. In the 1980s, lead underwriters in IPOs competed on implied valuation. This led to the regular occurrence

of downward price revisions and low IPO underpricing. In the early 1990s, prestigious lead underwriters held on average larger IPO market shares, and their market power increased. More underwriter market power is associated with higher IPO underpricing. The analyst-lust hypothesis says that issuers place more importance on engaging an underwriter with highly-ranked financial analysts that will give extensive bullish analyst coverage on the firm, than on avoiding an underwriter with a reputation for high IPO underpricing. In the bubble years, as well as the initial post-bubble years, the market share of lead underwriters increased significantly further. Underwriters had higher market power and relaxed their standards. Hence, the analyst coverage preference was taken to an extreme, so issuers accepted very low valuations. However, analyst coverage cannot solely account for the extreme situations in the late 1990s. If issuing firms wanted to purchase analyst coverage, they could have obtained this by paying higher underwriter spreads rather than by leaving money on the table. Yet, observations show they left excessive amounts of money on the table.

The spinning hypothesis provides a possible explanation. In the early 1990s, underwriters set up personal brokerage accounts for VCs and for the executives of future issuing firms, in order to allocate IPO shares to them. Such allocations are a form of side payments, meant to influence the choice of lead underwriter. Such practice is known as ‘spinning’. By the end of the ‘90s, spinning had become common. Shares were now also allocated to ‘friends and family’ of the decision makers. Executives then had incentives to seek underwriters with a reputation for severe IPO underpricing, as this meant a substantial increase to their personal wealth. In turn, this allowed the underwriters to underprice even more and IPO underpricing fed on itself. In the post-bubble period, however, increased regulatory scrutiny reduced spinning dramatically (Loughran & Ritter, 2004) and underpricing decreased again.

In these bubble periods, VC-backed IPOs appear to be more underpriced than non-VC-backed IPOs (Coakley et al., 2009; Franzke, 2003; Rossetto, 2008). The IPO underpricing differential

between VC-backed and non-VC-backed IPOs surged to a level of 25.0 percentage points in the sample of Lee & Wahal (2004). Dolvin (2005) finds that the true opportunity cost of issuance was also higher for VC-backed IPOs than for non-VC-backed offerings. This means that the higher IPO underpricing is not only the result of a larger share overhang. Moreover, prestigious underwriters and VCs together brought poorer-quality issues to the market than non-VC-backed issues in bubble periods. These IPOs produced higher average proceeds, but also left more money on the table. All this indicates that during the 1998-2000 internet bubble, VCs ceased their certification role (Coakley et al., 2009).

Rossetto (2008) provides a different explanation for hot-issue markets by describing a model where an early-stage investor takes a venture public in order to raise funds for a new investment opportunity. This model is then based on the finding that in hot-issue periods, IPO volumes appear to be correlated with fundraising for entrance to new opportunities (Black & Gilson, 1998; Pástor & Veronesi, 2005). Rossetto's model shows that for a given value of the IPO firm, an increase in the profitability of the outside opportunity leads to the early-stage investor selling a larger fraction of shares at a lower offer price. In consequence, good investment prospects trigger hot-issue markets: early-stage investors take existing firms public, sell more shares at a lower price, and invest the proceeds in new ventures. This helps to understand the time variation of IPO underpricing. Later, as firms have been taken public, the most profitable opportunities are already exploited and the IPO underpricing tends to decrease again. Once the 'opportunity wave' has passed, fewer firms are taken public, fewer shares are sold, and IPOs are less underpriced once again. Rossetto (2008) remarks: *"The papers which find less IPO underpricing for VC-backed firms refer to periods of relatively stable markets or very long periods where the hot-issue markets are not investigated separately. The studies that find higher VC IPO underpricing instead focus on hot-issue market periods and find more IPO underpricing for VC-backed firms."*

Accordingly, this paper investigates whether the effect of VC-backing on IPO underpricing and on the opportunity cost of issuance changes in hot-issue markets.

European research

Although the impact of VC-backing on IPO underpricing has been extensively researched in the U.S.A., similar work remains scarce in the European IPO literature. We were unable to find any such research performed on a set of IPOs from various European countries. This may be attributable to the lower relative importance of the VC industry in Europe as compared to the U.S.A.

Among the few studies on the impact of VC-backing in European IPOs, Franzke (2003) investigates a sample of German IPOs on the Neuer Markt between 1997 and 2002. She does not find evidence for the VC certification hypothesis, as in her sample, VC-backed IPOs are characterized by higher initial returns than non-VC-backed IPOs and are thus more underpriced. A note that should be made is that her definition of VCs is not quite the same as in other academic literature, as she includes bridge- and turnaround financing as well. Also, the period of her research is limited to the period around the internet bubble. Elston & Yang (2010) find no significant difference either, in IPO underpricing between VC-backed and non-VC-backed IPOs on the German Neuer Markt between 1996 and 2001. They attribute this to the fact that VC financing has only emerged in Germany relatively recently. The role VCs play is a weaker, because there are fewer incentives to reduce information asymmetry arising from outside ownership in the German market. Hence, Elston & Yang (2010) do not find evidence supporting VC certification. On the other hand, Coakley et al. (2009) do find evidence for VC certification in the UK IPO market between 1985 and 2003, although they exclude the internet bubble period of 1998-2000.

Formulation of Hypotheses

It is clear that there is no consensus on the role of venture capitalists in the existing literature. In the U.S.A., early studies find evidence for VC certification, although this is contradicted by later research. The conflicting results are due to changes in the underlying factors of IPO underpricing, as well as the changing VC role in hot-issue markets. In Europe, literature on the topic is scarce. Our paper contributes to the existing literature by investigating VC certification in European IPOs and whether the role of VCs changes in hot-issue markets. We do so by examining a sample of European IPOs in the period 2002-2015. Based on the existing literature we formulate two hypotheses:

H1: VCs certify the IPOs they back, which results in lower IPO underpricing, a lower opportunity cost of issuance (OCI), and a higher-quality underwriter.

H2: During hot-issue markets, IPO underpricing & the true cost of issuance (OCI) increase and VCs give up on their certification role.

III. Sample selection

In order to test our hypotheses, we construct a sample of European IPOs that took place between January 2002 and October 2015. The sample consists of 151 VC-backed and 500 non-VC-backed IPOs. The data were extracted from the Zephyr, Amadeus, Datastream, and Eikon databases. We collected data on the offer price and the first-day closing price to calculate initial returns, percentage of shares offered in the IPO, the percentage of primary shares in the offer, the lead underwriter of the IPO, underwriter ranks, the stock exchanges on which the IPOs were listed, the returns of the relevant market indices for these exchanges, company-specific data including turnover and the number of employees in the year before the IPO, the date of incorporation in order to calculate the company's age at IPO, and industry classification by means of U.S. SIC codes. Concerning this last item, we opted for U.S. SIC codes instead of the European NACE codes for the simple reason that SIC codes were more easily available for our sample of IPOs.

In the Zephyr database, we extracted an initial sample of 7723 IPOs that took place in the EU-28 countries over the period from 1997 until October 2015. The sample included 819 European VC-backed IPOs, of which roughly 45% were completed, 50% were rumoured and the others were only announced. By conducting manual investigation of a selection of rumoured and announced records, we learned that these IPOs were halted before completion. Therefore, we removed them from our sample. The non-VC-backed IPOs were all categorized as completed. For each IPO, we extracted data on total deal value, percentage of shares offered and, if available, we also included pre-deal turnover and a business description from the Zephyr database.

We used the Amadeus database to gather further company-specific data. Because we only had access to the historical archives of the Amadeus database from 2002 onwards, we removed the entries from before 2002. After removing IPOs that took place before 2002, as well as

duplicate entries, the sample was reduced to 5088 completed IPOs, of which 306 were VC-backed.

We identified companies by means of the ‘BvD ID number’ that we obtained from Zephyr. We subsequently constructed subgroups of the IPOs in our sample, based on the year in which they occurred. For offerings conducted in the period 2006-2015, the operating revenue and the number of employees from the accounting year before the IPO were available in the current version of the Amadeus database. For IPOs that took place before 2006, we consulted the historical archives of the Amadeus database. We also made use of these historical archives to find the necessary data on firms whose BvD ID numbers were not recognized in the current version of Amadeus¹². For each company, the U.S. SIC industry classification code, the date of incorporation, and the ISIN identification number were extracted as well.

Overall we found data in Amadeus on 266 VC-backed IPOs, of which three had no ISIN code, and on 2832 non-VC-backed IPOs, of which ten had no ISIN code. However, many of these observations included missing values for certain variables. Therefore, we supplemented these missing values with data from Zephyr, Datastream, and Eikon. For example, operating revenue was available for just over 70% of the companies found in Amadeus. We used ISIN codes to identify the firms in Datastream, in order to gather supplementary data on turnover in the year before IPO. For the remaining missing values, we used pre-deal turnover data from Zephyr.

Similarly, we used Eikon and Datastream to fill the missing values for the date of incorporation that we extracted from Amadeus. Using the date of incorporation, we calculated the company’s age at IPO. This way, we were able to increase the number of companies, for which the age at IPO is known, to over 3000, representing approximately 65% of the original

¹²We suspect that the Amadeus database deletes data on firms in the event of bankruptcy or takeover.

Zephyr sample. However, 20% of the companies in our sample appeared to have existed for less than one year at the time of IPO, which seems unlikely. After manually investigating a subsample of these companies, we learned that these records were predominantly incorrect. Consequently, we excluded companies with an age of zero from our sample. We also manually investigated the subsample of companies that were one year old at the time of IPO. As it appeared that the largest part of this subsample was correct, we retained all companies with an age greater than or equal to one.

We also noticed that the SIC codes from Amadeus contained multiple errors. When breaking down the VC-backed sample by industry, roughly 26% was categorized as a holding or a provider of investment services. However, when manually comparing SIC codes with Zephyr business descriptions, we noticed that many codes were incorrect. We therefore used the SIC codes gathered in Datastream, rather than those from Amadeus.

The available ISIN codes were then also used in the Eikon database to gather data on the stock exchanges where our sample firms went public. Records of the listing exchange were available for approximately 65% of the IPOs. We used daily total returns on the price index associated with the respective exchange, as a proxy for market returns. The market return on the IPO date was then subtracted from initial returns to calculate the abnormal return, consistent with the market-adjusted model known from event study methodology (Weston et al., 2014). We come back to the calculation of abnormal returns in Section IV.

For IPOs for which no listing exchange data were available, we assumed that the relevant market return was the return of the index associated with the exchange on which most other IPOs from the same country were listed. Based on Eikon data for the IPOs in our sample, we identified the main stock exchange per country. Based on the country of origin of the IPO company, we assigned the main listing exchange to the IPOs, for which no such data were available. Furthermore, some market indices lacked data for certain periods during which

some of our sample IPOs took place. In that case, the return on the Financial Times Stock Exchange 100 Index was used to calculate the abnormal return.

In order to calculate initial returns, we initially used the Zephyr data on ‘stock price after completion’ and offer price. However, when inspecting the calculated initial returns, many of the resulting values appeared to be unrealistic. Using Zephyr data, roughly 10% of the sample showed values for returns exceeding 500%, leading to average abnormal and initial returns of over 800%. The mean initial returns in the U.S. sample of Megginson & Weiss (1991) are 7.1% and 11.9% for VC-backed and for non-VC-backed IPOs respectively. Using a more recent sample of U.K. IPOs, Coakley et al. (2009) find a mean IPO underpricing of 9.2% in the non-bubble years, and 16.9% in the bubble years 1998-2000. In the sample of Dolvin, the mean initial returns range from 7.12% to 114.15% for different time periods and subsamples. While the latter is already a very high average compared to the other mean values in the literature, the mean in our Zephyr-based sample was still a multiple of Dolvin’s highest average IPO underpricing value. Thus, using Zephyr data, we observed values for initial returns that are clearly inconsistent with the values in data samples of the existing literature.

For this reason, we used the Eikon database to manually collect data on the 1033 IPOs in our sample for which age, offered stake, pre-deal turnover, SIC industry code, and ISIN identification number were available. 668 of these IPOs were available in Eikon. We manually collected data on the offer price, first-day closing price, the percentage of primary shares offered, the lead underwriter and whether the IPO was priced within, above, or below the initial price range during the book building period. We also corrected the Zephyr records on the offered stake where necessary, as the Eikon database appeared to be more reliable. For approximately 20% of the IPOs found in Eikon, no first-day closing price was available. We used Datastream to fill in these missing values. However, the initial returns calculated using the records from Datastream showed a larger variance than those calculated using Eikon data.

Therefore, we eliminated the observations with a return that was higher than the maximum initial return found using Eikon data. Nonetheless, the sample showed some outliers, with three IPOs demonstrating initial returns higher than 100% and also three IPOs with initial returns lower than -80%. After winsorizing at 1%, the final sample was obtained. Our final sample consists of 651 IPOs, of which 151 are VC-backed.

Descriptive Statistics

Summary statistics for this sample can be found in Table 1, panel A. The mean initial return is 6.28% and the median is 4.04%. These values are consistent with the mean initial returns in the academic literature. The average and median abnormal return are 6.29% and 4.12% respectively. In Table 1 panel B, summary statistics are presented for the VC-backed and the non-VC-backed subsamples, respectively. To compare the means of the subsamples, we conduct a two-sample t-test with equal variances for all variables. The results can be found in Table 2.

The average VC-backed abnormal return is 5.63%. Concerning the non-VC-backed IPOs, the average abnormal return of 6.49% is slightly higher. Even so, Table 2 shows that the difference is not statistically significant. Similarly, VC-backed IPOs also have a lower average OCI, but the difference is not statistically significant either. The average percentage of shares offered in a VC-backed IPO is 41.80%, as compared to 30.40% for non-VC-backed IPOs. The difference of 11.40% is strongly significant. So, it appears that VC-backed companies conduct IPOs that are relatively larger in terms of offered stake. The VC-backed IPO firms in our sample are also larger in terms of average turnover, although the difference is not significant.

Table 1 Summary statistics**Panel A: Descriptive Statistics**

Variable	Obs	Mean	Std. Dev.	Min	Quantiles			Max
					0,25	Median	0,75	
<i>Initial_return</i>	651	6,28%	13,99%	-69,53%	-0,18%	4,04%	12,26%	56,45%
<i>Abnormal_return</i>	651	6,29%	14,01%	-69,85%	-0,45%	4,12%	12,51%	57,72%
<i>OCI</i>	651	2,51%	1,00%	-152,35%	0,00%	1,12%	4,27%	100,00%
<i>Econover</i>	651	90,65	680,36	-0,23	1,80	2,77	4,33	10.154,32
<i>Offered_stake</i>	651	33,05%	20,00%	0,00%	21,20%	30,08%	42,33%	100,00%
<i>Turnover</i>	651	2,46E+08	1,50E+09	4	2,30E+06	1,50E+07	1,10E+08	3,60E+10
<i>Age_at_IPO</i>	651	13,46	19,14	1	3	8	15	149
<i>Underwriter_rank</i>	651	0,44	0,28	0	0,23	0,44	0,60	1

Panel B: Descriptive Statistics per category

		AR	OCI	EconOver	Offered St.	Turnover	Age	UW Rank
<i>VC</i>	<i>Mean</i>	5,63%	2,13%	2,69	41,80%	2,85E+08	15,68	0,51
<i>Backed</i>	<i>St. Dev.</i>	14,28%	11,39%	2,08	18,42%	8,76E+08	23,62	0,26
151 Obs	<i>Min</i>	-63,15%	-61,14%	0,04	8,34%	4,00	1	0,00
	<i>Max</i>	50,87%	96,67%	13,55	100,00%	9,97E+09	136	1,00
<i>Non-VC</i>	<i>Mean</i>	6,49%	2,62%	117,21	30,40%	2,35E+08	12,79	0,42
<i>Backed</i>	<i>St. Dev.</i>	13,94%	16,62%	774,54	19,13%	1,68E+09	17,54	0,28
500 Obs	<i>Min</i>	-69,85%	-152,35%	-0,23	0,01%	58,00	1	0,00
	<i>Max</i>	56,72%	100,00%	10.154,32	100,00%	3,60E+10	149	1,00

The average age of the VC-backed companies in our sample is 15.68 years, which is nearly three years older than the average non-VC-backed firms. This is remarkable because, for example, in the sample of Megginson & Weiss (1991), the average age of VC-backed firms is four years lower than the average age of non-VC-backed firms. The difference in their sample is strongly significant. The age difference in our sample is not statistically significant, however. This could be an indication of a structural difference between the European and the U.S. venture-capital markets. For example, in Europe, VCs regularly invest in buyouts. Buyout firms are often older firms, which may cause the higher average age in our VC-backed sample. Lastly, the difference between mean underwriter ranks is statistically significant at

Table 2 t-test for differences in means

t-tests of differences in means						
Variable	VC-backed	non-VC-backed	Difference in means t-stat	Hot issue market	Cold and neutral issue market	Difference in means t-stat
<i>Abnormal_return</i>	5,63%	6,49%	0,66	8,04%	5,32%	-2,38***
<i>OCI</i>	2,13%	2,62%	0,34	1,98%	2,79%	0,64
<i>Econover</i>	2,69	117,21	1,82*	20,09	129,45	1,97**
<i>Offered_stake</i>	41,80%	30,40%	-6,47***	32,79%	33,19%	0,25
<i>Turnover</i>	2,85E+08	2,35E+08	-0,36	3,58E+08	1,85E+08	-1,38
<i>Age_at_IPO</i>	15,68	12,79	1,63	14,61	12,83	-1,13
<i>Underwriter_rank</i>	0,51	0,42	3,31***	0,47	0,43	-1,77*

* significant at the 10% level
** significant at the 5% level
*** significant at the 1% level

the 10% level. The average rank of underwriters in VC-backed IPOs is higher than in non-VC-backed IPOs. This is consistent with the venture-capital certification hypothesis (Megginson & Weiss, 1991) and the market-power hypothesis, as described in Section II. Comparing the IPOs that took place in hot-issue markets with IPOs taking place in cold- and neutral-issue markets, we see that there are also some significant differences in means. In hot-issue-market IPOs, average underwriter rank is higher than in other IPOs. The difference is statistically significant at the 10% level. This is consistent with the finding of Loughran & Ritter (2004), who found that market shares of prestigious underwriters increased in the bubble period of the late 1990s. In cold- and neutral-issue markets, the average economic overhang is higher than in hot-issue-markets. However, this large average economic overhang seems to be mainly due to some extremely high values. Lastly, the average abnormal return of 8.04% in hot-issue markets is higher than the average abnormal return of 5.32% in cold- and neutral-issue markets. The difference is statistically significant at the 1% level. This is consistent with the theory of hot-issue markets, which says that hot-issue markets are associated with a higher number of IPOs and higher underpricing.

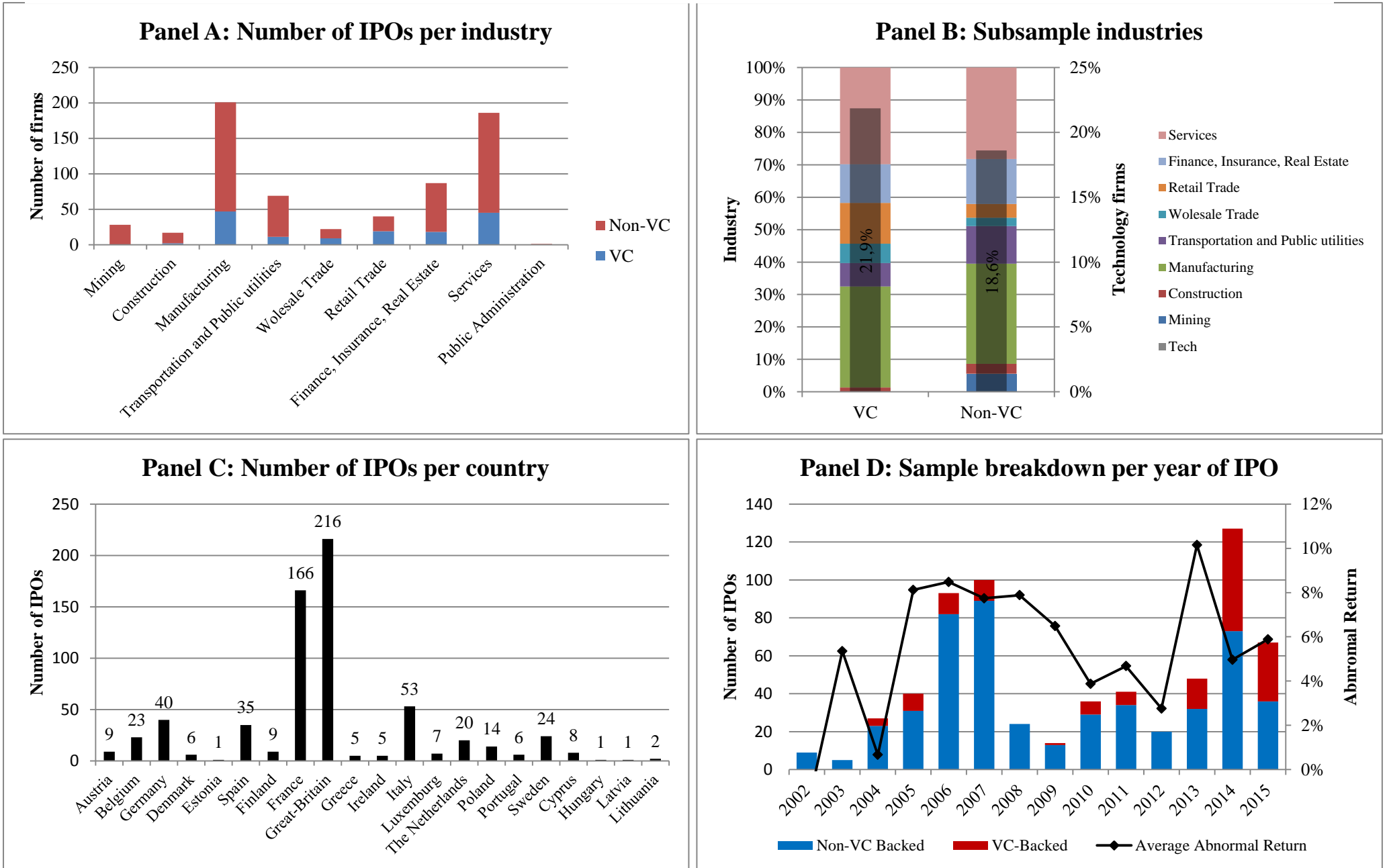
In Figure 4, the IPOs in our sample are broken down per industry, year of IPO, and country. Most IPOs in our sample are conducted by manufacturing and service firms. These are also the industries in which most VC-backed firms operate. Yet, when compared to non-VC-backed IPOs, VC-backed firms appear to be relatively more active in retail and wholesale trade, and less active in mining and construction. 21.9% of the VC-backed firms are active in high-technology sectors, as compared to 18.6% of the non-VC-backed firms in our sample. This is mildly consistent with the findings of Da Rin et al. (2011) and Lee & Wahal (2004), who show that venture capitalists tend to concentrate their investments in innovative sectors focused on high-end technology.

Our sample includes IPOs from 21 countries. The largest part of our sample consists of IPO firms from Great Britain and France. Together, these represent half of our sample.

Looking at the figures for the number of IPOs per year, we see that most of the IPOs in our sample occurred in the years 2006, 2007 and 2014. Based on our measure of market conditions, these years are indeed most frequently categorized as hot-issue markets. The years 2006 and 2007 are also widely considered as being “bubble” years.

We use quarterly average price-earnings and price-to-book multiples for each of the stock markets on which IPOs in our sample became listed, to determine whether the respective quarters were hot-, cold-, or neutral-issue markets. We discuss the methodology to label hot-issue markets more extensively in Section IV. In our sample, approximately 35% of all IPOs occurred in hot-issue periods, while 45% occurred in neutral-issue periods and the remaining 20% occurred in cold-issue periods. The hot-issue years in our sample seem to be preceded by high abnormal returns. This is consistent with the market cyclicity theory of Benveniste et al. (2002) and Lowry & Schwert (2002), as described above in Section II.

Figure 4 Descriptive Statistics



For 2008 and 2009, we have records of respectively zero and one VC-backed IPO in our sample. After a period of many IPOs in 2006 and 2007, the stock market crash of 2008 is obviously represented. We have no records of VC-backed IPOs in 2002 and 2003 either. This is probably due to inferior data quality in the early years of our sample, or may be attributable to shaky market conditions after the burst of the internet bubble in 2000. The situation may have been similar to the response to the stock market crash of 2008.

IV. Methodology

In order to test our hypotheses, we construct an OLS regression model and perform several multivariate analyses. In this section, we discuss the variables that are included in our regression model. Concretely, for the first hypothesis, we estimate the parameters of the following model:

$$Dependent = \alpha + \beta_1 VC_backed + \beta_2 Offered_stake + \beta_3 LnTurnover + \beta_4 LnAge + \beta_5 Tech + \beta_6 Underwriter_rank + \varepsilon$$

where:

Dependent is the dependent variable, being either the initial abnormal return (*AR*) as a proxy for IPO underpricing, or the true opportunity cost of issuance (*OCI*). In the traditional literature, simple initial returns are most often used as a proxy for IPO underpricing in OLS regressions (Barry et al., 1990; Megginson & Weiss, 1991). Even so, we believe that it is more correct to use abnormal initial returns, calculated in accordance with the “Market-adjusted return method” as described by Weston et al. (2014). According to the Market-adjusted return method, a firm’s expected return on a certain day in the event period is the return on the market index for that day:

$$\hat{R}_{jt} = R_{mt} \text{ for each company } j, \text{ listed on market } m, \text{ at day } t.$$

The initial abnormal return (AR_{jt}) is equal to the residual of the first-trading-day return:

$$AR_{jt} = r_{jt} = R_{jt} - \hat{R}_{jt} \text{ where } t = 1.$$

In our sample, the difference between simple initial returns and abnormal initial returns is only seldom higher than three percentage points, with a maximum of 5.5 percentage points. Therefore, we use the first-trading-day abnormal return as the first dependent variable of our regression.

As described earlier in Section II, Dolvin (2005) demonstrates that first-day returns are not the most appropriate measure to analyze VC certification. He argues that IPO underpricing is defined by two factors: the true (or opportunity) cost of issuance and the economic overhang. Economic overhang of VC-backed issues increased in the 1990s, which had an impact on the observed IPO underpricing and perhaps caused empirical studies to mistakenly reject the VC certification theory. Therefore, we use opportunity cost of issuance (OCI) as the second dependent variable in our regression. The venture-capital certification theory says that VC-backed IPOs should have a lower opportunity cost of issuance than non-VC-backed IPOs. We can adapt Dolvin's equation to calculate the opportunity cost of issuance (*OCI*) and economic overhang (*EconOver*) in the following way:

$$Initial\ Return = \frac{P_1 - OP}{OP} = \left[\frac{N_o(P_1 - OP)}{P_1 N_a - N_{o,p} OP} \right] \times \left[\frac{P_1 N_a - N_{o,p} OP}{N_o OP} \right] = OCI \times EconOver$$

Where *OP* is the offer price, P_1 is the first-day closing price, N_o is the number of shares offered, $N_{o,p}$ is the number of primary shares offered, and N_a is the total number of shares after the offer. After dividing both legs by N_a , *OCI* and *EconOver* can be calculated as follows:

$$OCI = \left[\frac{N_o(P_1 - OP)}{P_1 N_a - N_{o,p} OP} \right] = \left[\frac{\frac{N_o}{N_a}(P_1 - OP)}{P_1 \frac{N_a}{N_a} - \frac{N_{o,p}}{N_a} OP} \right] = \left[\frac{OS(P_1 - OP)}{P_1 - OS \times PS \times OP} \right]$$

$$EconOver = \left[\frac{P_1 N_a - N_{o,p} OP}{N_o OP} \right] = \left[\frac{P_1 \frac{N_a}{N_a} - \frac{N_{o,p}}{N_a} OP}{\frac{N_o}{N_a} OP} \right] = \left[\frac{P_1 - OS \times PS \times OP}{OS \times OP} \right]$$

Where *OS* is the offered stake, which equals N_o divided by N_a , and *PS* is the percentage of primary shares in the offer, which equals $N_{o,p}$ divided by N_o or, equivalently, $N_{o,p}$ divided by *OS* multiplied with N_a :

$$OS = \frac{N_o}{N_a}$$

$$PS = \frac{N_{o,p}}{N_o} = \frac{N_{o,p}}{OS \times N_a}$$

Accordingly, we estimate the regression model described above for two measures: the abnormal return and the opportunity cost of issuance.

To assess venture capitalist certification in terms of a firm's ability to attract higher-quality underwriters, we slightly adapt the previously described regression model:

$$\text{Underwriter_rank} = \alpha + \beta_1 \text{VC_backed} + \beta_2 \text{Offered_stake} + \beta_3 \text{LnTurnover} + \beta_4 \text{LnAge} + \beta_5 \text{Tech} + \varepsilon$$

The independent variables in our regressions consist primarily of a VC-backing dummy variable to test for the effect of VC backing, as well as several control variables that are commonly used throughout the existing literature. Concretely, we include the following independent variables:

1. *VC_backed*: a dummy variable indicating whether the offering is VC-backed. If venture capitalists perform a certification role, abnormal returns and OCI are expected to be lower for VC-backed IPOs (*VC_backed*=1) than for non-VC-backed IPOs (*VC_backed*=0) and underwriter rank is expected to be higher (Barry et al., 1990; Megginson & Weiss, 1991).
2. *Offered_stake*: although Megginson & Weiss (1991), Bradley & Jordan (2002), Lee & Wahal (2004), and Gompers (1996) use the natural logarithm of the offered amount to account for the offering size, we opt for a different measure. As can be seen in Table 3, which represents the correlation matrix of our regressions' variables, the offer size (*LnOffersize*) is strongly correlated with proxies for the company's size like, for example, pre-IPO turnover. We, however, want to model the effect of the relative importance of the offering size for each firm. This importance is best proxied by the offered stake, which is

the number of shares offered in the IPO divided by the number of all shares after the IPO. By using the percentage of shares offered in the IPO, we manage to isolate the company's size, as is shown in the equations below:

$$OfferSize = N_o \times OP$$

$$\text{Where: } N_o = N_a \times OS$$

$$\rightarrow OfferSize = N_a \times OS \times OP$$

$$\text{Where: } N_a \times OP = TFV$$

$$\rightarrow OfferSize = TFV \times OS$$

Where OP is the offer price, N_o is the number of shares offered, N_a is the total number of shares after the IPO, OS is the offered stake in percentage, and TFV is the total value of the firm at the time of the offer.

We expect the coefficient on the offered stake to be positive. Elston & Yang (2010) argue that a high percentage stake offered dilutes the percentage ownership and increases the risk of under-subscription. Thus, we expect the offered stake to have a positive effect on IPO underpricing.

3. *LnTurnover*: as a proxy for company size, we use the natural logarithm of one plus the pre-deal operating turnover. In our sample, VC-backed companies are on average larger than non-VC-backed ones, though the difference is not statistically significant, as can be seen in Table 2. Elston & Yang (2010) also incorporate a proxy for firm size in their analysis, although they use the log of market capitalization, which is calculated as the closing price multiplied by the number of shares outstanding. However, we suspect that this measure is subject to fluctuations in market-wide stock price valuation. Because our sample is collected over the period 2002-2015, it incorporates IPOs from the bubble years before 2008, and IPOs from the recent years after the crash. Stock price valuations have

fluctuated heavily over our sampling period. Moreover, the closing price is also used in the calculation of both of the dependent variables: AR and OCI. For these reasons, we prefer to opt for a firm's pre-IPO turnover as measure of firm size.

4. *LnAge*: this variable accounts for age differences. Consistent with Dolvin (2005), we use the natural logarithm of one plus the age of the IPO firm. Megginson & Weiss (1991) also incorporate age in their regressions, as they suspect that older firms experience less information asymmetry with external parties and that this has implications for the underpricing of their IPOs. VC-backed IPO firms in our sample are on average older than non-VC-backed firms. Hence, we expect this variable to be negatively associated to IPO underpricing and the OCI.
5. *Tech*: we use a dummy variable to control for industry differences. Using the SIC codes of our sample companies, we categorize them as technology firms (*Tech*=1) and others (*Tech*=0), as exemplified by Dolvin (2005) and Loughran & Ritter (2004). Tech firms are suspected to experience greater information asymmetries with external parties, as they more often count on intangible assets. Dolvin's results also show that high-technology issues have larger average share overhang, which can lead to higher IPO underpricing. To decide whether a firm is considered a technology firm or not, we used the SIC-codes classification on Jay Ritter's website (<http://bear.warrington.ufl.edu/>) in combination with Appendix D of his paper "Why has IPO underpricing changed over time?" (Loughran & Ritter, 2004). The classification can be found in Appendix A.
6. *Underwriter_rank*: Booth & Smith (1986) developed the underwriter-certification hypothesis and found empirical evidence supporting the theory. We expect that in our sample, IPOs underwritten by high-prestige underwriters are characterized by a lower AR and OCI. We also hypothesize that VC-backed IPOs are more often underwritten by higher-prestige underwriters than non-VC-backed IPOs. To correctly assess whether

venture capitalists perform a certification role, we choose to control for lead underwriter prestige. Consistent with the literature, we use underwriter ranks based on market share. Among others, Barry et al. (1990), Bradley & Jordan (2002), and Dolvin (2005) also control for underwriter rank in their regressions. In U.S. research, the Carter & Manaster (1990) underwriter rank is most often used as a proxy for underwriter prestige. As mentioned in Section II, the Carter & Manaster rank is not applicable in European research. It excludes smaller underwriters that account for 67.5% of the European IPO market. Moreover, the Carter & Manaster rank is based on underwriters' placement in IPO 'tombstone announcements'¹³. These tombstone announcements no longer exist in Europe (Migliorati & Vismara, 2014). Therefore, the Carter & Manaster rank is not an appropriate measure for European research. Migliorati & Vismara (2014) propose an alternative European underwriter rank, based on the number of companies taken public in a specific market. We primarily use this ranking, and supplement it with similar rank values for the prestigious international U.S. based underwrites that are not included in Migliorati & Vismara's ranking. To construct this supplementing rank, we use the sample of Corwin & Schultz (2005). This sample lists U.S. underwriters and includes the Carter & Manaster rank, as well as the number of IPOs an underwriter was involved in over the period 1997-2002. In order to calculate a ranking weighted on the number of IPOs that an underwriter was engaged in, we implement the method used by Migliorati & Vismara: for each underwriter in Corwin & Schultz's sample, we divide the number of companies it brought public by the maximum number of companies brought public by one underwriter in the U.S. market.

¹³ Tombstone announcements are deal - specific underwriting lists based upon the number of shares underwritten

Furthermore, we do not include interaction terms in our regression, as none of the interaction effects show a significant effect on the dependent variables and these interaction terms only introduce high correlations with other independent variables. We also do not include a variable that models the effects of price range adjustments, although this is commonly done throughout the literature (Bradley & Jordan, 2002; Benveniste & Spindt, 1989; Dolvin, 2005; Weiss-Hanley, 1993). As described in Section III, we collected data on the pricing relative to filing. However, only 8 of the 651 IPOs in our sample were priced above the initial price range and only 20 were priced below the filing range. Therefore, we do not incorporate this variable in our regression. In the U.S. IPO markets, upward adjustment appears to be much more common than in Europe. This could be due to institutional differences such as the difference between the German Neuer Markt, where pricing above the initial price range is not allowed, and NASDAQ, where upward adjustment and pricing above initial price range is common (Aussenegg et al., 2002).

In order to test our *second* hypothesis, we divide our sample in IPOs that took place during hot-issue markets and those that took place during cold- and neutral-issue markets. Based on this division, we add a supplementary variable to the previous regression models:

$$Dependent = \alpha + \beta_1 VC_backed + \beta_2 Offered_stake + \beta_3 LnTurnover + \beta_4 LnAge + \beta_5 Tech + \beta_6 Underwriter_rank + \beta_7 Hot_issue + \varepsilon$$

and

$$Underwriter_rank = \alpha + \beta_1 VC_backed + \beta_2 Offered_stake + \beta_3 LnTurnover + \beta_4 LnAge + \beta_5 Tech + \beta_6 Hot_issue + \varepsilon$$

7. *Hot_issue*: this variable accounts for the effect of the specific market conditions that occurred during the period in which the IPO took place. It is a dummy variable that equals one if the issue took place in what we define as a hot-issue market, and zero otherwise. We define hot-issue markets for each listing exchange individually, because European

markets witnessed IPO waves in different periods over the years 2002-2015. IPO waves occur during hot-issue markets, such as described in Section II, but sometimes IPO waves also occur due to opportunity shocks by institutional changes, such as entry to the European Union, for example. To correctly distinguish between hot-issue periods and other periods, we construct a measure for the ‘hotness’ of the market, based on the prevalent valuations at a certain point in time. As described more extensively in Section II, stock valuations are relatively high in hot-issue markets. These high valuations make it attractive for firms to conduct an IPO, because they imply higher IPO offer prices (Benveniste & Spindt, 1989; Cook et al., 2006; Lowry & Schwert, 2002). We collected data on the quarterly price-earnings (P/E) and price-to-book (P/B) multiples for each market index, as proxies for market valuation. We normalize the P/E and P/B multiples by dividing them by the average over the total time period. Subsequently, we construct an exchange-specific proxy for market valuation by taking the average of the normalized P/E and P/B multiple for each quarter on the respective stock exchange. We use this market valuation indicator to rank each quarter of the period 2002-2015. For each market individually, we define the tertile with the highest valuation proxies as a hot-issue market, while the second and third tertile are defined as neutral- and cold-issue markets, respectively. Based on the IPO date and the appropriate exchange, we assign each IPO in our sample to a cold-, neutral- or a hot-issue period. For some exchanges we have no data on the average P/E and P/B multiples of the earliest quarters. In that case, we categorize these quarters as being neutral-issue periods. Consequently, 30% of the quarters are deemed hot-issue periods and 40% neutral-issue periods. This, and institutional shocks to IPO deal flow, may be the reason why 45% of IPOs are categorized in neutral-issue periods, compared to 35% in hot-issue periods, which may seem counterintuitive, as one would expect that most IPOs would take place in hot-issue periods.

To test whether venture capitalists change their certification role in such a hot-issue market, we split up the full sample into two parts: offerings that took place during hot-issue markets and offerings that took place during cold- and neutral-issue markets. Then, we run the regressions used for our first hypothesis separately on both of these subsamples. This way, we investigate whether the VC-backing-dummy coefficient changes sign and, thus, whether we find support for the idea that VCs give up on their certification role during hot-issue markets.

Table 3 presents the correlations between the variables. Some of the variables have a correlation that is statistically significant at the 5% level. Yet, most of these correlation coefficients are low, with absolute values below 0.2. Some variables are slightly more correlated, with absolute values higher than 0.2: *Offered_stake* is the only variable that is mildly correlated with the dependent variable OCI. Higher percentages of shares offered are, hence, associated with a higher true cost of issuance. This is no surprise, as the percentage of shares offered determines the impact of the absolute value of IPO underpricing on the cost of issuance. In our adaptation of Dolvin's OCI, offered stake figures in the denominator, and offered stake multiplied with the fraction of primary shares figures negatively in the nominator. Therefore, it is only normal that *Offered_stake* and *OCI* are positively correlated. *LnOffersize* is the only independent variable that is mildly correlated with *Underwriter_rank*. The positive correlation suggests that IPOs with a larger offer size are more often underwritten by high-quality underwriters. Following the decomposition of the offer size as explained previously, offer size is determined by company size and offered stake. Further, the correlation between *Underwriter_rank* and offered stake is very low, and the correlation between *LnTurnover* and *Underwriter_rank* approaches the value of the correlation between *LnOffersize* and *Underwriter_rank*. As described above, *LnTurnover* is used as a proxy for firm size. Therefore, it seems that high-quality underwriters appear to conduct larger offerings mostly when the large deal size is due to the large size of the company.

Table 3 Correlation matrix

Correlation Matrix										
	<i>Abnormal return</i>	<i>OCI</i>	<i>Underwriter rank</i>	<i>VC_backed (=1)</i>	<i>LnOffer size</i>	<i>Offered stake</i>	<i>LnTurnover</i>	<i>LnAge</i>	<i>Tech (=1)</i>	<i>Hot_issue</i>
<i>Abnormal_return</i>	1,0000									
<i>OCI</i>	0,4651**	1,0000								
<i>Underwriter_rank</i>	-0,0033	-0,0376	1,0000							
<i>VC_backed (=1)</i>	-0,0259	-0,0133	0,1287**	1,0000						
<i>LnOffer size</i>	-0,0595	0,0354	0,2053**	0,3398**	1,0000					
<i>Offered stake</i>	-0,0215	0,3323**	0,0121	0,2462**	0,5017**	1,0000				
<i>LnTurnover</i>	0,0131	-0,0497	0,1636**	0,150**	0,4357**	0,1499**	1,0000			
<i>LnAge</i>	-0,0451	-0,0567	0,1239**	0,0466	0,1067**	-0,0654	0,2396**	1,0000		
<i>Tech (=1)</i>	-0,0087	-0,1092	-0,0380	0,0348	-0,0771	-0,0543	-0,0899**	-0,0519	1,0000	
<i>Hot_issue</i>	0,0210	-0,0001	0,0258	0,0836**	0,1728**	0,0861**	0,0690	0,0816**	-0,0179	1,0000

where:

Abnormal_return = variable constructed by adjusting the initial return (= first-day closing price/offer price-1) by the market return on that day

OCI = the opportunity or true cost of issuance of an IPO, as defined by Dolvin (2005)

Underwriter_rank = score assigned to the lead underwriter of the IPO based on Migliorati & Vismara (2014) and Corwin & Schultz (2005)

VC_backed = dummy variable equal to 1 if the issue is backed by a venture capitalist, zero otherwise

Offered stake = percentage of the issuing firm's equity that is offered

LnTurnover = natural logarithm of 1 plus the issuing firm's turnover

LnAge = natural logarithm of 1 plus the age of the issuing firm at IPO date.

Tech = dummy variable equal to 1 if the issuing firm is classified as a technology firm, zero otherwise, based on Loughran & Ritter (2004)

Hot_issue = dummy variable equal to 1 if issue takes place in a hot_issue market, zero otherwise

**significant at the 5% level

Data are from the Zephyr, Amadeus and Datastream databases for the 2002 to 2015 period.

LnOfferSize and *Offered_stake* are also positively correlated with VC-backing and the correlation of *LnTurnover* and *VC_backed* is significant as well. This supports the earlier finding that VC-backed IPOs are often larger than non-VC-backed IPOs, and that VC-backed firms in our sample are larger on average. Lastly, *LnTurnover* and *LnAge* are mildly and positively correlated as well. This is an indication for the intuitively plausible notion that older firms are often larger firms. Some other variables have higher correlations, with correlation coefficients higher than 0.4: The dependent variables *AR* and *OCI* are obviously correlated, as *OCI* is a factor of initial returns, and abnormal return is the initial return minus the market return. *LnOfferSize* is moderately correlated with *LnTurnover* and *Offered_stake*. As described above, this is the reason why we use *Offered_stake* rather than *LnOfferSize*. We want to control for the effects of firm size and the effects of offering size separately. The *Tech* variable is not significantly correlated to any other variable. Thus, in our sample, IPOs by high-technology firms do not appear to be VC-backed more often, which contradicts the findings of Da Rin et al. (2011) and Lee & Wahal (2004). The hot-issue market dummy is also only very mildly correlated with the other variables, though significantly so. Nonetheless, *Hot_issue* is slightly and positively correlated with *VC_backed*. This is a slight indication of the notion that VC-backed firms are taken public during hot-issue markets more often than non-VC-backed firms, which is visually illustrated in Figure 4. This notion was investigated and confirmed by Lerner (1994), who argues that established VCs appear to be particularly proficient at taking companies public near market peaks. Whether this is true in the European IPO markets exceeds the scope of this paper. *Hot_issue* also has a positive and statistically significant correlation with *LnOfferSize* and *Offered_stake*. For this reason, IPOs in hot-issue markets appear to be slightly larger offerings, mostly because of a higher percentage of shares offered, as the correlation with *LnTurnover* is not statistically significant.

We discuss the results of our multivariate analyses in the next section.

V.Results

In Table 2, the abnormal returns are compared for the VC-backed and the non-VC-backed sample. The mean abnormal return for VC-backed IPOs is 5.63%, compared to 6.49% for the non-VC-backed sample. Thus, IPO underpricing seems to be lower on average in the VC-backed sample, which is consistent with the VC certification hypothesis. However, the difference is small and is not statistically significant. To ascertain whether the VC-certification hypothesis holds true, further examinations are needed. Accordingly, we perform several ordinary-least-squares (OLS) regressions on our data samples, for each of the formulated hypotheses.

H1: VCs certify the IPOs they back, which results in lower IPO underpricing, a lower opportunity cost of issuance (OCI), and a higher-quality underwriter.

In order to test the first hypothesis, we run an OLS regression for each dependent variable against a VC-backed dummy variable, as well as the control variables described in Section IV. To investigate whether VC-backing results in lower IPO underpricing, we use abnormal returns on the first trading day after the IPO as dependent variable. We then run the same regression using the second measure of VC certification: the OCI, in accordance with Dolvin (2005). Third, we test whether VC certification manifests itself in higher underwriter quality. The results of these regressions can be found in Table 4, panel B.

Considering the first regression, with abnormal returns as the dependent variable, we find no support for VC certification. The VC-backing dummy appears to have no effect on IPO underpricing, as its coefficient is statistically insignificant. Furthermore, our entire regression model appears redundant, as none of the independent variables exhibit any significant coefficient. On top of this, an insignificant F-statistic and a low adjusted R-squared conclude that this regression model has little predictive value. We hereby find no support for the

Table 4 Regression Hypothesis 1

Panel A: Regression Description

This table presents OLS regression results for abnormal initial returns, true cost of issuance, and underwriter rank as follows:

$$Dependent = \alpha + \beta_1 VC_backed + \beta_2 Offered_stake + \beta_3 LnTurnover + \beta_4 LnAge + \beta_5 Tech + \beta_6 Underwriter_rank^* + \varepsilon$$

where:

Dependent = dependent variable, either underpricing (Abnormal return), true cost of issuance (OCI), or underwriter_rank (Underwriter_rank)

VC_backed = dummy variable equal to 1 if the issue is backed by a venture capitalist, zero otherwise

Offered_stake = percentage of the issuing firm's equity that is offered

LnTurnover = natural logarithm of 1 plus the issuing firm's turnover

LnAge = natural logarithm of 1 plus the age of the issuing firm at IPO date.

Tech = dummy variable equal to 1 if the issuing firm is classified as a technology firm, zero otherwise, based on Loughran & Ritter (2004)

Underwriter_rank = score assigned to the lead underwriter of the IPO, based on Migliorati & Vismara (2014) and Corwin & Schultz (2005)*

*when regressing on underwriter ranking, this variable is omitted as independent variable

Data is from the Zephyr, Amadeus, Datastream and Eikon databases for the 2002 to 2015 period.

Panel B: Regression Results

Indep. Variable	Abnormal_return		OCI		Underwriter_rank	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
<i>Intercept</i>	0.063	1.87	0.036	1.05	0.182	2.79***
<i>VC_backed (=1)</i>	-0.007	0.53	-0.030	2.13**	0.076	2.85***
<i>Offered_stake</i>	-0.018	0.61	0.287	9.42***	-0.045	0.78
<i>LnTurnover</i>	0.002	0.77	-0.005	2.44**	0.012	3.17***
<i>LnAge</i>	-0.008	1.32	-0.002	0.24	0.025	2.11**
<i>Tech (=1)</i>	-0.003	0.23	-0.038	2.62***	-0.020	0.72
<i>Underwriter_rank</i>	0.000	0.02	-0.010	0.49	/	/
<i>N° of obs</i>	651		651		651	
<i>F (5, 278)</i>	0,856		17,12***		6,34***	
<i>Adj. R²</i>	-0,0052		0.1295		0.0394	

* significant at the 10% level

** significant at the 5% level

*** significant at the 1% level

literature that reports lower IPO underpricing in VC-backed IPOs (Megginson & Weiss, 1991). This is consistent with more recent research. Most of these later studies, however, find support for the opposite effect: VC-backed IPOs are associated with more IPO underpricing than their non-VC-backed counterparts (Bradley & Jordan, 2002; Francis & Hasan, 2001; Lee & Wahal, 2004). Only one study shows results in line with our own. Elston and Yang (2010) find no significant effect of VC-backing on IPO underpricing in either direction in the German Neuer Markt.

It is possible that this first result confirms the notion that IPO underpricing is not a reflection of VC certification. As described above, Dolvin (2005) argues that an IPO's initial return might not be the right measure of indirect issuance costs and, in consequence, that venture-capital certification should be measured differently. Rather, he states that the true opportunity cost of issuance is a superior measure. We test his suggestion by running the previous regression, but instead, using the OCI as the dependent variable. Our results support Dolvin's theory and suggest that VC certification does indeed manifest itself in a lower opportunity cost of issuance, rather than in lower IPO underpricing. The VC-backing dummy in our regression has a negative influence on the OCI and is significant at the 5% level. Our model also yields several other interesting results. For example, the percentage of the firm's equity that is on offer (*Offered_stake*) appears to have a significant positive influence on the firm's true cost of issuance. Thus, firms that put a larger percentage of shares on offer in the IPO, appear to suffer a higher cost of issuance. This is in line with the findings of Elston and Yang (2010), who explain this finding as follows: a high offered stake dilutes the percentage ownership of the pre-existing owners and increases the risk of under-subscription. Hence, the higher cost of issuance. Further, *LnTurnover*, which is a proxy for a firm's size, appears to have a significant negative influence on OCI. This result is significant at the 5% level and suggests that larger firms are associated with a lower cost of issuance. Larger firms may

experience a lower cost of issuance, because they are less information-problematic than smaller firms. Literature supportive of this result includes Barry et al. (1990) and Francis & Hasan (2001). Next, we obtain a rather puzzling result. It appears that firms active in high-tech industries (*Tech*) are associated with a lower cost of issuance. This result is significant at the 1% level, but is in conflict with the existing literature (Bradley & Jordan, 2002; Dolvin, 2005). These studies argue that high-technology firms often have large intangible assets, which are associated with greater uncertainty about their value than tangible assets. Therefore, it is expected that these firms have to underprice their IPOs more, in order to compensate for the additional uncertainty faced by outside investors. Our results suggest that this is not the case in our sample. Lastly, both the variable representing the firm's age at IPO and lead underwriter rank, appear to have no significant relation to the OCI. The overall predictive power of this regression model is quantified by a highly significant F-statistic and an R-squared of around 13%, which shows that the model explains more of the variation in the OCI, than in abnormal returns.

As for our third regression, with the lead underwriter rank as the dependent variable, the results confirm the hypothesis that VC certification does indeed manifest itself in the ability to attract higher-quality underwriters. The VC-backing dummy is highly significant (1% level) and appears to positively influence the *Underwriter_rank*. Thus, this suggests that VC-backed firms manage to attract more prestigious, higher-quality underwriters when going public, which is consistent with results from earlier studies (Bradley & Jordan, 2002; Megginson & Weiss, 1991). The results also suggest that firm size (*LnTurnover*) and a firm's age at IPO (*LnAge*) have a significantly positive influence on a firm's ability to engage the services of a higher quality underwriter when going public. On the other hand, both the percentage of equity offered (*Offered_stake*) and the fact that a firm is active in a high-tech industry (*Tech*), appear to have no significant effect on *Underwriter_rank*. The overall model appears to be

relevant, as shown by a highly significant F-statistic. However, with an R-squared of only around 4%, its predictive power is rather low.

Although we find no support for the traditional theory of VC certification resulting in lower IPO underpricing, our results show that venture capitalists do appear to certify the IPOs they back, in the form of lower opportunity costs of issuance and the ability to engage the services of more prestigious underwriters. The following section discusses the results concerning our second hypothesis.

H2: During hot-issue markets, IPO underpricing & the true cost of issuance (OCI) increase and VCs give up on their certification role.

To test the second hypothesis, we first investigate whether the fact that an IPO takes place during a hot-issue market has an influence on IPO underpricing, on the true cost of issuance, and on the lead underwriter's rank. As described in Section IV, this is done by adding an extra dummy to the previous models, which equals one if the issue took place during a hot-issue market and zero otherwise (*Hot_issue*). The results of the regression can be found in Table 5, panel B. We also specifically test if the role of a VC changes between hot-issue markets and cold- or neutral-issue markets. We do this by splitting up our sample and running the regressions on both samples, as described in Section IV. The results can be found in panel B of Table 6, for hot-issue markets, and Table 7, for neutral- and cold-issue markets.

First of all, it appears that IPO underpricing (*Abnormal_return*) does not change in hot-issue markets. *Hot_issue* namely is insignificant in our first regression. The rest of the model also remains insignificant in predicting IPO underpricing. We must therefore reject part of our second hypothesis, which states that IPO underpricing increases during hot-issue markets. This result defies previous studies, which have found IPO underpricing to significantly increase in hot-issue markets (Coakley et al., 2009; Franzke, 2003; Rossetto, 2008).

Table 5 Regression Hypothesis 2a: The influence of hot-issue markets

Panel A: Regression Description

This table presents OLS regression results for abnormal initial returns, true cost of issuance, and underwriter rank as follows:

$$\text{Dependent} = \alpha + \beta_1 \text{VC_backed} + \beta_2 \text{Offered_stake} + \beta_3 \text{LnTurnover} + \beta_4 \text{LnAge} + \beta_5 \text{Tech} + \beta_6 \text{Underwriter_rank}^* + \beta_7 \text{Hot_issue} + \varepsilon$$

where:

Dependent = dependent variable, either underpricing (Abnormal return), true cost of issuance (OCI), or underwriter_rank (Underwriter_rank)

VC_backed = dummy variable equal to 1 if the issue is backed by a venture capitalist, zero otherwise

Offered_stake = percentage of the issuing firm's equity that is offered

LnTurnover = natural logarithm of 1 plus the issuing firm's turnover

LnAge = natural logarithm of 1 plus the age of the issuing firm at IPO date.

Tech = dummy variable equal to 1 if the issuing firm is classified as a technology firm, zero otherwise, based on Loughran & Ritter (2004)

Underwriter_rank = score assigned to the lead underwriter of the IPO, based on Migliorati & Vismara (2014) and Corwin & Schultz (2005)*

Hot_issue = dummy variable equal to 1 if the issue takes place in a hot-issue market, zero otherwise

*when regressing on underwriter ranking, this variable is omitted as independent variable

Data is from the Zephyr, Amadeus, Datastream and Eikon databases for the 2002 to 2015 period.

Panel B: Regression Results

Indep. Variable	Abnormal_return		OCI		Underwriter_rank	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
<i>Intercept</i>	-0,008	-0,57	-0,030	-2,10**	0,076	2,84***
<i>VC_backed (=1)</i>	-0,019	-0,65	0,288	9,42***	-0,045	-0,78
<i>Offered_stake</i>	0,002	0,75	-0,005	-2,43**	0,012	3,16***
<i>LnTurnover</i>	-0,008	-1,36	-0,001	-0,21	0,025	2,10**
<i>LnAge</i>	-0,003	-0,23	-0,038	-2,62***	-0,020	-0,71
<i>Tech (=1)</i>	0,000	0,02	-0,010	-0,49	/	/
<i>Underwriter_rank</i>	0,009	0,69	-0,007	-0,50	0,002	0,07
<i>Hot_issue</i>	0,057	1,65	0,040	1,13	0,181	2,69***
<i>N° of obs</i>	651		651		651	
<i>F (5, 278)</i>	0,44		14,69***		5,28***	
<i>Adj. R²</i>	0,0050		0,1258		0,0380	

* significant at the 10% level

** significant at the 5% level

*** significant at the 1% level

Moreover, when running our regression on IPO underpricing separately for hot-issue IPOs and cold- or neutral-issue IPOs, we discover that VCs do not appear to certify the issues they back in terms of IPO underpricing for either of the two sub-samples. The IPO underpricing regression model shows no significance in both cases. This again contradicts our first hypothesis and the existing literature, which suggest that VCs only give up on their certification role during hot-issue markets (Lee & Wahal, 2003; Loughran & Ritter, 2004). Again, the overall relevance and predictive power of our model appears to be very low, as is shown by an insignificant F-statistic and an extremely low R-squared.

Second, the OCI of a firm's IPO does not seem to fluctuate between market cycles. We derive this from the result that, in our second regression, adding the hot-issue dummy (*Hot_issue*) has no significant effect. This result can be seen in Table 5, panel B. The estimates of our different independent variables remain the same and the extra dummy variable appears to have no significant influence on the OCI. Moreover, the F-statistic remains highly significant, while the R-squared remains around 13%. This rejects our hypothesis that the OCI increases during hot-issue markets, and is in line with Dolvin (2005). Dolvin namely uses this result to support the claim that, although IPO underpricing did increase during the 1998-2000 bubble period, the underlying component that truly reflects the cost of issuance did not. The higher IPO underpricing found by research of IPOs in bubble periods, is, therefore, mainly attributable to higher economic overhang. This may explain the contrasting results in the academic literature discussed previously. Nevertheless, when splitting up our sample in a hot-issue subsample and a cold- and neutral-issue subsample, and running the original OCI regression from hypothesis 1, we find that there is a significant difference between the two samples. Table 6 Panel B shows that the VC-backing dummy loses its significant effect on OCI in the hot-issue sample, while Table 7 Panel B shows that in the cold- and neutral-issue sample, the significance of its effect increases from the 5% level to the 1% level.

Table 6 Regression Hypothesis 2b: VC certification in hot-issue markets

Panel A: Regression Description

This table presents OLS regression results for abnormal initial returns, true cost of issuance, and underwriter rank as follows:

$$\text{Dependent} = \alpha + \beta_1 \text{VC_backed} + \beta_2 \text{Offered_stake} + \beta_3 \text{LnTurnover} + \beta_4 \text{LnAge} + \beta_5 \text{Tech} + \beta_6 \text{Underwriter_rank} + \varepsilon$$

where:

Dependent = dependent variable, either underpricing (Abnormal return), true cost of issuance (OCI), or underwriter_rank (Underwriter_rank)

VC_backed = dummy variable equal to 1 if the issue is backed by a venture capitalist, zero otherwise

Offered_stake = percentage of the issuing firm's equity that is offered

LnTurnover = natural logarithm of 1 plus the issuing firm's turnover

LnAge = natural logarithm of 1 plus the age of the issuing firm at IPO date.

Tech = dummy variable equal to 1 if the issuing firm is classified as a technology firm, zero otherwise, based on Loughran & Ritter (2004)

Underwriter_rank = score assigned to the lead underwriter of the IPO, based on Migliorati & Vismara (2014) and Corwin & Schultz (2005)*

*when regressing on underwriter ranking, this variable is omitted as independent variable

Data is from the Zephyr, Amadeus, Datastream and Eikon databases for the 2002 to 2015 period.

Panel B: Regression Results

Indep. Variable	Abnormal_return		OCI		Underwriter_rank	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
<i>Intercept</i>	0,136	2,32**	0,134	2,29**	0,220	1,80
<i>VC_backed (=1)</i>	0,002	0,08	0,004	0,19	0,126	2,84***
<i>Offered_stake</i>	-0,086	-1,61	0,018	0,35	-0,307	-2,78***
<i>LnTurnover</i>	0,000	-0,09	-0,007	-2,06**	0,015	2,12**
<i>LnAge</i>	-0,015	-1,54	0,006	0,60	0,036	1,81
<i>Tech (=1)</i>	0,007	0,31	-0,048	-2,11**	-0,095	-1,99**
<i>Underwriter_rank</i>	0,020	0,64	-0,016	-0,51	/	/
<i>N° of obs</i>	231		231		231	
<i>F (5, 224)</i>	1,43		0,52		6,70***	
<i>Adj. R²</i>	0,0014		0,0087		0,0940	

* significant at the 10% level

** significant at the 5% level

*** significant at the 1% level

Table 7 Regression Hypothesis 2c: VC certification in neutral- and cold-issue markets

Panel A: Regression Description

This table presents OLS regression results for abnormal initial returns, true cost of issuance, and underwriter rank as follows:

$$Dependent = \alpha + \beta_1 VC_backed + \beta_2 Offered_stake + \beta_3 LnTurnover + \beta_4 LnAge + \beta_5 Tech + \beta_6 Underwriter_rank * + \varepsilon$$

where:

Dependent = dependent variable, either underpricing (Abnormal return), true cost of issuance (OCI), or underwriter_rank (Underwriter_rank)

VC_backed = dummy variable equal to 1 if the issue is backed by a venture capitalist, zero otherwise

Offered_stake = percentage of the issuing firm's equity that is offered

LnTurnover = natural logarithm of 1 plus the issuing firm's turnover

LnAge = natural logarithm of 1 plus the age of the issuing firm at IPO date.

Tech = dummy variable equal to 1 if the issuing firm is classified as a technology firm, zero otherwise, based on Loughran & Ritter (2004)

Underwriter_rank = score assigned to the lead underwriter of the IPO, based on Migliorati & Vismara (2014) and Corwin & Schultz (2005)*

*when regressing on underwriter ranking, this variable is omitted as independent variable

Data is from the Zephyr, Amadeus, Datastream and Eikon databases for the 2002 to 2015 period.

Panel B: Regression Results

Indep. Variable	Abnormal_return		OCI		Underwriter_rank	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
<i>Intercept</i>	0,031	0,76	0,000	0,01	0,183	2,39**
<i>VC_backed (=1)</i>	-0,016	-0,88	-0,048	-2,60***	0,045	1,35
<i>Offered_stake</i>	0,017	0,47	0,392	10,60***	0,058	0,87
<i>LnTurnover</i>	0,002	0,93	-0,004	-1,74	0,010	2,15**
<i>LnAge</i>	-0,004	-0,51	0,000	0,01	0,021	1,45
<i>Tech (=1)</i>	-0,010	-0,55	-0,035	-1,93	0,024	0,72
<i>Underwriter_rank</i>	-0,019	-0,71	-0,027	-1,00	/	/
<i>N° of obs</i>	420		420		420	
<i>F (6, 413)</i>	0,51		4,46***		3,04**	
<i>Adj. R²</i>	-0,0076		0,2187		0,2698	

* significant at the 10% level

** significant at the 5% level

*** significant at the 1% level

Also, for the hot-issue sample, the F-statistic and R-squared of the OCI regression drop to an insignificant value, while in the cold- and neutral-issue sample, the F-statistic remains highly significant and the R-squared surges from 13% to around 22%. This means that, during hot-issue markets, VC-backed IPOs appear to be no longer associated with lower OCI than non-VC-backed IPOs. In contrast, during neutral- and cold-issue markets, the opposite is true. This confirms our hypothesis that during hot-issue markets, VCs give up on their certification role. Again, this result is in line with Dolvin (2005), although he also finds VC-backed IPOs to have a significantly higher OCI than non-VC-backed IPOs in hot-issue markets.

Third, market cyclicity does not seem to reduce VC certification in the form of attracting more prestigious underwriters to VC-backed IPOs. The hot-issue dummy (*Hot_issue*) is insignificant when adding it to our original regression. However, when running our original regression on both split samples, we do obtain a surprising result. It appears that VC-certification in the form of attracting higher-quality underwriters occurs mainly during hot-issue periods, and occurs less during cold- or neutral-issue periods. We derive this from the observation that in the hot-issue sample, VC-backing appears to significantly increase the ranking of the lead underwriter, as can be seen in Table 6 Panel B, while in the neutral- and cold-issue sample, it appears to have no effect, as can be seen in Table 7 Panel B. Then again, in the hot-issue sample, our model appears to explain only around 9% of the variance in underwriter ranking, while in the neutral- and cold-issue sample, the adjusted R-squared is around 27%. The F-statistic remains significant in both samples.

Robustness checks

We perform several robustness checks in order to validate our results.

First of all, we re-run our regressions on a sample excluding the observations for which we make use of closing prices extracted from Datastream, to calculate the initial abnormal return

and the OCI. This leaves us with a sample of 515 observations. As we noticed a higher variation in initial returns calculated with Datastream closing prices, this could perhaps affect our results. However, it appears that this is not the case, as our results remain more or less the same for this sample. The only substantial change is that the adjusted R^2 of our regression to test hypothesis 1 in terms of OCI, thus without the hot-issue dummy, increases from 17% to 20%. On the other hand, for our hypothesis 1 regression on underwriter quality, the *VC_backed* dummy and *Offered_stake* go from being significant at the 5% and 1% level, respectively, to being significant at the 10% and 5% level.

In a similar fashion, we re-run our regressions while excluding the observations from our original sample for which we constructed the underwriter-rank variable based on the sample of Corwin and Schultz (2005). As described in Section IV, we supplemented the Migliorati and Vismara (2014) rank for large international U.S.-based underwriters. In order to control if this operation does not distort our results, we exclude these observations from our sample. This leaves us with 605 entries. All of our previous results continue to hold after this operation.

Next, we substitute the proxy that we used for firm size, turnover, by another measure: the pre-IPO number of employees. Again, this hardly changes our results. As a proxy for firm size, the number of employees appears to have the same negative effect on the OCI as the turnover, although it is only significant at the 10%. As for the rest, our results stay exactly the same.

Further, we perform the same regression analyses for a sample excluding low-priced (penny) stocks. We therefore exclude all stocks with an offer price below €3. Bradley et al. (2004) show that these stocks are more information problematic and Dolvin (2005) argues that, therefore, VC certification should therefore more strongly manifest itself in penny stock IPOs. By excluding penny stocks, we test whether the support that we find for VC certification in

our total sample, is not only due to penny stock certification. After re-running our regressions using the subsample of 472 non-penny-stock observations, the results confirm these suspicions. Our results stay generally the same, but, as expected, the VC-backing dummy loses its significance for the OCI as dependent variable. This suggests that the VC-certification that we find in our full sample is primarily due to penny stock certification. Moreover, the adj. R^2 of the regression on the OCI, to test for hypothesis 1, decreases from 13% to 5%.

For completeness, we also repeat our analysis on the opposite sample: a sample consisting exclusively of penny stocks. We expect a stronger certification effect than in the full sample, as is suggested by Dolvin (2005). For a sample of 179 penny stock observations, our model yields results in line with what we expected. The significance of the VC-backed dummy in the OCI regression increases and, in addition, the adjusted R^2 of our model surges to 40%. This confirms that VC certification manifests itself more strongly among penny stock IPOs. Besides this finding, the regression on underwriter quality loses significance for penny stocks. This can be attributable to the fact that penny stocks are often smaller firms. In our regression to examine VC certification in underwriter reputation according to our first hypothesis, the proxy for size was strongly significant. Penny stocks are usually smaller firms and, therefore, probably backed less often by high quality underwriters. This result may also have to do with the dramatic decrease in the number of observations. Conclusively, these results confirm the finding of Bradley (2004) and Dolvin (2005) that VC certification is particularly present in penny stock IPOs.

Finally, we check our regressions for heteroscedasticity. One of the assumptions of the OLS regression model is that the variance of the error term is constant and independent. In other words, the error terms are assumed to be homoscedastic. However, the outcome of a Breusch-Pagan/ Cook–Weisberg test on our regressions shows that heteroscedasticity is present in our

sample. This indicates that the assumption of constant and independent error term variance is violated. Although this does not result in biased parameter estimates, this can cause standard errors to be biased and, thus, influence the t-statistics and significance of the estimates. In order to relax this assumption, we specify that our regressions use robust standard errors. This does not change the estimated coefficients, but it should provide us with more correct significance tests. After running our regressions including this specification, the VC-backed dummy in our OCI regressions, to test for both hypotheses, goes from being significant at the 5% level, to being significant at the 10% level. The significance of our other variable estimates remains unchanged. So, although our main variable loses some of its significance, our results still hold after this test.

We conclude that, after checking for robustness, our results mostly hold, but specifically that VC certification, which manifests itself in a negative effect on the OCI, is primarily due to penny-stock certification.

VI. Conclusions

Previous studies on the impact of venture-capital backing in IPOs find mixed and often conflicting results with regards to venture-capital certification. Moreover, hardly any of these studies investigate a sample of European IPOs. Therefore, we examine a set of 651 IPOs from 21 different European countries between 2002 and 2015 in order to test for different forms of venture-capital certification. Furthermore, we investigate whether this certification role changes according to market cyclicity. Concretely, we examine if VCs give up on their certification roles during hot-issue markets or not.

First, we assess venture-capital certification by implementing the traditional methodology and using IPO underpricing, proxied by abnormal initial return, as a measure of the cost of issuance. We find no evidence in favor of the venture-capital certification theory in lowering IPO underpricing.

It seems that, as is suggested by the inconsistency in the findings of previous studies, IPO underpricing is not the right measure for a firm's indirect cost of issuance when going public. Dolvin (2005) claims that, instead, VC certification should be apparent in the true cost of issuance (OCI). OCI is an underlying component of IPO underpricing which isolates the effect of share retention by insiders during an IPO, and is a more correct measure for the indirect cost of issuance that a firm incurs to compensate outside investors for information asymmetries. We test whether venture-capital certification results in lower true costs of issuance, and we find results that support this notion. However, when checking for robustness, it appears that this finding is primarily driven by the certification of penny stock IPOs in our sample. This result is in line with the findings of Dolvin (2005).

Third, we examine a last form of VC certification. Based on findings of Megginson & Weiss (1991) and Barry et al. (1990), who suggest that VC-backed firms are generally taken public

by higher-quality underwriters than non-VC-backed IPOs, we test the hypothesis that this holds true in Europe during our sample period. Our findings support the certification hypothesis, as VC backing appears to increase an issuing firm's ability to engage the services of a more prestigious underwriter. This result is in line with previous studies (Barry et al., 1991).

Lastly, we examine whether VC certification is influenced by market cyclicity. Rossetto (2008) suggests that VCs give up on their certifying role in hot-issue markets and that, in such periods, VC-backed IPOs are even more underpriced than non-VC-backed IPOs. We find limited support for this. During a hot-issue market, VCs are no longer associated with lower OCI. In contrast, it appears that VC certification in the form of underwriter prestige primarily manifests itself during hot-issue markets and less so during neutral- or cold-issue markets. Market cyclicity therefore seems to have opposite effects on lowering the cost of issuance and attracting higher-prestige underwriters.

Appendix A. Technology Firms

Tech stocks are defined as those in SIC codes 3571, 3572, 3575, 3577, 3578 (computer hardware), 3661, 3663, 3669 (communications equipment), 3671, 3672, 3674, 3675, 3677, 678, 3679 (electronics), 3812 (navigation equipment), 3823, 3825, 3826, 3827, 3829 (measuring and controlling devices), 3841, 3845 (medical instruments), 4812, 4813 (telephone equipment), 4899 (communications services), and 7371, 7372, 7373, 7374, 7375, 378, and 7379 (software). Loughran & Ritter (2004)

VII.References

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